

MANAGING URBAN STORMWATER



Soils and Construction

Volume 2A Installation of services

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Department of **Environment & Climate Change** NSW



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Contents

	Acknowledgments	iv
1	Introduction	1
2	Statutory requirements	5
3	Project planning	9
4	Erosion and sediment control plans	15
5	Erosion and sediment control measures	19
6	Managing erosion and sediment control	23
7	Site restoration and rehabilitation	37
	Bibliography	40
	Appendices	41
	Appendix A: Sample erosion and sediment control plan – small project	42
	Appendix B: Sample erosion and sediment control plan – large project	44
	Appendix C: Selection of control measures	51

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Photography credits:

Contents opener	Temporary installation of hay bales during trenching work in street T Marony/Rockdale City Council
Section 1 opener	Installing stormwater pit connection T Marony/Rockdale City Council
Section 2 opener	Rock breaker excavating trench for service installation T Marony/Rockdale City Council
Section 3 opener	Project planning at Hornsby Council K Walters/DECC
Section 5 opener	Soil stabilisation on steep bank using sandbags T Marony/Rockdale City Council
Section 6 opener	Installing seepage collar in trench T Marony/Rockdale City Council
Section 7 opener	Staged regeneration of coastal bushland following service installation T Marony/Rockdale City Council



1. Introduction

1.1	Service installation projects	2
1.2	Purpose and scope	2
1.3	Structure of this document	3
1.4	Characteristics of service installations	3
1.5	Management principles	3

1.1 Service installation projects

Service installation projects include activities such as laying of pipelines for water, stormwater, sewerage or gas, the construction of power lines, and similar projects. They can vary significantly in their scale, location and construction technique. Proper planning and installation of erosion and sediment control measures is required to ensure that the land disturbance associated with such projects does not lead to significant detrimental impacts on the surrounding environment. This principle holds for all such work regardless of whether it is undertaken in urban, rural or bushland locations.

1.2 Purpose and scope

The purpose of this document is to provide guidelines, principles and recommended design standards for managing erosion and sediment control during service installation. The target audience for this document is anyone involved in the planning, design, approval and construction of service installation projects including officers from local government, state government agencies, utilities, consulting firms, contractors, etc.

This document guides the user in applying the principles and practices of erosion and sediment control described in volume 1 of *Managing urban stormwater: soils and construction* (Landcom 2004) to service installation projects. It should therefore be read and used in conjunction with volume 1. While some of the key elements of volume 1 are outlined in this document, the reader will need to access the background information and technical detail provided in volume 1.

Throughout this report, cross-references to *Managing urban stormwater: soils and construction* vol. 1 (Landcom 2004) are shown in bold, for example, see **1**: section 5.3. Similarly, references to *Managing urban stormwater: soils and construction* vol. 2 (DECC 2007) are shown as, for example, **2**: C *Unsealed roads*.

While this document focuses primarily upon the installation of new services, many of the techniques discussed are equally applicable to the repair or upgrade of existing services.

This document does not address broader environmental issues associated with service installation projects such as impacts on flora and fauna. Many of these will depend on the route selected for the service, and should therefore be identified and assessed in the project planning and environmental assessment phase.

1.3 Structure of this document

Section 2 summarises the statutory requirements that apply to erosion and sediment control aspects of service installation projects in New South Wales

Section 3 discusses the planning considerations for erosion and sediment control during service installation projects

Section 4 describes the preparation of erosion and sediment control plans for service installation projects

Section 5 notes applicable erosion and sediment control measures

Section 6 discusses managing erosion and sediment control during service installation projects

Section 7 outlines restoration and rehabilitation considerations for service installation

Appendices contain sample erosion and sediment control plans for small and large service installation projects.

1.4 Characteristics of service installations

There are a number of key characteristics of service installation projects in New South Wales that can influence the planning, construction, and maintenance of associated erosion and sediment control measures. These projects are often:

- linear in nature
- variable in length, from metres through to many kilometres
- confined to a limited width or easement
- routed across a variety of topography and soil types
- required to cross streams or other water bodies, involving special treatment such as boring, bridging, or temporary stream diversions
- associated with other construction activities, including roadworks.

Services can be installed underground or above-ground. Typical techniques for underground service installations include:

- conventional open cut trenching
- auger boring
- slurry boring
- pipe jacking
- horizontal directional drilling
- microtunnelling
- tunnelling.

Alternatively, service installations can be above-ground, with infrastructure (e.g. pipelines) supported on raised pedestals, gantry structures or other forms of structural supports that require additional ground works to be constructed.

In addition to the service installation, whether underground or above-ground, other surface works are typically required for ongoing operation, access and maintenance activities. Such works include minor buildings, other structures and access roads.

1.5 Management principles

There are seven general principles of effective soil and water management for land disturbance associated with urban development (see **1**: section 1.6). The principles broadly apply to the planning, design and construction of service installation projects and can be paraphrased as:

- 1 assess the soil and water implications of a project at the planning stage
- 2 plan for erosion and sediment control and assess site constraints during the design phase and before any earthworks begin
- 3 minimise the area of soil disturbed and exposed to erosion

- 4 conserve topsoil for later site rehabilitation/regeneration
- 5 control water flows from the top of and through the project area – divert up-slope 'clean' water away from disturbed areas and ensure concentrated flows are below erosive levels
- 6 rehabilitate disturbed lands quickly
- 7 maintain erosion and control measures appropriately.

These principles provide a framework for applying the specific erosion and sediment control practices described in this document.



2. Statutory requirements

2.1	Consultation requirements	6
2.2	Relevant legislation	6

2.1 Consultation requirements

A number of state and local regulatory authorities may need to be consulted during the planning process to ensure activities associated with service installation are undertaken in accordance with all necessary statutory requirements relating to erosion and sediment control. These agencies may also need to be consulted during the preparation of various plans such as erosion and sediment control plans (ESCPs).

2.2 Relevant legislation

The requirements of a number of pieces of legislation may need to be considered in the planning and design stages of a service installation project, within the development assessment framework and provisions of the *Environmental Planning and Assessment Act 1979*. This section, however, focuses on the main pieces of legislation that relate specifically to erosion and sediment control during service installation projects and which may also have broader applicability to the project. These are the:

- *Protection of the Environment Operations Act 1997*
- *Rivers and Foreshores Improvement Act 1948*
- *Fisheries Management Act 1984*.

Other Acts that may need to be considered during project planning, and which may indirectly influence aspects of erosion and sediment control (e.g. through route selection) are listed below, but are not discussed in any detail in this document:

- *National Parks and Wildlife Act 1974*
- *Native Vegetation Act 2003*
- *Roads Act 1993*
- *Soil Conservation Act 1938*.
- *Threatened Species Conservation Act 1995*
- *Water Management Act 2000*.

For a more detailed description of relevant legislation see 1: appendix K.

The information below was current at the time of publication. However, statutory requirements and the roles of government agencies can change over time – proponents should check that this information is current during the planning stage of their project.

Protection of the Environment Operations Act 1997

The Department of Environment and Climate Change NSW (DECC) is the regulatory authority for:

- activities listed in schedule 1 of the *Protection of the Environment Operations Act 1997* (POEO Act)
- activities carried on by a state or public authority
- other activities in relation to which a licence regulating water pollution is issued.

Local councils are the regulatory authority under this Act for other activities (see DEC 2006a).

Section 120 of the POEO Act prohibits water pollution, except in accordance with the provisions on an environment protection licence issued under the Act. Proponents undertaking a large-scale service installation project that has the potential to pollute waterways should consider applying to DECC for an environment protection licence before undertaking the work.

Rivers and Foreshores Improvement Act 1948

Activities associated with the installation of services that require a permit under the *Rivers and Foreshores Improvement Act 1948* include any that have the potential to:

- result in the excavation or removal of material from the bank, shoreline or bed of any river, lake, coastal lake, lagoon or land within 40 metres from the top of the bank or shore of any water body, or
- obstruct the flow of water in a river, lake, coastal lake or lagoon.

The Department of Water and Energy (DWE) and NSW Maritime administer this Act. Approval requirements under the Act are scheduled to be replaced in 2007 by new provisions under the *Water Management Act 2000*.

Fisheries Management Act 1994

The NSW Department of Primary Industries (DPI) is responsible for the administration of the *Fisheries Management Act 1994*. This Act provides a comprehensive framework for the sustainable management of fish resources. The former NSW Fisheries has been incorporated into the NSW DPI.

This Act requires a permit for any activity associated with the installation of services that:

- involves dredging or reclamation works
- has the potential to block the passage of fish
- has the potential to harm marine vegetation.

The following publications provide further guidance on the requirements of this Act:

- *Policy and guidelines – aquatic habitat management and fish conservation* (NSW Fisheries 1999)
- *Policy and guidelines for fish-friendly waterway crossings* (NSW Fisheries 2003).



3. Project planning

3.1	Introduction	10
3.2	Developing systems for documentation and communication	10
3.3	Assessing constraints and opportunities	11
3.3.1	Site/route selection	11
3.3.2	Site assessment	11
3.3.3	Other environmental considerations	12
3.4	Site restoration and remediation	13
3.5	Other planning considerations	13
3.5.1	Combined infrastructure developments	13
3.5.2	Occupational health and safety	13
3.5.3	Traffic control plan	13

3.1 Introduction

The planning procedure outlined below and the planning activities presented in the following sections should be systematically addressed to minimise the effect that service installations may have on the surrounding environment through soil erosion and sedimentation. These activities include:

- developing systems for documentation and communication
- assessing constraints and opportunities
- preparing an ESCP (dealt with in more detail in section 4)
- restoring and remediating sites
- other planning considerations.

3.2 Developing systems for documentation and communication

All personnel involved with a project should be made aware of their specific responsibilities to ensure proper environmental management and care. Responsibility for this awareness ultimately lies with the project principal (the organisation on whose behalf the work is being undertaken). This requires the principal to plan, implement and control the systems that will facilitate the management of the environmental aspects of the project. To this end, ESCPs should be developed in consideration of the project's overall environmental objectives. ESCPs would normally be detailed within the principal or contractor's environmental management system (EMS) and presented as part of a construction environmental management plan (CEMP).

The primary purpose of a CEMP is to describe how a contractor will manage and control the environmental aspects of the project. It helps all personnel associated with the project meet their obligations and ensure that the client achieves the environmental objectives and targets of the project.

The CEMP should interface with other plans, such as the project quality plan, any site environmental management plan, construction plan, occupation health and safety (OH&S) plan, community involvement plan, etc. It should describe the overall project management system and expand on the environmental section of the project business plan. This enables the CEMP to be tailored to suit the specific needs of the project.

The CEMP is a manual for all the relevant site personnel including the superintendent, construction managers, foreman and subcontractors. It is a practical and living document that should cover all environmental aspects of activities associated with the project. It should be revised and updated as construction progresses to remain relevant to changing circumstances.

The CEMP should include at least the following key components:

- description of the principal or contractor's environmental management system
- CEMP objectives and targets
- risk assessment
- constraints
- roles, responsibilities and contact details
- environmental controls
- monitoring and compliance.

These components set the scene for documentation and communication within the project because they identify the aims, actions and outcomes needed to meet the project's environmental objectives.

Of these components, the requirements for monitoring and compliance warrant special mention. It is important that the project principal or their representative conduct regular audits or inspections of compliance with environmental conditions. They should also ensure that incentives for rapid completion of the project do not promote environmentally harmful practices. This could mean penalising contractors for poor environmental performance.

The CEMP provides direction for implementing and ongoing monitoring of environmental controls for the development of the project and should demonstrate the conformance of a contractor's EMS with several relevant standards and guidelines, including the following:

- AS/NZS ISO 14001: 2004. *Environmental management systems – requirements and guidance for use*
- NSW Construction Policy Steering Committee *Environmental management systems guidelines*, 1998 (for NSW Government projects).

For guidance on the preparation of ESCPs that may form part of the CEMP, see section 4.

3.3 Assessing constraints and opportunities

The assessment of constraints and opportunities for the proposed work and associated environmental protection measures influences several stages of planning:

- site/route selection
- site assessment
- other environmental considerations.

3.3.1 Site/route selection

This document does not provide direct guidance for selecting the route of the service installation but assumes that the approximate route has already been selected by assessing the landscape and related constraints and opportunities. Carefully choosing the easement route to avoid sensitive environments and areas of high erosion hazard is a key element in minimising environmental degradation.

Opportunities may be identified in the detailed planning process for minor route alterations that avoid areas that are environmentally sensitive or that have high constraints. If high-risk areas cannot be avoided, then appropriate control measures should be implemented to mitigate any adverse environmental impact, and sensitive areas should be marked in the field (by flagging, taping etc.) so that all parties understand the need for caution when working nearby.

Where possible, erosion and sediment control measures should also be determined and positioned to avoid areas of high environmental value and minimise any adverse impact on the surrounding environment.

3.3.2 Site assessment

During the design phase, the site or area of the proposed work should be investigated and inspected to identify and assess opportunities and constraints that could influence the adoption of suitable erosion and sedimentation control measures. This process

should be undertaken early in the development of the project to identify and plan for any potential adverse impacts that the project might have on the environment.

Site characteristics and constraints that should be investigated and evaluated in the development of erosion and sediment control strategies include:

- existing exposed areas or likely areas of soil disturbance
- existing vegetation
- site topography (slopes and contours)
- location of existing or potential drainage lines and waterways, and associated waterfront (riparian) lands
- soil constraints, such as erodibility, erosion hazard, dispersibility, texture, soil pH, salinity, shallow soil depth, low soil fertility, areas susceptible to tunnel erosion, expansive or reactive soils
- landscape constraints, such as mass movement, flood hazard, water logging, high watertable and rock outcrops
- rainfall erosivity and runoff coefficient
- acid sulfate and contaminated soils
- opportunities to repair previous or existing areas of land degradation
- disposal of surplus excavated material.

Tunnel erosion is particularly significant in relation to underground service installations. Charman and Murphy (2000) provide guidance on determining the susceptibility and management requirements of soils in relation to this form of erosion.

For further information see 1: section 3, which describes DECC's soil landscape maps and reports. These reports and maps provide comprehensive detail on the constraints over much of eastern and central NSW.

3.3.3 Other environmental considerations

Besides the key site characteristics and constraints identified above, the selection of appropriate erosion and sediment control measures should also be considered to limit (or prevent) an adverse effect on the existing environment.

The nature of the environment in sensitive areas can limit the measures that can be used for erosion and sediment control. Disturbance to existing vegetation should be minimised when installing controls, especially along watercourses, on highly erosive lands and in high-conservation-value areas.

Where native animals are likely to occur, the soil and water management measures should be selected to reduce possible adverse effects on them. For example, controls should be placed so they do not significantly impede animal movements – silt fences may restrict the passage of small mammals and reptiles. Hay bales may be unsatisfactory because some animals may see the bales as a food source and therefore damage the control measure. Hay may also introduce non-native seeds into areas of native vegetation. However, these problems are less likely if straw bales are used instead.

3.4 Site restoration and remediation

The planning process should consider what site restoration and remediation work will be required following the installation or maintenance activity. Site restoration and remediation should be undertaken continually during construction or during suitable stages of the completed works. See section 6 of this document for further details.

3.5 Other planning considerations

3.5.1 Combined infrastructure developments

Project planning should consider any effects from activities on land adjoining the area affected by the service installation works. Where possible an ESCP may include both lots of works. It is advisable to check with the stakeholders responsible for the adjoining works to identify how the service installation work has been considered by their plans.

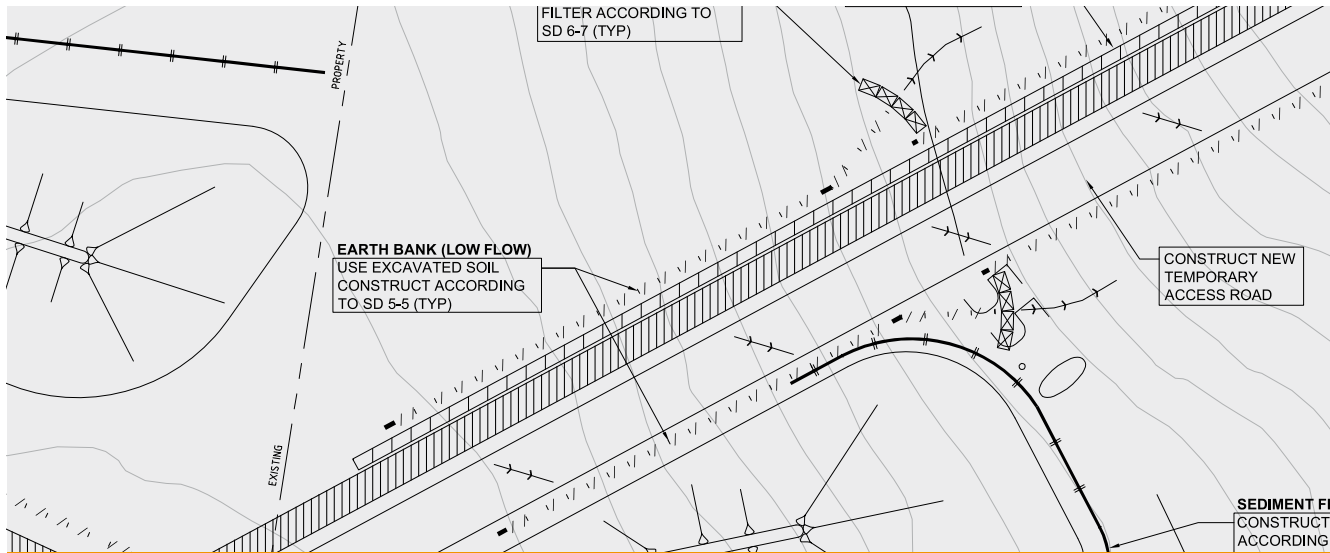
3.5.2 Occupational health and safety

Workplace health and safety should be considered when preparing an ESCP. Work practices or installations should be incorporated into the site risk assessment undertaken before installation. All construction work should be undertaken following the requirements of WorkCover NSW, and the *Occupational Health and Safety Act 2000*, and associated Regulations.

3.5.3 Traffic control plan

Many service installations occur on or near public roads, which brings a risk of injury to workers and/or the public, and potential damage to plant. Traffic control measures should conform to applicable Roads and Traffic Authority (RTA) and local council requirements (e.g. AS 1742.3: 2002 *Manual of uniform traffic control devices: traffic control devices for works on roads*.)

Traffic control plans developed for the project should be considered when preparing an ESCP. If no plan exists, then a separate plan may be required specifically for the installation and maintenance of the erosion and sediment control measures. The RTA or local council should be contacted where necessary before undertaking any works within the road reserve.



4. Erosion and sediment control plans

4.1 Requirement for plans	16
4.2 Recommended content of ESCPs	16

4.1 Requirement for plans

Volume 1 of *Managing urban stormwater: soils and construction* specifies that an ESCP is required for small urban development projects where an area of 250–2500 m² will be disturbed, and a more detailed and broadly focused soil and water management plan is required (SWMP) where more than 2500 m² will be disturbed (see 1: section 2).

This two-tiered approach is not considered particularly suitable for erosion and sediment control planning for non-urban developments or activities, such as installing services or constructing roads. Therefore an ESCP should be prepared for *all* service installation projects where more than 250 m² will be disturbed, with the content and level of detail in the ESCP determined by the nature of the project, the site and the surrounding environment, as described in the following sections.

No formal plan is normally needed if less than 250 m² will be disturbed, unless the project is located on particularly hazardous lands (e.g. very steep slopes), or near particularly sensitive environments (e.g. a creek crossing). However, appropriate erosion and sediment control measures should be employed in all cases, and consent should be sought from the relevant authorities, where required.

4.2 Recommended content of ESCPs

Where required, an ESCP should be prepared and implemented for each section of the site before any work begins on that section. When preparing the ESCP, the site should be subdivided into sections based upon the separate catchment areas that will be affected by the work.

As detailed in 1: section 2.1, ESCPs should comprise both:

- one or more drawings or maps (typically 1:500 to 1:1000 scale) showing the layout and details of erosion and sediment control measures
- supporting commentary or construction notes containing explanatory text, calculations and diagrams as necessary.

Where applicable, the ESCP map should show the location of the following activities:

- access and haulage tracks
- stockpile and storage areas
- temporary work areas
- materials processing areas
- crossings (road and creeks)
- compound areas, such as the contractor's and the principal's facilities
- any other activities that might affect water quality.

The ESCP should be revised whenever the construction program, scope of work or work methods change, whenever the work methods and control structures are found to be ineffective, or if so directed by the relevant regulatory authority. It should describe all matters listed in 1: section 2.2 and table A.1 as appropriate.

For additional information on the preparation of ESCPs, see 1: section 2. Appendices A and B provide sample ESCPs for small and large-scale service installation projects, respectively.

Table 4.1 Checklist of issues to be considered when preparing an ESCP for a service installation project

Issue	Check
Locate site compounds, access tracks, stockpile sites and temporary work areas so that disturbed areas are minimised. Restrict operation and storage of construction equipment to these disturbed areas	
Stage work and programming of construction activities to minimise the extent and duration of disturbance to vegetation. This may include leaving the clearing and initial earthworks in or near watercourses until works are about to commence. Identify how the distance between the 'front end' of service installation works (clearing) and the 'back end' of works (respreading topsoil and revegetation) on the easement will be controlled	
Manage upstream 'run-on' water to protect disturbed areas during construction activities or land disturbance	
Install and stabilise or line temporary drains or diversion banks before earthworks begin	
Design and construct drainage paths to ensure that runoff from disturbed areas is directed to adequate sediment trapping/filtering control measures	
Retain grasses and small understorey species wherever possible to reduce soil erosion	
Protect haul roads and access tracks from erosion and scouring	
Control erosion during construction of embankments	
Construct batters in a manner to help retain topsoil on batter slopes	
Protect soil stockpiles from erosion by rain and surface flows	
Protect trenches from erosion by rain and surface flows	
Prevent the deposition of mud and litter on roadways around the site	
Size sediment basins appropriately for projects where they are needed	
Use appropriate work methods within or near waterways or other environmentally sensitive areas	
Manage water (including stormwater or groundwater flowing into trenches), wastewater and slurries produced during the project. Consider issues of collection, treatment, reuse and discharge	
Manage and monitor site discharges to protect downstream areas/waters	
Locate, design and install collars, trench stops etc. to prevent subsoil tunnel erosion	
Use effective methods for backfilling and compaction of soil materials in trenching projects	
Specify methods for undertaking and staging the topsoiling and revegetation of the site as work proceeds	
Reuse cleared vegetative matter to provide immediate erosion protection after backfilling/surface works are completed	
Record details of the inspection and maintenance program for all erosion and sediment controls	
Determine need for permanent erosion and sediment control measures for above-ground service installations, particularly for sites of high erosion hazard or environmental sensitivity. Inspect and maintain such controls periodically	



5. Erosion and sediment control measures

5.1	Background	20
5.2	Soil stabilisation	20
5.3	Water control	20
5.4	Sediment control	20

5.1 Background

Erosion and sediment control measures commonly employed during the installation of services are highlighted below, covering:

- soil stabilisation
- water control
- sediment control.

These measures, where relevant, should be incorporated into the ESCP. Volume 1 provides further details on their design, installation and maintenance. Appendix C contains guidance on selecting the appropriate measures.

5.2 Soil stabilisation

Potential methods of soil stabilisation are listed below:

- revegetation
- turf stabilisation
- seeding, broadcast or hydroseeding
- mulches
- biodegradable blankets
- synthetic polymer blankets
- soil binders.

For further information regarding these measures, see 1: appendix D.

5.3 Water control

Methods for controlling surface water runoff are:

- diversion/earthbanks (see 1: section 5.4.4)
- grassed and armoured waterways (see 1: section 5.3.3)
- permeable riprap waterways (see 1: section 5.4.4)
- impermeable (concrete-lined) waterways (see 1: section 5.4.4)
- temporary water crossings (see 1: section 5.3.4)
- check dams (see 1: section 5.4.3)
- outlet protection (energy dissipators) (see 1: section 5.4.5).

Table 5.1 lists recommended design criteria for temporary erosion and sediment control measures having a design life of less than six months including applicable average recurrence intervals (ARI) for drainage design.

5.4 Sediment control

Methods for sediment control are listed below:

- grass filter strips (see 1: section 6.3.8)
- sediment filter fencing (see 1: section 6.3.7)
- turf strips (see 1: section 6.3.8)
- gravel inlet filters (see 1: section 6.3.7)
- sediment retention basins (see 1: section 6.3.3).

Further information on these is provided in volume 1 (Landcom 2004).

Volume 1 (section 6.3.2) states that the construction of a sediment basin is unlikely to be necessary if the estimated annual soil loss is less than 150 m³ from the disturbed sub-catchment. It is envisaged that the long, narrow footprint of most service installation projects will mean that few warrant the construction of one or more sediment retention basins. However, it is recommended that projects disturbing more than 2500 m² of land within a specific sub-catchment (of a potential basin site) should include an assessment of the need for a basin, using the revised universal soil loss equation (see 1: appendix A). The environmental implications of sediment basins should, however, be considered before they are constructed, especially in areas of high environmental sensitivity, where the plan may need to consider other means of retaining sediment (see 1: section 4.4.2).

Table 5.1 Minimum design storms for temporary erosion and sediment control measures (with design life up to 6 months)

Control measure	Minimum design storm event – average recurrence interval (ARI)	
	Standard design	Sensitive environment ¹
Temporary drainage (erosion) controls		
(e.g. diversion banks, perimeter banks, catch drains, level spreaders, check dams, batter drains and chutes) should be designed to have a non-erosive hydraulic capacity (excluding freeboard) sufficient to convey the nominated design storm event	2-year ARI	5-year ARI
Temporary sediment controls		
(e.g. sediment fences, stacked rock sediment traps etc.) in small catchments where used as a 'last line of defence' (no sediment basin down-slope) should be constructed to remain structurally sound in the nominated design storm event	2-year ARI	5-year ARI
Type C sediment retention basins		
Designed to achieve required water quality for flows up to:	0.5 x 1-year ARI	1-year ARI
Embankment and spillway	10-year ARI	20-year ARI
Type D or F sediment retention basins		
Basin volume based on nominated percentile rainfall depth for 5-day duration ² storm:	75 th percentile	80 th percentile
Embankment and spillway	10-year ARI	20-year ARI

1 A 'sensitive environment' is one with a high conservation value, or that supports human uses of water that are particularly sensitive to degraded water quality.

2 Storm duration can be modified for different management regimes – see 1: section 6.3.4.



6. Managing erosion and sediment control

6.1	Environmental management of sites	24
6.2	Trenching	24
6.2.1	Trenches running across grade	25
6.2.2	Trenches running down grade	25
6.2.3	Trenches running obliquely across grade	27
6.3	Stream or water crossings	27
6.4	Soil and stockpile management	29
6.5	Work areas and building platforms	32
6.6	Access roads	32
6.7	Managing dry-weather discharges	32
6.7.1	Overview	32
6.7.2	Management strategies	33
6.8	Disposal of water from pipe flushing or pressure testing	35

6.1 Environmental management of sites

The contractor carrying out the service installation is directly responsible for ensuring that measures are effective in preventing sediment from leaving the site. The method of service installation will dictate the type and magnitude of the erosion and sediment control measures required.

Erosion and sediment control measures should be installed before work begins to prevent erosion and effectively intercept sediment migration. Section 5 identifies some relevant control techniques for service installations.

Good site management is needed during construction, with 'cleaning as you go' to help ensure that roadways are free of sediment, and sites are secured and tidy. The erosion and sediment control measures should be inspected and maintained regularly to ensure that they are working effectively, especially after each storm event.

Additional control measures should be implemented for the service installation activities listed below, and these measures are described in the following paragraphs.

- trenching – across, down and obliquely to grade
- stream or water crossings
- soil and stockpile management
- water extraction
- work areas and building platforms
- access roads
- pollution control
- disposal of water from pipe flushing or pressure testing.

6.2 Trenching

Trenches should be constructed so that they are adequately protected from erosion. This can be achieved by undertaking the following:

- avoid trenching in areas where water flow is likely to concentrate. Alternatively, schedule work during periods when rainfall erosivity is low (see 1: table 6.2)
- ensure trench widths and depths are the minimum necessary. Limiting the width of the disturbed area within the easement is an important management tool, particularly in sensitive environments
- divert surface water away from trench openings
- use sandbags as plugs or bulkheads across trench inverts to shorten the length of sediment-laden water flow in the trench
- leave excavations open for the minimum practical time (try to limit the time trenches are left open to fewer than three days). Avoid opening trenches whenever the risks of storms are high
- organise service installations to enable progressive backfilling
- ensure plugs, collars or trench stops are employed to control tunnel erosion after backfilling is completed. Proper seepage collars or clay/bentonite plugs may be necessary in highly erodible soils
- provide an appropriate allowance for settling of uncompacted backfill material (e.g. 10%)
- after backfilling, remove excess or unsuitable spoil from the site. Then, replace topsoil and vegetate to match surrounding ground levels and vegetation species as soon as possible.

Installing diversion banks (also referred to as cross berms) diagonally across the easement is a key element of erosion control for linear service installations. The banks need to be spaced according to:

- the erodibility of the soils
- the slope of the land
- local rainfall erosivity.

The spacing of berms according to slope is particularly important on down grades.

Cross banks need to discharge away from the disturbed area of the easement into a stabilised area or sedimentation measure. Successive banks down a slope should be designed and constructed to ensure that a bank does not capture the discharge from the previous bank, which would otherwise can lead to a concentration of flows, the failure of down-slope banks and significant erosion and sediment pollution. Figure 6.1 shows important aspects of erosion and sediment control during trenching.

Environment ACT (1998) specifies that different measures need to be considered for trenches running:

- across grade
- down grade
- obliquely across grade.

6.2.1 Trenches running across grade

Where the trench runs parallel with the surrounding contours (that is across grade), heaped soil from the excavation should be placed and compacted on the uphill side of the trench to form an earth bank. This bank aims to prevent polluted stormwater from accumulating by directing water around and away from the open trench.

The earth banks should be placed and formed so that they effectively act as a catch drain or mitre drain and do not trap pools of water at their bases, nor cause erosion at their outlets. Their construction should consider soil erodibility, catchment area and resulting runoff, and discharge onto stable lands.

For more information on the construction of mitre drains, see **2: C Unsealed roads**.

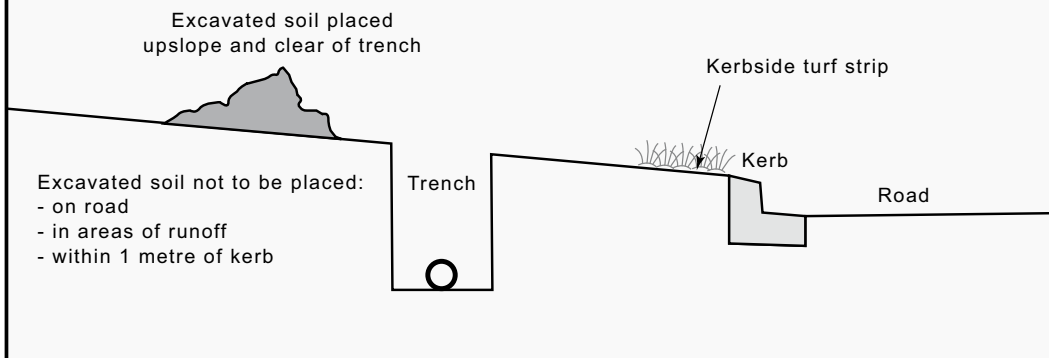
6.2.2 Trenches running down grade

Where the trench runs perpendicular to the surrounding contours (up or down grade), adequate measures should be taken to capture any sediment-laden waters downstream. Depending on the size of the installation this may be as simple as a silt fence erected on the downstream side, or more elaborate such as trench stops.

A trench stop is essentially a weir constructed transversely to the direction of the trench to reduce flow lengths, velocities and sediment-laden water. Where trench stops are required, they should be installed so that the top of the downstream trench stop is no lower than the preceding base of the upstream trench stop (figure 6.2).

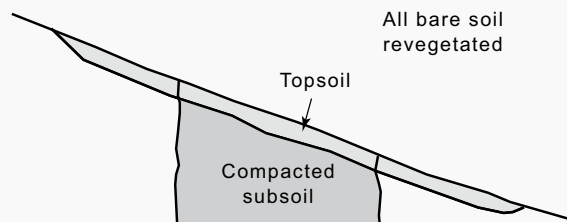
Sandbags may be used as plugs, bulkheads or trench stops across the trench invert, except on highly erodible soils, where proper seepage collars (figure 6.3), clay plugs etc. may be more suitable.

When excavating trench...

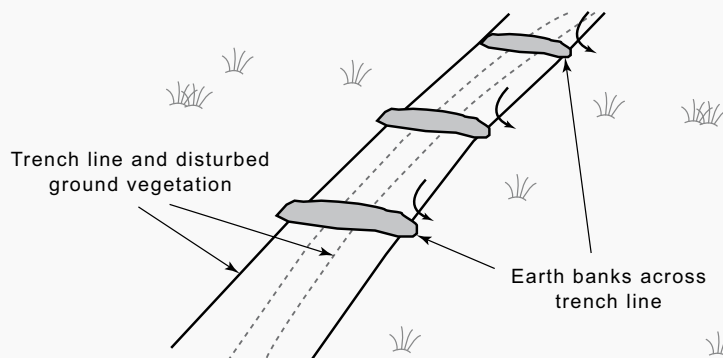


When backfilling trench...

Trench backfilled, compacted to 95 per cent standard compaction, topsoiled, levelled and topped up as necessary should subsidence occur



On steep and/or long sections of trench...



Construction notes for figure 6.1

1. Do not open any trench unless it is likely to be closed in three days
2. Place excavated material up-slope of the trench
3. Stockpile topsoil separately from subsoil
4. Divert runoff from the line of the cut with diversions as directed by SD 5-2
5. Rehabilitate in accordance with specification

Figure 6.1 Erosion and sediment control during trenching activities

Care should be taken in the backfilling operation to prevent the trench operating as a subsoil drain. The backfill should therefore be properly compacted and trench stops installed where gradients are considered steep enough to warrant them.

6.2.3 Trenches running obliquely across grade

Where the trench will run obliquely across the grade, soil from the excavation should be heaped on the uphill side of the trench to form an earth bank. Depending on the trench grade, and likely soil loss from the trench, trench stops may also be required.

6.3 Stream or water crossings

Where a service installation crosses a watercourse, there is significant potential for environmental degradation. Trenching should be stopped short of the watercourse and a trench stop left in place until the water crossing has been initiated. Where water crossings are necessary, less-invasive construction techniques, such as bridge crossings or underboring, should be considered in preference to excavation of the streambed.

Works in and around all streams and waterways should meet all statutory and other requirements of regulatory authorities for works in waterways. Procedures developed for works in waterways should describe methods to minimise erosion, water quality impacts and other impacts.

If a bridge crossing is required to allow construction access or for maintenance requirements, then the structure should be designed so that it does not become a channel constriction that may cause backup of flow or washouts during periods of high stream flow.

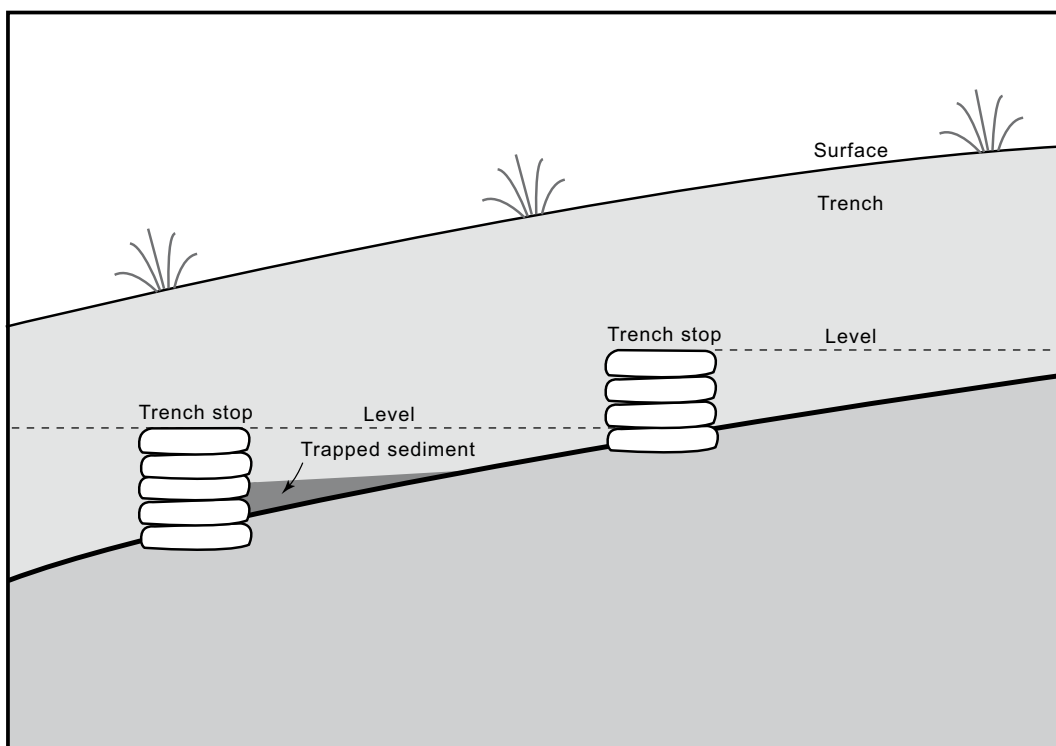


Figure 6.2 Typical trench stop detail

All works within the core riparian zone should be undertaken in accordance with the checklist in table 6.1. Further guidance is provided in **1**: section 5.3. Where services need to be placed across a creek, stream or waterway, measures need to be undertaken to:

- divert the water flow while the service is being installed
- protect the waterway from erosion and sediment damage
- maintain flow to avoid upstream flooding.

Temporary flow diversions may be installed in the streambed using a piped culvert or excavated channel that has been stabilised with a plastic or similar erosion-resistant lining. See **1**: section 5.3.4 for further guidance.

Avoid excavating steep creek banks to provide vehicular access. It is usually better to push materials up to the bank to act as a ramp and remove this material once the work is complete. For further information relating to vehicular creek crossings, see **2**: *C Unsealed roads*. Figure 6.4 provides sketches of typical stream diversion techniques.

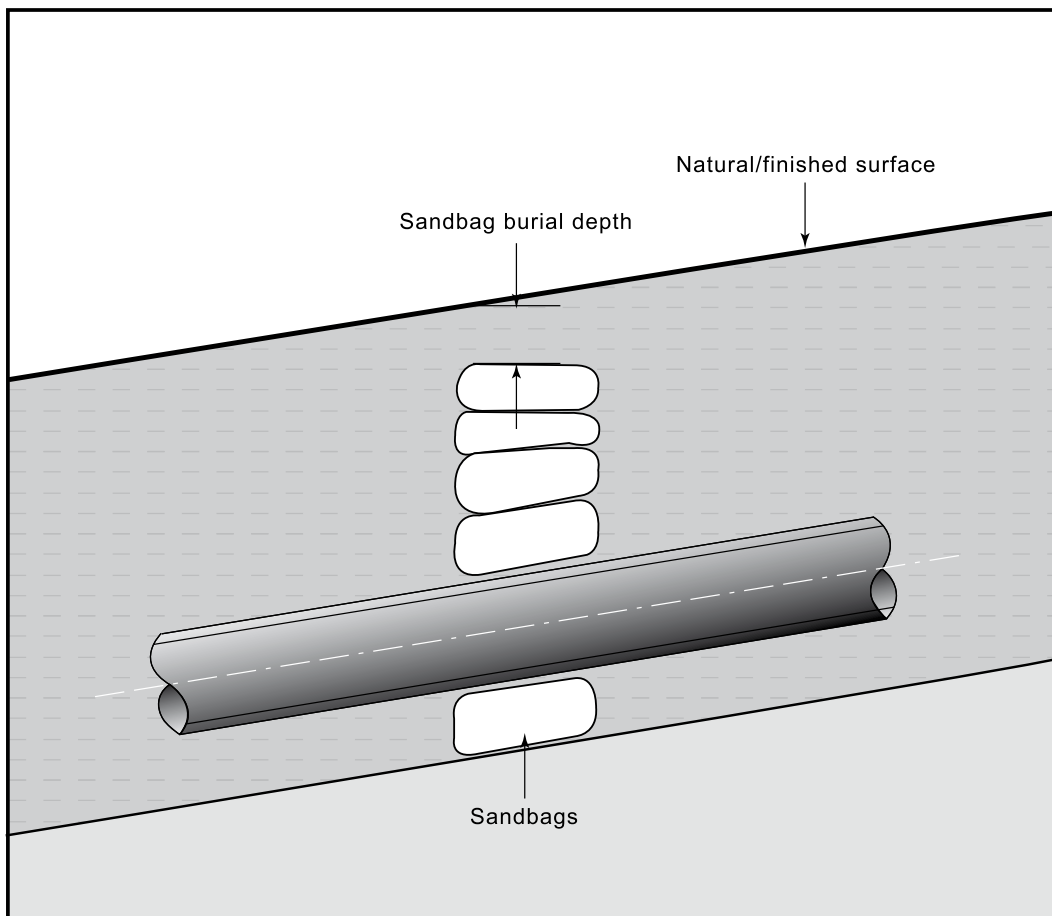


Figure 6.3 Detail of typical seepage collar or bulkhead

6.4 Soil and stockpile management

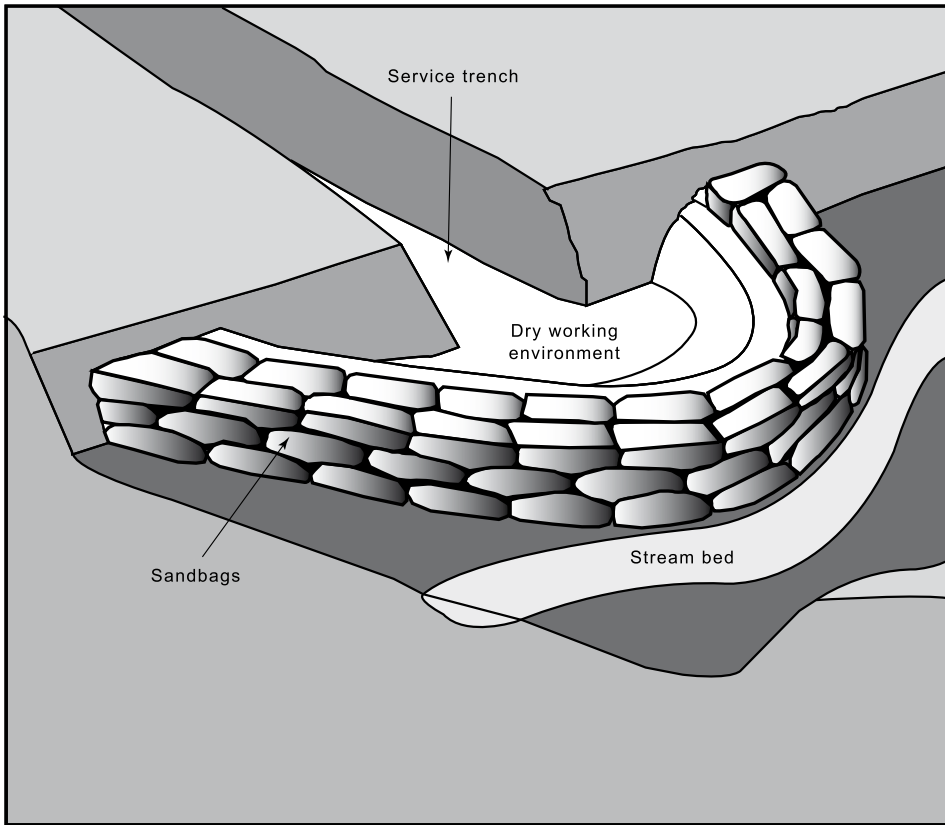
Measures to minimise erosion and control sedimentation should be implemented before stripping or stockpiling of any material. Stockpile material may include excavated trench material or dewatered slurries.

Stockpiles should be adequately protected from erosion. Generally stockpiles should be constructed according to 1: section 4.3. However the techniques listed in Table 6.2 should also be considered.

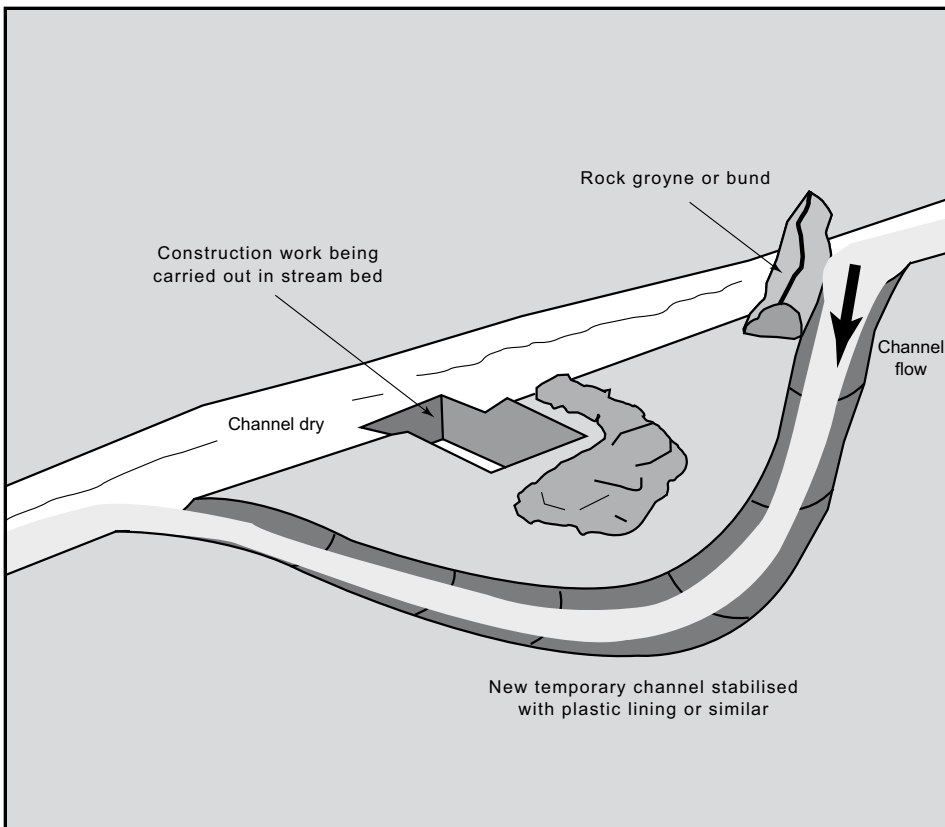
If sediments potentially contain acid sulfate or other contamination, prevent contamination of the underlying soil by stockpiling the excavated material in a bunded area. The bund area should be constructed on a concrete pad or some other surface of low permeability, or by lining it with HDPE sheeting. In these circumstances, it is generally good practice to construct stockpile bunds capable of containing runoff from the stockpile equivalent to a 10-year ARI, 24-hour duration rainfall event. Allow an additional 100 millimetres freeboard after the displacement of the stockpile has been taken into account. Further guidance on the management of acid sulfate soils is available in the *Acid sulfate soil manual* (ASSMAC 1998).

Table 6.1 Checklist for service installation within the core riparian zone of a waterway

Check	Action
	Minimise erosion and movement of sediment due to disturbance of stream banks and bottom substrate
	Time construction to minimise impact on ecology, including fish
	Plan and design works to minimise the number of stream crossings required
	When underboring using a directional drill: <ul style="list-style-type: none"> • use a closed recirculatory drilling mud system to prevent impacts on environmental water quality • prepare contingency plans to deal with 'frac outs', where the drill line encounters a geological fracture, potentially leading to the discharge of drilling mud to a waterway • monitor water quality during such drilling as part of the plan
	Locate stockpiles of excavated soil above the 2-year ARI flood level where practical
	Stop trenching short of the watercourse and leave a trench stop in place until the creek crossing has been initiated.



Option 1 – stream diversion located within stream bed



Option 2 – stream diversion via a new excavated channel

Figure 6.4 Options for typical stream diversion techniques (redrawn from Environment ACT 1998)

Table 6.2 Checklist for soil and stockpile management

Issue	Check
Locate stockpiles away from hazards such as areas of concentrated flow, channels, gutters, drains, and steep slopes	
Stockpile topsoil separately from general excavated material so that it may be used when rehabilitating the site	
Where possible, ensure spoil is not placed where it is likely to fall or wash into roads, gutters or drains	
Place spoil on the uphill side of trenches to divert water flow away from the trench line, or use temporary bunds for a similar effect	
If the stockpile must be placed on the gutter side, protect the toe of fill using sandbags to divert water away from the fill	
Stockpile material (particularly topsoil) for the minimum time needed only	
Divert surface water away from soil stockpiles using sandbags or earth diversion drains	
Prevent sediment loss from stockpiles by installing sediment fences on their downstream side	
Cover or otherwise manage stockpiles that are susceptible to wind or water erosion	
Establish a cover crop of suitable vegetation to protect soil stockpiles that are expected to remain in place for longer than 60 days	
Do not place stockpiled materials inside vegetation protection areas or within 5 metres of retained trees	
Site stockpiles so that any slumping will not affect erosion and sediment control measures or infringe specified minimum clearance requirements	
Stockpile topsoil that is uncontaminated by noxious weeds for later spreading on fill batters and other areas. Stockpile other material separately from the topsoil	
Maintain stockpiles to prevent weed growth	
Reuse all stockpiled material on-site where possible. Dispose of excess stockpiled material appropriately	
Place bunding around stockpiles if the material is a slurry or contains acid sulfate or contaminated soil	
Construct bunds from low permeability materials, such as clays or compacted soils, to prevent seepage through walls	
Design the down-gradient bund wall to contain stockpiled or stored materials where the stockpile and bunding is placed on sloping ground	
Construct bund walls on the up-gradient side on sloping ground to withstand erosion from up-gradient stormwater flow	
Inspect and maintain bund walls regularly to ensure that any damage or breach is rectified as soon as practicable	

6.5 Work areas and building platforms

For guidance relating to erosion and sediment control during the construction of building platforms, foundations and footings, see 1: section 9.

6.6 Access roads

For guidance on the construction of access roads or maintenance tracks, see 2: *C Unsealed roads*.

In particular, road crossings constructed across drainage lines (including small gullies) should ensure that stream flows are not impeded and that erosion and local flooding is avoided.

6.7 Managing-dry weather discharges

6.7.1 Overview

In addition to the 'conventional' application of erosion and sediment control measures to minimise the impact of polluted stormwater runoff during the land disturbance, service installation projects commonly include specific activities that can produce wastewater containing very high levels of sediment, such as

- saw cutting, drilling, boring and tunnelling
- site dewatering involving the pump-out (or similar) of water that has collected in open trenches, pits etc. This water may have entered the pit or trench as surface flow or sub-surface (groundwater) flow.

The contractor should understand the environment they are working in and should evaluate and minimise the potential impacts of such discharges. The contractor should undertake appropriate measures to prevent pollution or degradation of the receiving water body. Wastewater management techniques should be defined in the planning phase of the project, rather than waiting until a trench is filled with sediment-laden water.

Discharge water should not be allowed to:

- enter any surface water (e.g. stormwater drainage, ephemeral stream, creek or river) or groundwater where the nature of the discharge will affect the environmental values or other beneficial use of the receiving water body
- cause or contribute to stream erosion
- have a detrimental impact on flora and fauna downstream of the discharge point.

Depending on the scale, location and duration of the service installation project, the following issues may need to be considered when identifying and planning appropriate wastewater management techniques:

- the likely quantity and quality of water to be discharged
- verification that the quality of discharge water will comply with applicable discharge limits
- likely duration and frequency of the discharge
- assessment of the viability of treating or recycling the wastewater
- assessment of the existing environment that will receive the discharge
- a strategy for monitoring and assessing control measures during the life of the project.

6.7.2 Management strategies

The operations should be managed to avoid pollution occurring as a result of discharging:

- water collected in trenches, sediment basins or other excavations
- water extracted by the temporary lowering of watertables
- slurries generated during boring, cutting and tunnelling activities.

All wastewater from dewatering operations will need to be treated on-site to an acceptable level before being discharged into existing stormwater systems or waterways, or collected for reuse elsewhere on-site for other construction activities.

The contractor should manage dewatering to ensure there is no significant change in the quality or flow regime of surface water or groundwater.

Lowering the watertable near a coastal or estuarine environment may cause saltwater intrusion to the aquifer and should be avoided. Similarly, the contractor should assess the impact of dewatering on local vegetation, springs, wetlands and groundwater bores used by others in the vicinity of the project. Where the assessment indicates a potential reduction in watertable or quality of groundwater, the contractor should either design the dewatering system to overcome this threat or provide an acceptable alternative water supply to affected parties.

Depending on the quantity and quality of the water, wastewater or slurry produced by dewatering, boring or similar operations, the water could be treated simply by discharging it to a grassed area or passing it through a silt trap or geotextile-wrapped gravel filter (see 1: SD 6-11) to reduce suspended solids before it enters receiving waters or a natural watercourse.

A more complex treatment arrangement is likely to be required where a large quantity of water is to be managed, or the level of sediment contamination is expected to be high (e.g. slurries from significant concrete cutting and/or subsurface boring, drilling or tunnelling activities).

The dewatering of spoil slurries excavated during trenching or tunnelling for service installations should be adequately controlled. Where there is a reasonable possibility that groundwater may be contaminated as a result of previous or adjacent land use (e.g. industrial sites, service stations), groundwater should be tested before commencing dewatering activities to determine whether toxic substances or petroleum products are present.

Again, depending on the scale and nature of project, water from the dewatering of slurries, sediment-laden materials, trench excavations or wet boring or drilling activities may need to be:

- collected
- treated (if deemed necessary)
- reused on-site (where applicable)
- discharged or disposed of when a suitable discharge quality is achieved
- monitored.

Collection

Discharge water from the works should be collected for reuse or treatment, if necessary, before discharge from the site. The collected water may need to be stored in a basin or other suitable collection facility, depending on the likely contamination.

Treatment

The contractor should consider constructing a sediment basin to allow sediment to settle before water is released from the site where the wastewater contains a high concentration of suspended solids, is of variable quality or may cause turbidity in receiving waters. See 1: section 6 and 1: appendix E for further details on treatment options for reducing turbidity.

Given the short duration of most service installation projects, sediment basins may often not be a practicable solution. Sediment basins may also have only a limited effect in dispersible soils. Alternative methods of treatment may therefore need to be considered. Depending on the quantity and quality of water to be treated, it may be appropriate to utilise a packaged or transportable treatment facility, or transport the wastewater to an appropriate treatment facility.

Water containing excessive levels of colour, odour-producing substances or toxins may require pre-treatment. This may be achieved via pH adjustment, flocculation agents or with the use of portable treatment plants to adjust the discharge water quality to meet applicable discharge criteria.

Reuse

Recycling of water is the recommended option wherever practical, for purposes such as dust control and washdown water, thereby minimising consumption of potable (mains) water and pollution of downstream environments. Refer to *Managing urban stormwater: harvesting and reuse* (DEC 2006b) for information on stormwater reuse.

Using water for local groundwater recharge may be acceptable provided:

- there is sufficient area to recharge
- silt or clay will not clog the recharge area
- it will not degrade groundwater quality e.g. lead to salinisation
- it will not lead to local flooding or land subsidence.

Irrigation may be acceptable provided water quality meets applicable criteria, and consideration has been given to the rate of evaporation, the quantity of water involved and the effects on the proposed discharge area.

Cutting, drilling or boring systems with recirculatory water recycling systems should be used in preference to those where such water is discharged.

Discharge and disposal

Regulatory and management authorities (such as local councils, DECC, Department of Planning and local water authorities) may need to be consulted and the relevant approvals obtained before disposing of any water from dewatering operations, depending on specific regulatory requirements.

Monitoring

The operator should develop and maintain a program that monitors, records and reports on the effects of dewatering. The program should include:

- a record of the quantity of water discharged
- regular visual inspection of the dewatering system to confirm its integrity and note impacts at the point of release
- suitable monitoring facilities (e.g. bores to record the effects of pumping on the watertable)
- relevant water quality analysis of the water discharged and the receiving environment
- periodic investigations of the impacts on the environment. Photographic records of vegetation and other sensitive parameters should be included as appropriate.

6.8 Disposal of water from pipe flushing or pressure testing

Flushing and pressure testing of pipelines can potentially generate large volumes of wastewater contaminated by pollutants such as heavy metals, oil and grease, biocides and sediment. The discharge of such wastewater needs to be adequately controlled using measures such as those outlined previously for dewatering.

Such wastewater should be collected and reused where possible. In large projects, the water can be reused from one section of a pipeline to the next.

Biocides should be used in hydrostatic testing of pipelines only where necessary. Where such test water cannot be reused, it will need to be disposed of in an appropriate manner ensuring no runoff to receiving waters. If this is not possible, then the water will need to be disposed of at an appropriate treatment facility or in accordance with section 6.7 above.



7. Site restoration and rehabilitation

7.1	Introduction	38
7.2	Progressive revegetation	38
7.3	Removal of temporary erosion and sediment measures	38
7.4	Site stabilisation	38

7.1 Introduction

The restoration and rehabilitation of the site should be considered throughout the project, from the planning stage, during the works and after completion of the service installation. Site rehabilitation should cover the following topics, outlined in more detail below:

- progressive revegetation
- removal of temporary erosion and sediment measures
- site stabilisation.

7.2 Progressive revegetation

To minimise the area of disturbance during construction it is important to stage the works, and to progressively revegetate and rehabilitate the area. All disturbed areas should be stabilised as soon as possible after completion of the works.

Typical rehabilitation techniques are described in 1: section 7.

7.3 Removal of temporary erosion and sediment measures

All sediment retention structures should be removed before project completion once all upstream areas have been vegetated or otherwise stabilised. Operational basins and spillways should be progressively removed along linear infrastructure projects, once their catchments have been stabilised.

The rehabilitation work should restore the ground surface area approximately to its original condition, and should include the following:

- removal of all redundant mattresses from basin spillway(s) by:
 - burying them in the structure area
 - reusing them for scour protection, or
 - removing them from the site
- spreading and compacting of basin embankment material to reform the existing landscape. The disturbed material should be compacted to at least the relative density of the existing material in the adjacent ground
- removal of unnecessary access roads or any other temporary works
- reinstatement of stored topsoil and vegetation.

7.4 Site stabilisation

All disturbed areas should be rehabilitated as soon as possible after excavation or completion of the construction period. This includes, but may not be limited to:

- restoration of all surfaces to their original condition (or as specified otherwise by the relevant authority)
- re-establishment of surface stability with suitable cover to achieve a permanent C-factor of less than 0.1 (equivalent to 60 per cent ground cover) within 20 working days from the start of works

- inspection of the rehabilitated lands to ensure sufficient ground cover has established to prevent erosion. Sites may be considered adequately rehabilitated once a C-factor of 0.05 (equivalent to 70 per cent ground cover) is achieved and is likely to be maintained (see 1: section A6)
- retention of temporary erosion and sedimentation control works until areas of revegetation have established or the site has stabilised, and then disposal of the materials and works appropriately.

Routine inspections and auditing of the constructed works should continue until the above requirements are satisfied.

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Appendices

Appendix A: Sample erosion and sediment control plan – small project	42
Appendix B: Sample erosion and sediment control plan – large project	44
Appendix C: Selection of control measures	51

Appendix A: Sample erosion and sediment control plan – small project

The sample ESCP provided below covers the installation of services adjacent to an existing road by way of trenching. The ESCP is to be used for guidance only, and care should be taken when creating site-specific ESCPs to ensure that they address all of the relevant considerations discussed within volume 1, and previously within this document.

This sample plan comprises a map (figure A.1, ESCP-001), relevant standard drawings and a supporting commentary.

Sample ESCP commentary

- 1 Ensure site works do not start until the erosion and sediment control works are installed and functional
- 2 Install sediment fences (SD 6-8) as shown on the attached drawing*
- 3 Provide mesh and gravel 'sausage' protection (SD 6-11) to protect gutter inlets adjacent to and immediately downstream of the works
- 4 Strip and stockpile topsoil (preferably still vegetated) (SD 4-1) separately from subsoil or overburden for later rehabilitation of the site
- 5 Place all stockpiles in the location shown on ESCP-001 and at most 5 (preferably 2) metres from the edge of any essential construction activity
- 6 Respread topsoil and rehabilitate all disturbed areas within 5 working days of the completion of works
- 7 Check all erosion and sediment controls at least weekly and after moderate to heavy rain to ensure they are maintained in a fully functional condition
- 8 Photocopies of the following standard drawings are appended to this commentary:
 - SD 4-1 Stockpile management
 - SD 6-8 Sediment fence
 - SD 6-11 Mesh and gravel inlet
- 9 The works shall provide for the safe passage of pedestrians
- 10 Once the permanent landscaping has been established, the temporary erosion control measures should be removed.

* Note: cross-references to standard drawings in appendices A and B are to volume (Landcom 2004).

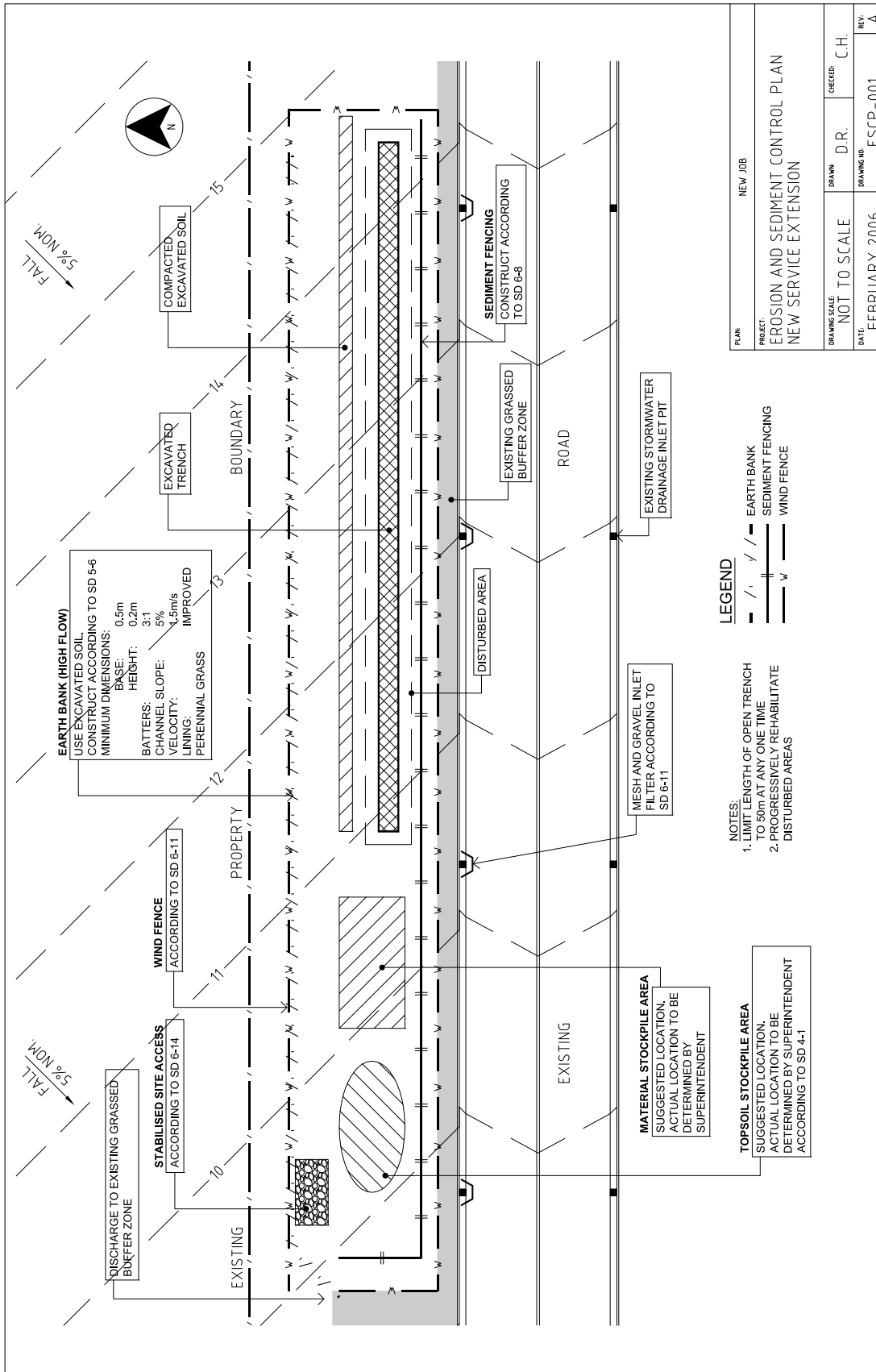


Figure A.1 ESCP-001: Sample ESCP for new service extension

Cross-references are to Landcom (2004)

Appendix B: Sample erosion and sediment control plan – large project

The sample ESCP that follows looks at the installation of a new service line, by means of trenching, through an undisturbed bushland environment. The example requires the diversion of a stream.

Background

- 1 Site constraints and characteristics are identified in table B.1 (ESCP-002).
- 2 The likely soil loss was calculated using the revised universal soil loss equation (RUSLE). The values of the RUSLE factors are: LS = maximum of 2.53 adopting the 300-metre slope length and the grade of 5%, P = 1.3, C = 1.0 for bare soil.
- 3 The calculated average annual soil loss of 120 m³/year is less than the limiting size of 150 m³/yr as specified in 1: section 6.3.2, so a sediment basin is not required at this site. (This is reasonable, as the detrimental effects of constructing a sediment basin would far exceed the environmental advantages given the nature of the site.)

Table B.1 ESCP-002 Site constraints and characteristics	
Constraint/opportunity	Value
Rainfall erosivity	Moderate (R-factor = 3,500)
Slope gradients	Moderate (up to 5%)
Potential erosion hazard	High (from 1: figure 4.6)
Rainfall zone	Zone 1
Soil erodibility	Low to moderate (K-factor = 0.04)
Calculated soil loss	460 tonnes/ha/yr (350 m ³ /ha/year, specific gravity 1.3 t/m ³)
Soil loss class	Class 3
Soil texture group	Type C
Dispersible subsoil (%)	Insignificant (0–2% dispersible, Emerson classes 6, 7 and 8)
Runoff coefficient	0.5 adopted
Disturbed site area	Total disturbed area of 9500 m ² (maximum disturbed area per catchment is 4000 m ²)

General instructions

- 1 Read this ESCP together with the engineering plans and any other plans or written instructions that may be issued relating to development at the subject site.
- 2 Ensure that all soil and water management works are undertaken as instructed in this specification and constructed following the guidelines stated in volumes 1 and 2C of *Managing urban stormwater: soils and construction* (Landcom 2004; DECC 2007).
- 3 Inform all subcontractors of their responsibilities in reducing the potential for soil erosion and pollution to up-slope or down-slope areas.

Land disturbance conditions

- 4 Where practicable, keep the soil erosion hazard on the site as low as possible and as recommended in table B.2 (ESCP-003).
- 5 Undertake works in the following sequence:
 - (i) Construct stabilised site accesses at locations as shown on figure B.1 (drawing ESCP-002) and following standard drawing SD6-14
 - (ii) Install all barrier and sediment fencing where shown on drawing ESCP-002 and following SD 6-8
 - (iii) Install energy dissipators where shown on drawing ESCP-002 and following SD 5-8
 - (iv) Construct high-flow earth banks where shown on drawing ESCP-002 to detail shown on SD 5-6
 - (v) Clear the site and strip and stockpile the topsoil in the locations shown on drawing ESCP-002 following SD 4-1
 - (vi) Undertake all essential construction works. Before beginning the trenching for the installation of the services at the stream crossing, the stream is to be temporarily diverted as per figure 6.4, option 2
 - (vii) Grade site to final grades and apply permanent stabilisation (rectify site to original condition) within 20 days of completion of construction works
 - (viii) Remove temporary erosion control measures after the permanent landscaping has been completed.

Table B.2 ESCP-003 Limitations to access

Land use	Limitation	Comments
Construction areas	Disturbance to be no further than five (preferably two) metres from the edge of any essential engineering activity as shown on the engineering plans	All site workers shall clearly recognise these zones that, where appropriate, are identified with barrier fencing (upslope) and sediment fencing (down slope), or similar materials
Access areas	Limited to a maximum width of 10 metres	The site manager shall determine and mark the location of these zones on-site. They can vary in position to best conserve the existing vegetation and protect downstream areas while being considerate of the needs of efficient works' activities. All site workers will clearly recognise boundaries of the work area as marked with barrier mesh, sediment fencing, or similar materials
Remaining lands	Entry prohibited except for essential thinning of plant growth	Thinning of growth might be necessary for fire hazard reduction

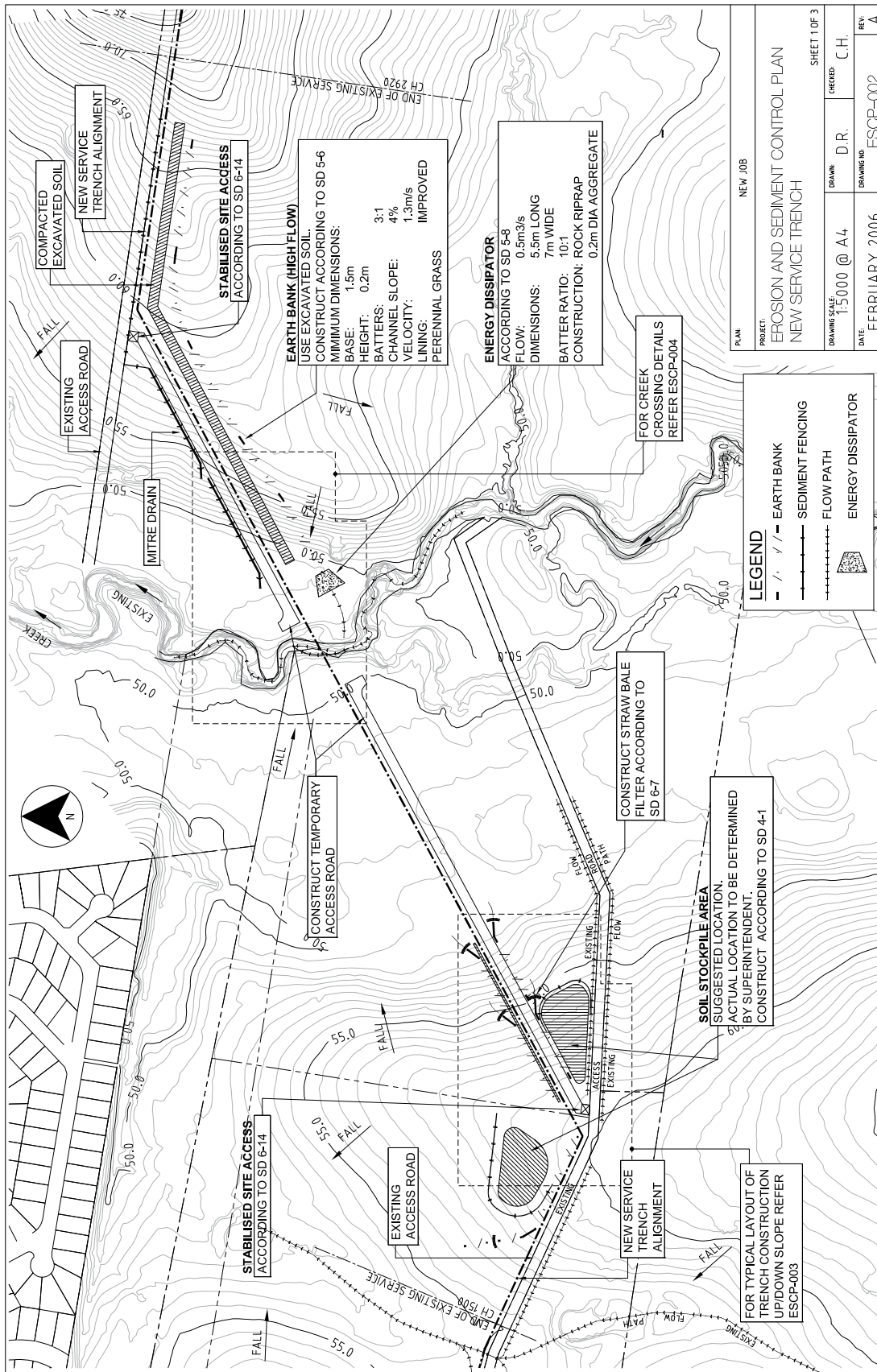


Figure B.1 ESCP-002: Sample ESCP for new service trench

Cross-references are to Landcom (2004)

Soil erosion control conditions

- 6 Install clearly visible barrier fencing where shown on figure B.1 (ESCP-002) and elsewhere at the discretion of the site superintendent to ensure traffic control and prohibit unnecessary site disturbance.
- 7 Build earth batters with as low a gradient as practicable, but no steeper than 2(H):1(V) as the maximum slope length is not expected to exceed 5 metres
- 8 Construct stream diversions to be stable for and safely convey at least the 5-year ARI time of concentration storm event.
- 9 Ensure protection from erosive forces on all lands to meet the requirements of table B.3 (ESCP-004).
- 10 A suggested listing of plant species for temporary cover (less than 3 months) in areas of sheet flow is shown in table B.4 (ESCP-005). Reinforced kikuyu turf is suggested for use in concentrated flow paths.
- 11 Wherever practicable, keep foot and vehicular traffic away from rehabilitated areas.
- 12 Ensure permanent rehabilitation initially achieves a C-factor of less than 0.1 and sets in motion a program that ensures it drops permanently, by vegetation, paving, armouring, etc. to less than 0.05 within a further 60 days. Local water restrictions permitting, regular watering of newly planted areas is recommended, until an effective and vigorous cover has been established. Apply follow-up seed and fertiliser as necessary in areas of minor soil erosion and/or inadequate vegetative protection.
- 13 The revegetation program should look to re-establish species endemic to the local area. Replace the natural surface soils and use non-persistent annual cover crops.

Table B.3 ESCP-004 Maximum C-factors at nominated times during works

Lands	Maximum C-factor	Remarks
Waterways and other areas subjected to concentrated flows, post-construction	0.05	Applies after 10 working days from completion of formation and before the area or waterway is allowed to carry any concentrated flows. Flows will be limited to those shown in 1: table 5.2. Foot and vehicular traffic will be prohibited in these areas (70% ground cover)
Stockpiles, post-construction	0.10	Applies after 10 working days from completion of formation. Maximum C-factor of 0.10 equivalent to 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 equivalent to 50% ground cover

Table B.4 ESCP-005 Plant species for ground cover

Sowing season	Seed mix and quantity
Autumn / winter	Oats @ 40 kg/ha Japanese millet @ 10 kg/ha
Spring / summer	Japanese millet @ 20 kg/ha Oats @ 20 kg/ha

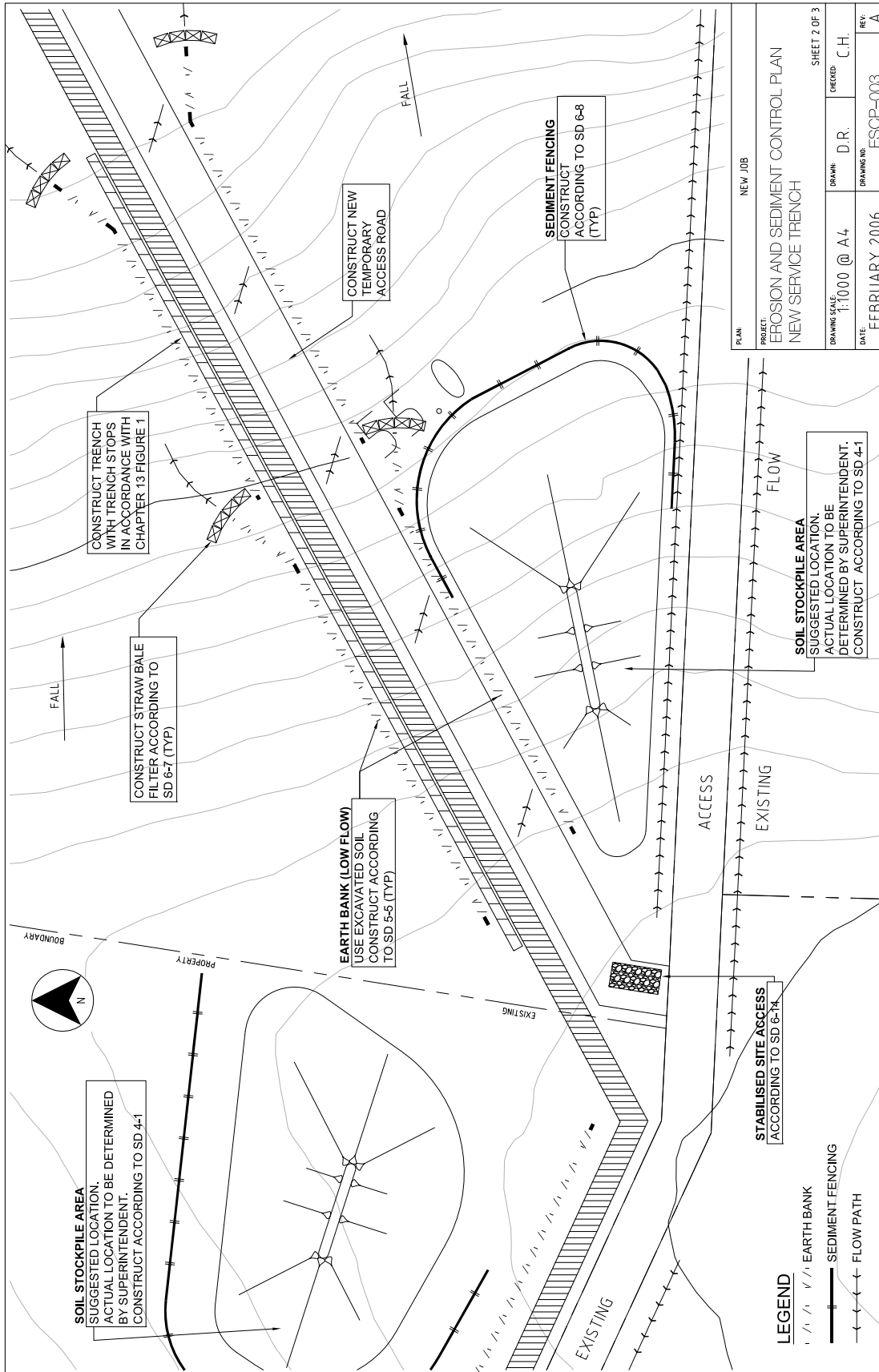


Figure B.2 ESCP-003: Sample ESCP for new service trench

Cross-references are to Landcom (2004)

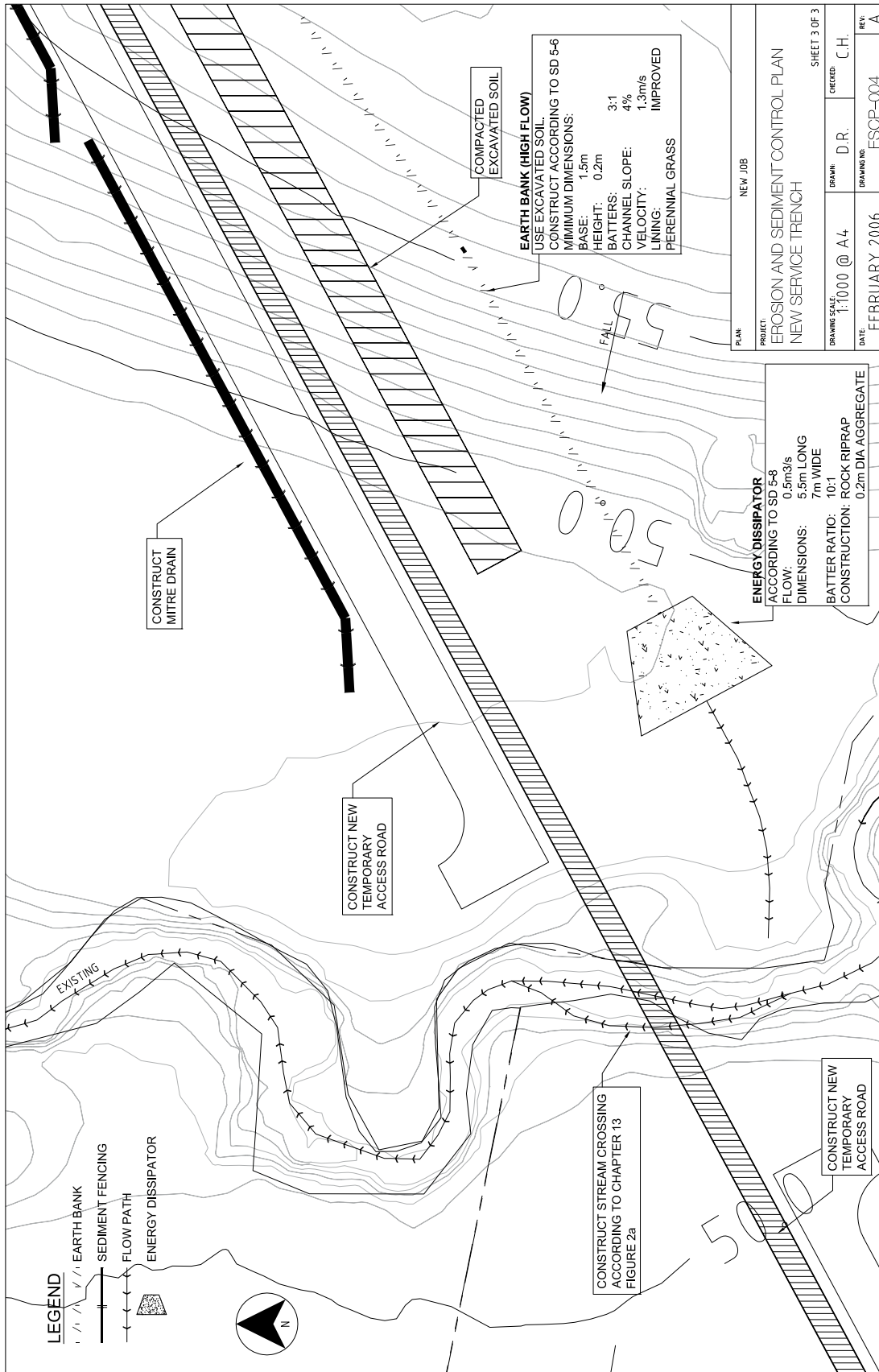


Figure B.3 ESCP-004: Sample ESCP for new service trench

Cross-references are to Landcom (2004)

Sediment control conditions

- 14 Install sediment fences (SD 6-8) where shown on figures B.1, B.2 and B.3 (drawings ESCP 002–004). Other fences can be placed elsewhere at the discretion of the site superintendent. These are to contain the coarser sediment fractions (including aggregated fines) as close as possible to their source.
- 15 Remove sediment from any trapping device and place it where further pollution to down-slope lands and waterways cannot occur.
- 16 Place stockpiles (SD 4-1) where shown on drawings ESCP 002–004 and not within five metres of significant vegetation, concentrated water flows, roads or other hazard areas.
- 17 Stockpiles are to be covered while the site is left unattended or during rain.
- 18 Control dewatering of trenches and spoil slurries adequately. Water should be treated on-site by discharging through the adjacent grassed area once satisfactory settlement of sediment has been achieved.
- 19 Retain temporary sediment traps until after the land draining to those traps is completely rehabilitated.

Site inspection and maintenance conditions

- 20 Empty waste bins as necessary. Disposal of waste should be undertaken in a legal manner according to all necessary approvals and licences, and as approved by the site superintendent.
- 21 Ensure the site superintendent inspects the site at least weekly and especially following all storm events. These inspections should specifically address the following:
 - (i) ensure that drains are operating properly and any necessary repairs are carried out
 - (ii) remove spilled sand or other materials from hazard areas, including lands closer than five metres from areas of likely concentrated or high velocity flows, especially waterways and paved areas
 - (iii) remove trapped sediment whenever the remaining capacity is less than the design capacity
 - (iv) ensure rehabilitated lands have effectively reduced the erosion hazard and initiate upgrading or repair as appropriate
 - (v) construct additional erosion and/or sediment control works as might become necessary to ensure the desired protection is given to down slope lands and waterways, and make ongoing changes to the Drawings where they prove inadequate or are subjected to changes due to altered conditions on the work-site or elsewhere in the catchment
 - (vi) maintain erosion and sediment control measures in a fully functioning condition until all earthwork activities are completed and the site is rehabilitated, and
 - (vii) remove temporary soil conservation structures as the last activity in the rehabilitation program.
- 22 The site superintendent shall keep a logbook, making entries at least weekly, immediately before forecast rain and after rainfall. Entries should include:
 - (i) a record of rainfall events
 - (ii) the condition of any soil and water management works
 - (iii) the condition of vegetation and any need to irrigate
 - (iv) the need for dust prevention strategies, and
 - (v) any remedial works to be undertaken.

The logbook will be kept on-site and made available to any authorised person on request. A copy should be given to the project manager at the conclusion of works.

Appendix C: Selection of control measures

This appendix describes a step-by-step process for selecting erosion and sediment control measures, based on an approach developed by Soilcon Pty Ltd for the Queensland Department of Main Roads. Figure C.1 is a simple flowchart that asks whether the problem is:

- erosion or sedimentation
- rain drop impact or flowing water
- sheet flow or concentrated flow.

The flowchart then guides the user to table C.1 outlining groups of treatment options which are described in detail in *Managing urban stormwater: soils and construction* vol. 1.

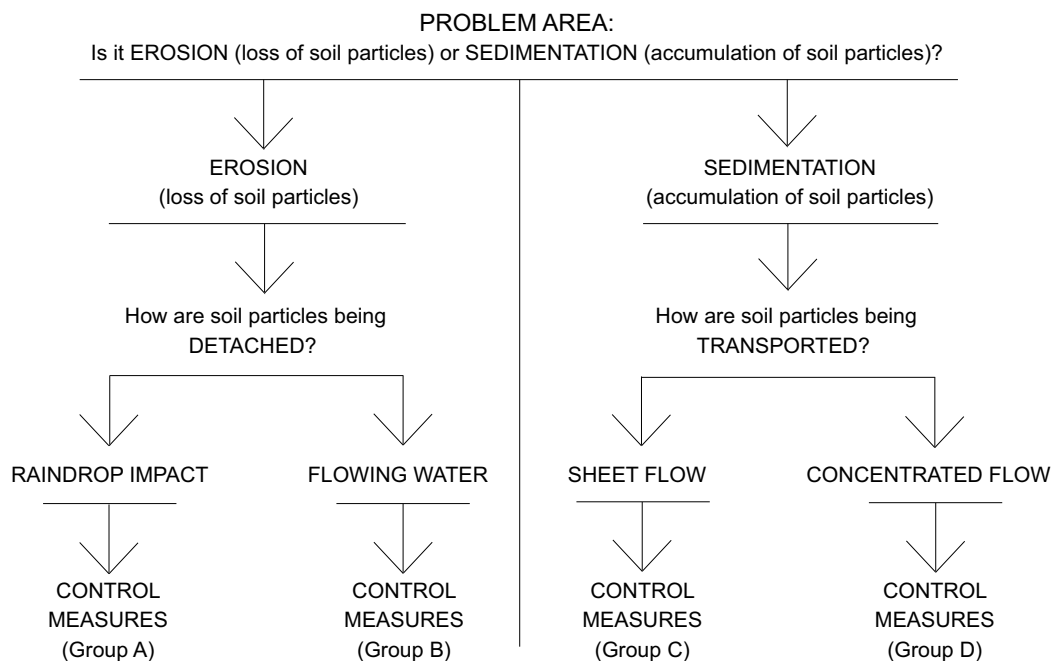


Figure C.1 Decision-support flowchart for selection of erosion and sediment control measures (modified from Soilcon Pty Ltd. Used with permission)

Table C.1 Erosion and sediment control measures

Group A: Erosion control – raindrop impact

Vegetation

- temporary vegetation – cover crop only
- permanent vegetation – introduced (exotic) pasture species or native (endemic) species
- see 1: sections 4.3.2, 7.1, 7.2, appendix A6 and appendix G



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Batter blankets

- vegetation promotion blankets
- vegetation suppression blankets
- needle-punched geotextile membrane
- builder's plastic membrane
- see 1: section 5.4.2, SD 5-2, appendix A6 and appendix D



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Soil surface mulching

- hydromulch or hydraulic bonded fibre matrix
- blown straw, hay, crop residue, with bitumen tack
- tub-ground or chipped organic mulch
- brush-matting
- rock or gravel mulch
- see 1: section 7.4, figure 7.3, appendix A6 and appendix D



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Geocellular containment systems

- non-woven geotextile type material
- polypropylene material (perforated and non-perforated)
- see 1: section 5.4.2, SD 5-3 and appendix D



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Surface roughening

- roughening parallel to contour
- contour ripping or scarifying
- trackwalking
- see 1: section 4.3.2, figures 4.3(a) and (b)



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Geobinders

- organic tackifiers
- co-polymer emulsions
- bitumen emulsion
- cementitious products
- see 1: section 7.1.2, appendices A6 and D



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Table C.1 Erosion and sediment control measures

Group B: Erosion control – flowing water

Up-slope diversions

- excavated channel-type bank
- backpush-type bank or windrow
- catch drains
- shoulder dyke
- see 1: section 5.4.4, SD 5-5 and SD 5-6



Mid-slope diversions

- berms and benches
- temporary diversions (at cut/fill line)
- cross banks
- see 1: section 4.3.1, figure 4.2 and appendix A4



Soft armour channels

- trapezoidal or parabolic shape
- consider channel grade and maximum permissible velocity
- establish vegetative ground cover
- standard (non-reinforced) or reinforced turf
- biodegradable erosion control mat (temporary) or synthetic erosion control mat (permanent)
- see 1: sections 5.4.3, 7.3, SD 5-7 and appendix D



Hard armour channels

- loose rock
- rock-filled wire mattresses
- articulating concrete block systems
- grouted rock
- cast in situ concrete
- builder's plastic lining or geotextile lining
- see 1: section 5.4.4, table 5.2, figure 5.4 and appendix D



In-stream diversions

- temporary coffer dams
- water-filled structures
- temporary lined channel (stream diversion)
- see 1: section 5.3.5 and appendix I



Table C.1 Erosion and sediment control measures

Group B: Erosion control – flowing water

Check dams

- stacked rock
- sandbags and geotextile sausages
- straw bales
- logs
- proprietary products
- see 1: section 5.4.3, SD 5-4, and figures 5.3(a) and (b)



Batter drains

- concrete (pre-cast or in-situ)
- half 'armco' pipe
- sandbags
- rock-filled wire mattresses
- loose rock rip-rap
- builder's plastic or geotextile lined chutes
- see 1: section 5.4.4 and appendix D



Grade control structures and flumes

- gully pits and field inlets
- sandbag drop structures
- rock-filled wire gabions and mattress structures
- driven sheet piling
- concrete chutes
- inclined pipe spillways
- builder's plastic-lined chutes



Outlet dissipation structures

- loose rock riprap aprons
- rock-filled wire mattresses
- roughness elements
- hydraulic jump-type structures
- impact type structures
- see 1: sections 5.4.5, figures 5.8, 5.9, 5.10, 5.11 and SC 5-8



Revetments and retaining walls

- riprap
- rock-filled wire gabions and mattresses



Table C.1 Erosion and sediment control measures

Group C: Sediment control – sheet flows

Vegetative buffers

- well established sward with good groundcover
- see 1: section 6.3.8, table 6.4, SD 6-13 and appendix G



Sediment barriers/filters

- sediment fences
- vegetation, brush, rock or gravel windrows
- earthen down-slope diversion directing sheet flows to sediment traps or sumps
- straw bale barriers
- see 1: section 6.3.7, SD 6-7, SD 6-8, figure 6.10 and appendix D



Site exit points

- shaker ramps
- rock aprons
- wheel wash systems
- see 1: section 6.3.9 and SD 6-14



Table C.1 Erosion and sediment control measures

Group D: Sediment control – concentrated flows

Sediment curtains/turbidity barriers

- floating geotextile
- proprietary polypropylene products
- temporary coffer dams
- water-filled structures
- see 1: section 6.3.7, SD 6-10 and appendix D



Sediment traps

- stacked rock/timber with geotextile
- excavated sumps
- straw bale or sand bag structures
- gully pit, field inlet and kerb inlets
- see 1: section 6.3.6, figure 6.11, SD 6-11, SD 6-12



Sediment retention basins

- type C (riser type) basin
- type F (extended settling) basins
- type D (flocculation) basins
- see 1: sections 6.3.3, 6.3.4 and 6.3.5, SD 6-3, SD 6-4, appendices E and J



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