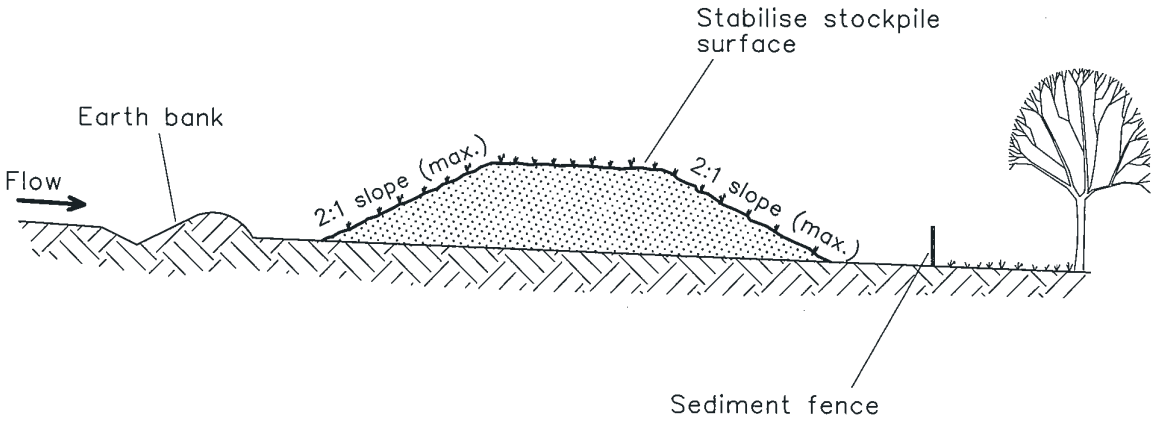
BLUE BOOK STANDARD DRAWINGS

STANDARD DRAWINGS

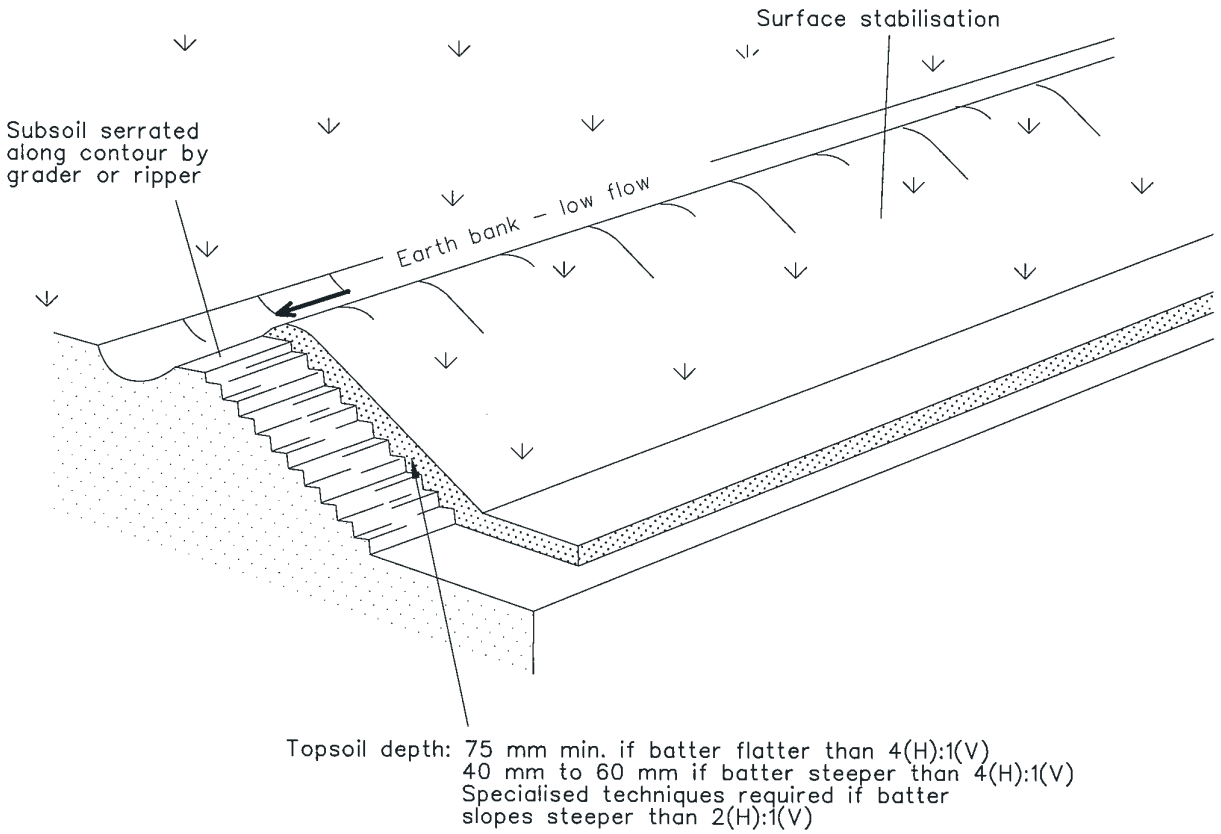


Construction Notes

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

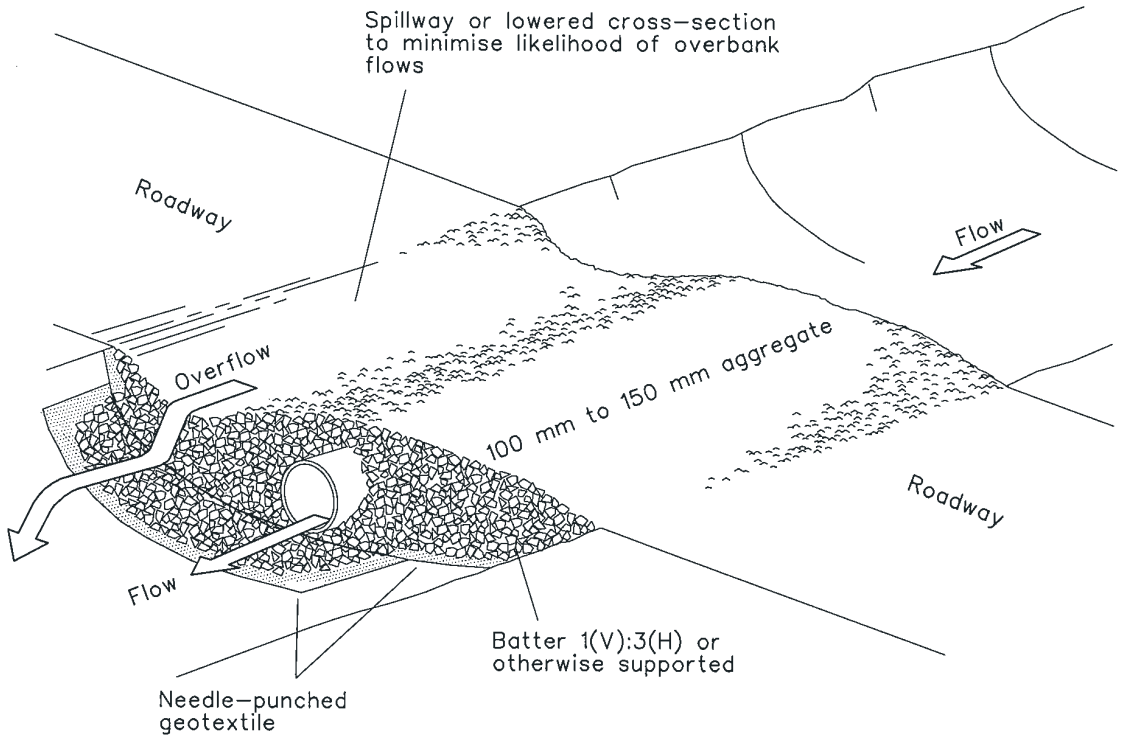
SD 4-1



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.

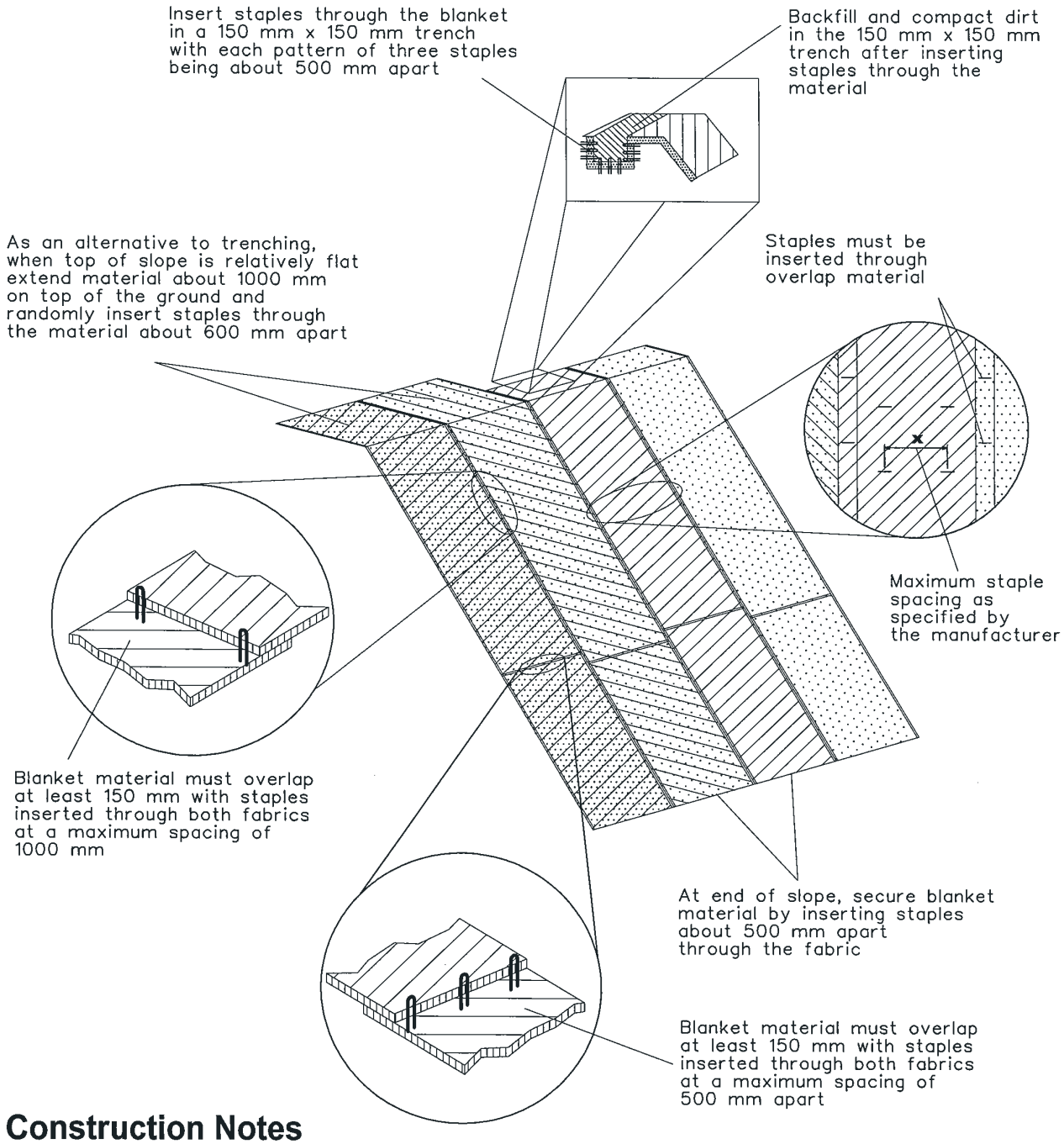
REPLACING TOPSOIL SD 4-2



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.

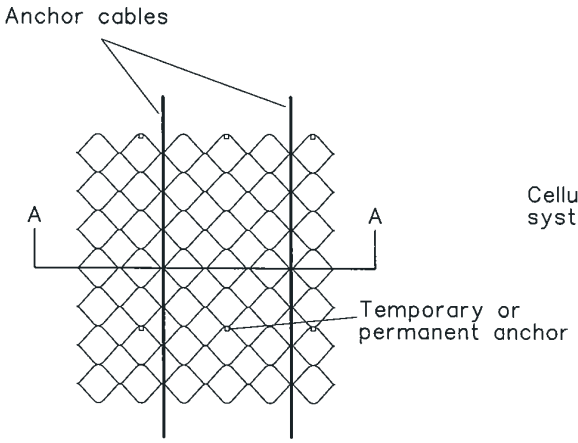
TEMPORARY WATERWAY CROSSING SD 5-1

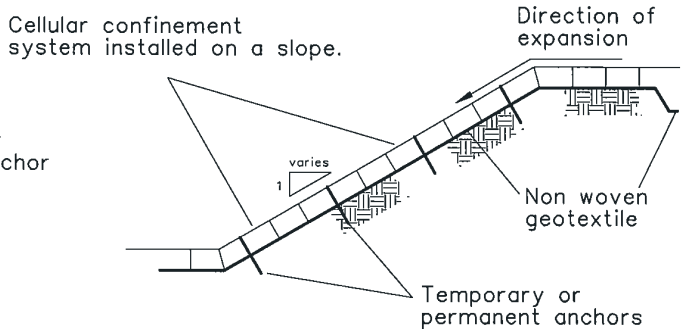


Construction Notes

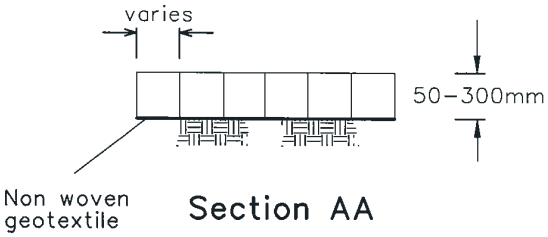
1. Remove any rocks, clods, sticks or grass from the ground surface before laying the matting.
2. Spread topsoil to at least 75 mm depth.
3. Where appropriate, complete fertilising and seeding on a properly prepared seedbed (Standard Drawing 7-1) before laying the matting.
4. Ensure the fabric can be continuously in contact with the soil by grading the surface carefully first.
5. Lay the matting in "shingle-fashion" with the ends of each upstream roll overlapping the next roll downslope.
6. Ensure sufficient staples are used to maintain a good contact between the soil and the matting.

RECP : SHEET FLOW SD 5-2

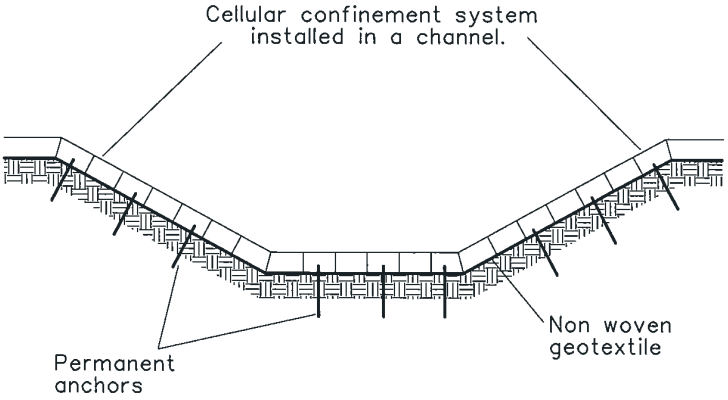




Slope Protection System



Section AA

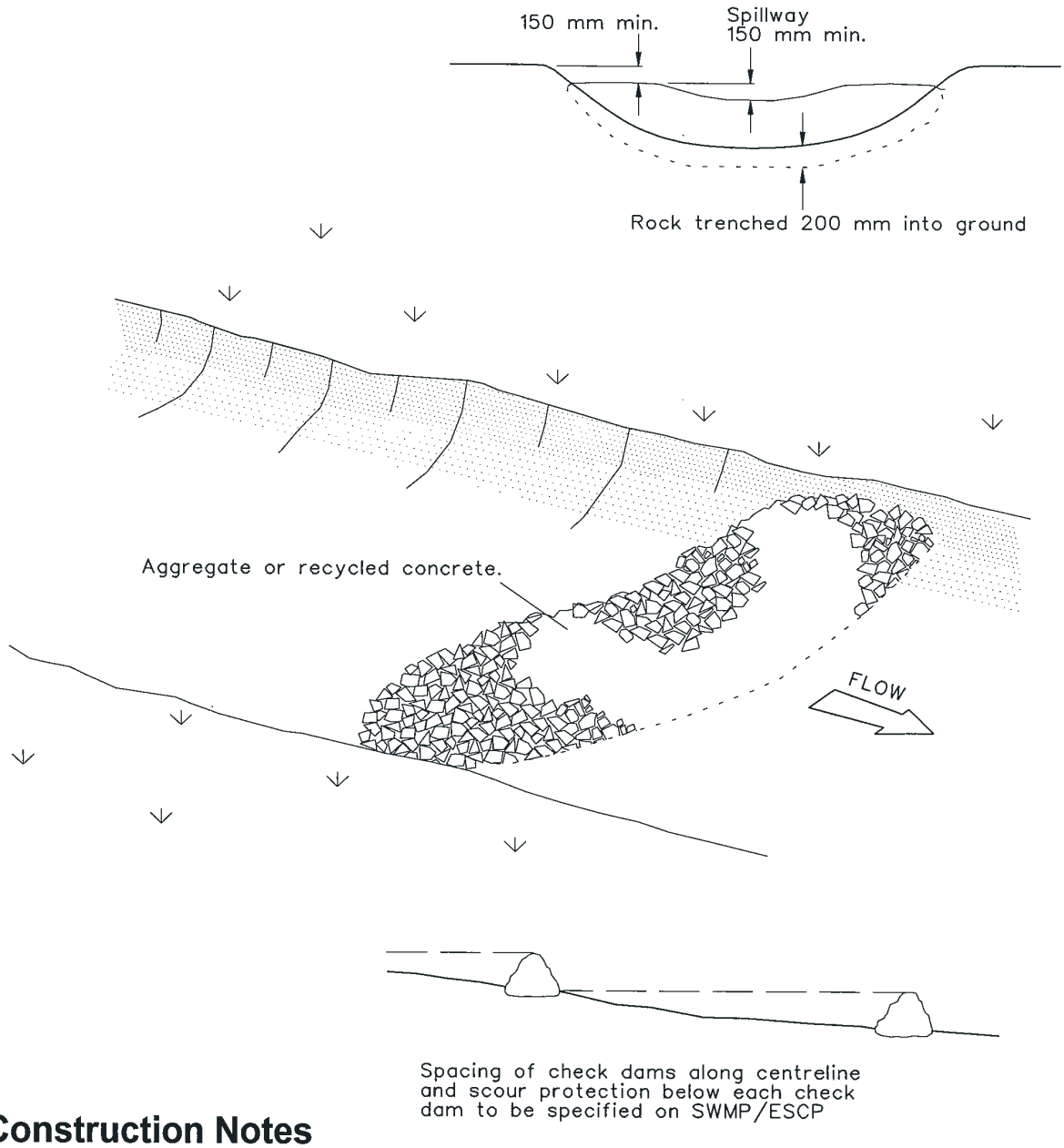


Channel Protection System

Construction Notes

1. Undertake design only with the help of a suitably qualified geotechnical engineer.
2. Anchor systems on steep slopes to prevent sliding or movement under gravitational forces. This might include the use of high tensile, low creep cables made of polyester (not polypropylene), rope or steel wire.
3. Place thick, non woven geotextiles under the cellular confinement system to allow for lateral drainage.
4. Fill the cells with soil, rock or concrete depending on the application.

CELLULAR CONFINEMENT SYSTEMS SD 5-3



Spacing of check dams along centreline and scour protection below each check dam to be specified on SWMP/ESCP

Construction Notes

1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.

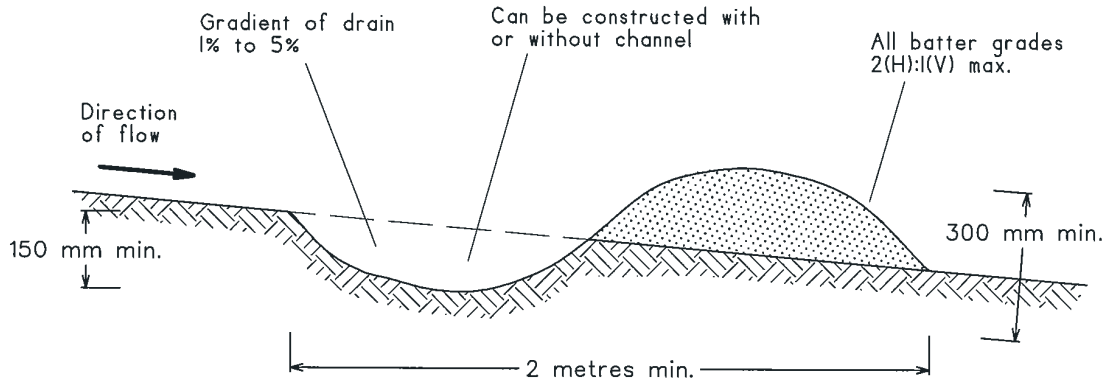
2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.

3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.

4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

ROCK CHECK DAM

SD 5-4

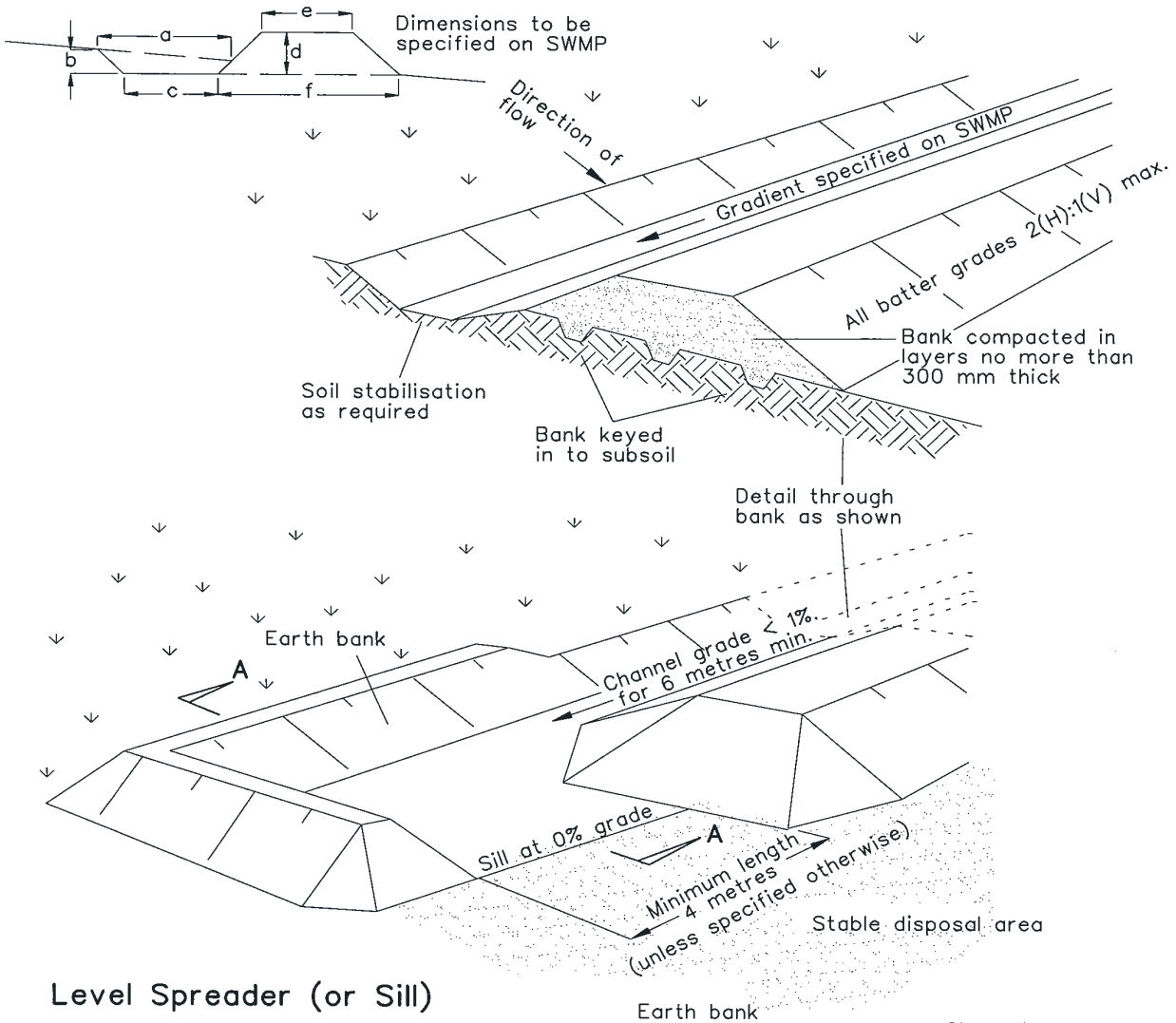


NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

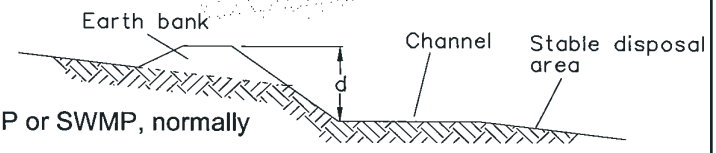
Construction Notes

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.
5. 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



Level Spreader (or Sill)

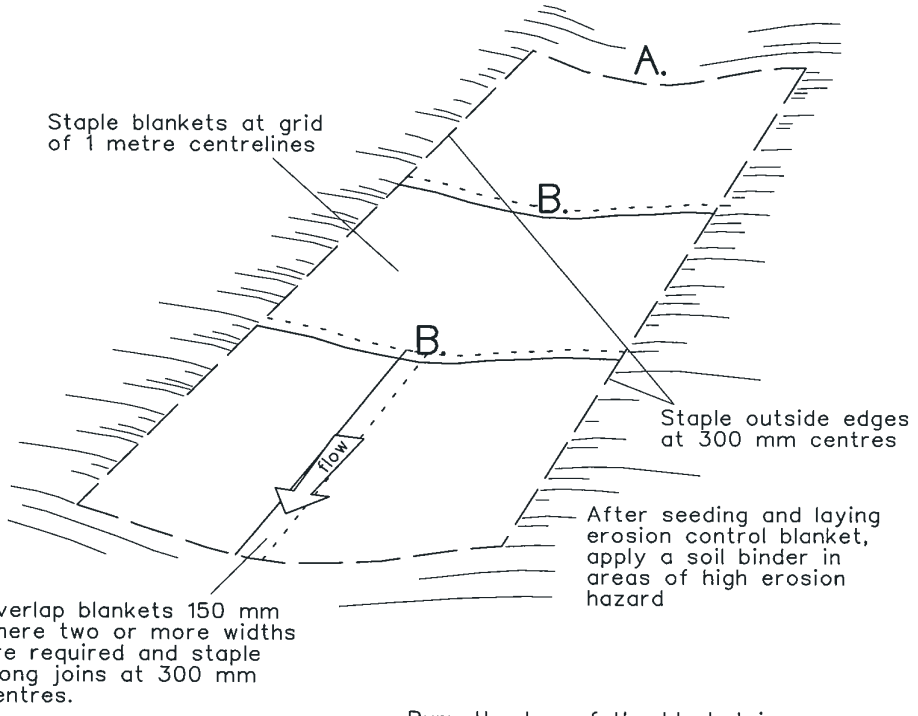


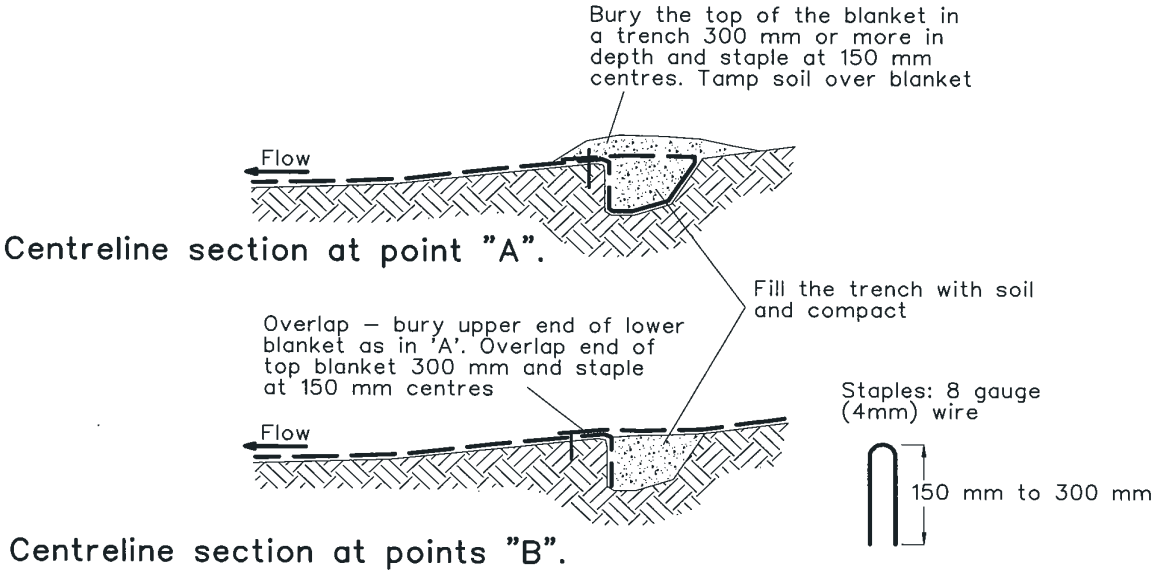
Section AA

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

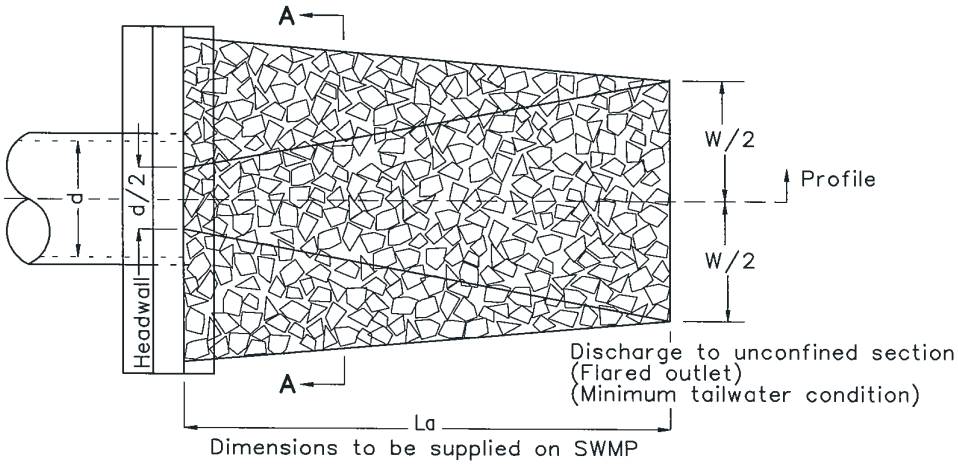




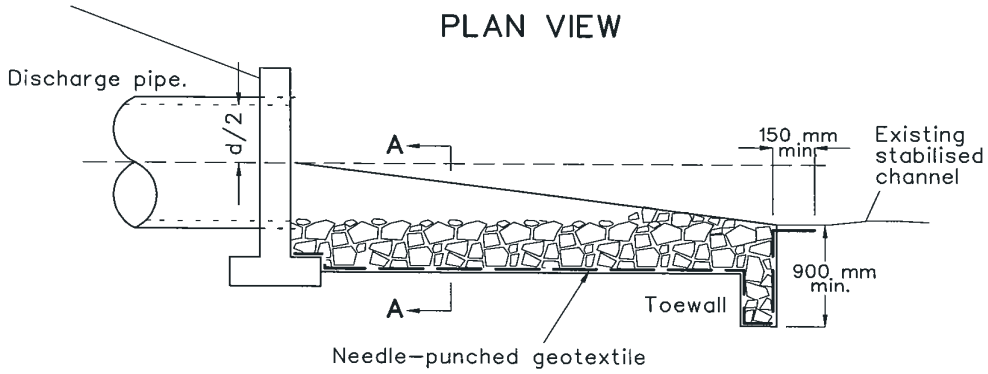
Construction Notes

1. Remove any rocks, clods, sticks or grass from the surface before laying matting
2. Ensure that topsoil is at least 75 mm deep.
3. Complete fertilising and seeding before laying the matting.
4. Ensure fabric will be continuously in contact with the soil by grading the surface carefully first.
5. Lay the fabric in "shingle-fashion", with the end of each upstream roll overlapping those downstream. Ensure each roll is anchored properly at its upslope end (Standard Drawing 5-7b).
6. Ensure that the full width of flow in the channel is covered by the matting up to the design storm event, usually in the 10-year ARI time of concentration storm event.
7. Divert water from the structure until vegetation is stabilised properly.

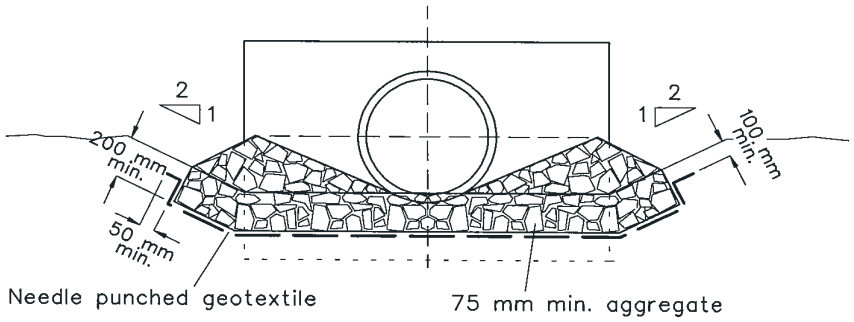
RECP : CONCENTRATED FLOW — SD 5-7



PLAN VIEW



PLAN VIEW

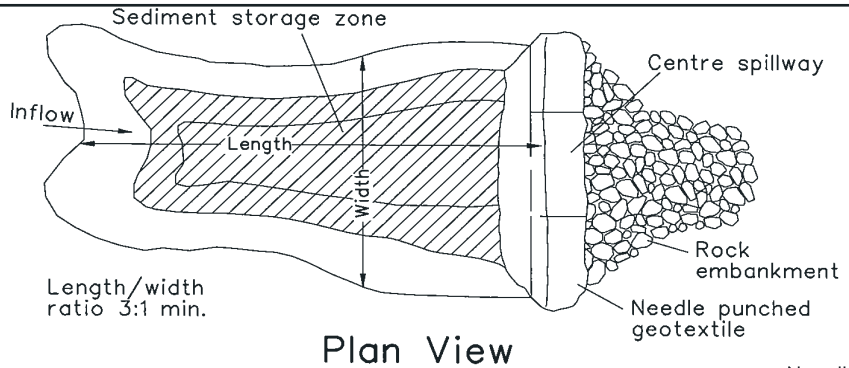


CROSS SECTION AA

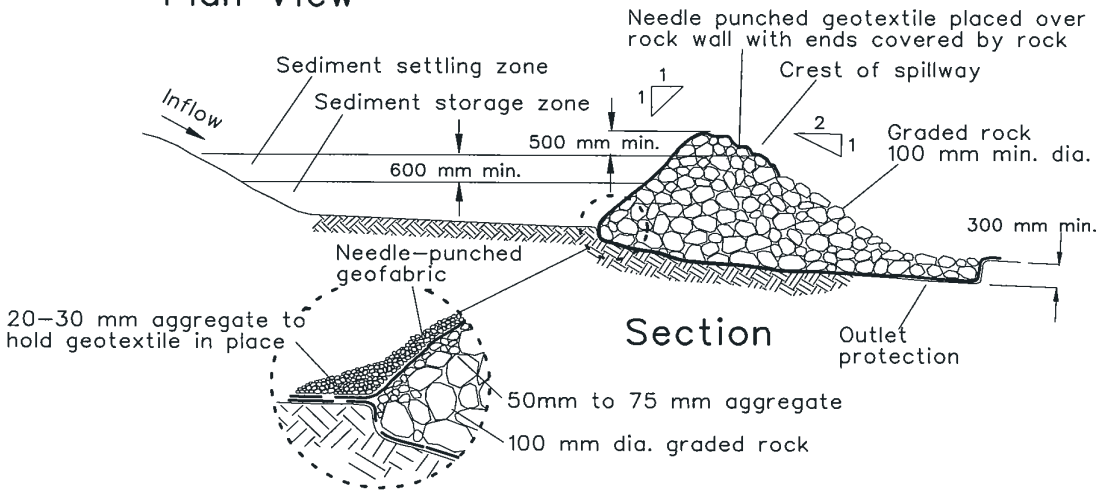
Construction Notes

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

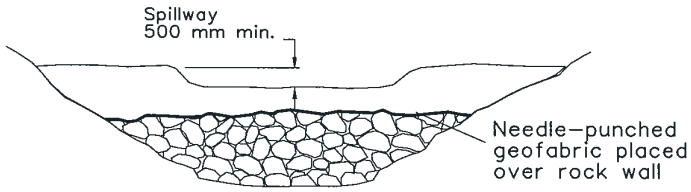


Plan View



Section

NOTE:
Spillway width and depth, wall crest width and downstream outlet protection measures to be specified on SWMP.



Downstream Elevation

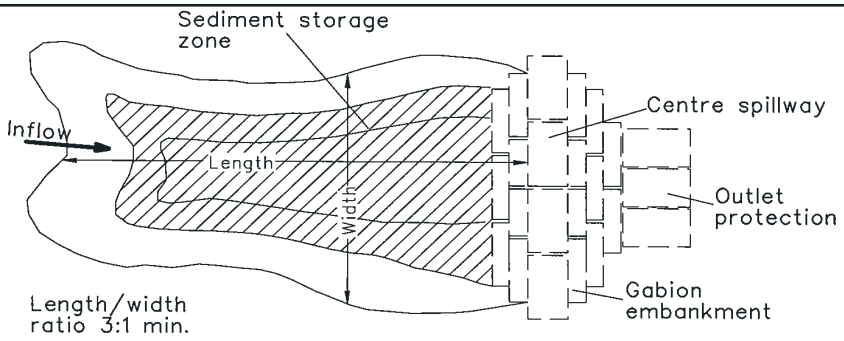
Construction Notes

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

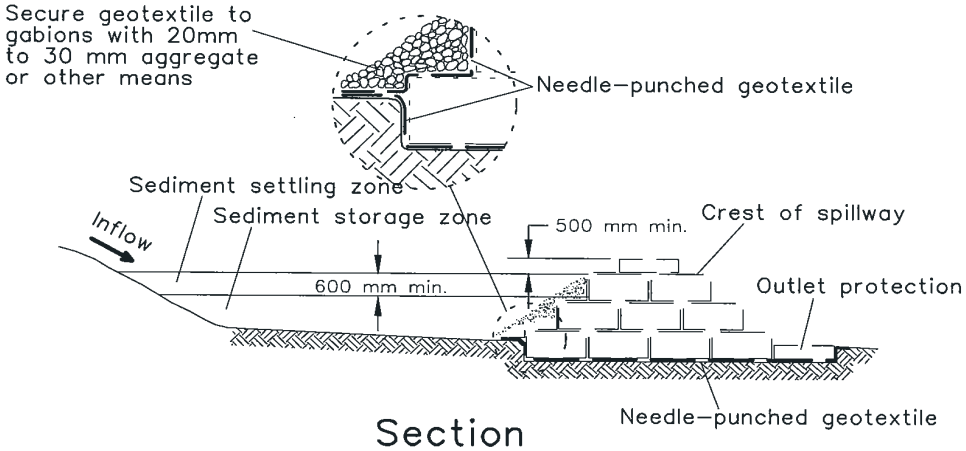
ROCK SEDIMENT BASIN

(APPLIES TO 'TYPE C' SOILS ONLY)

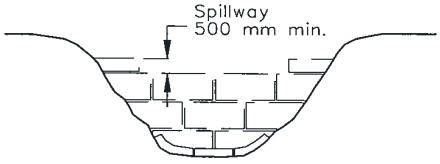
SD 6-1



Plan View



Section



Downstream Elevation

NOTE: Spillway width and depth, wall crest width and downstream outlet protection measures to be specified on SWMP.

Construction Notes

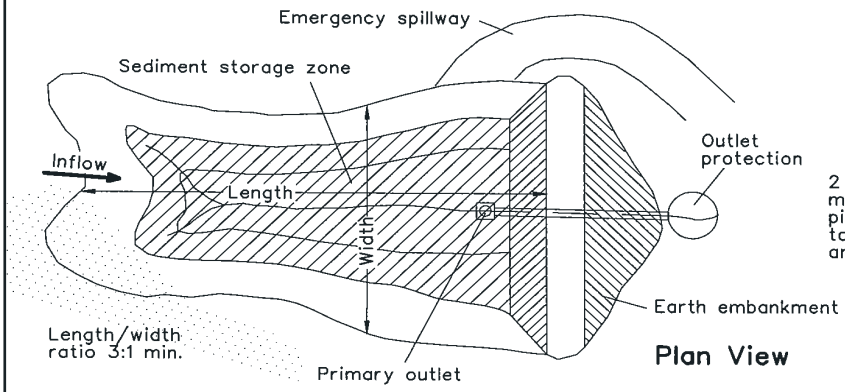
(Applies to Type C soils only)

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.

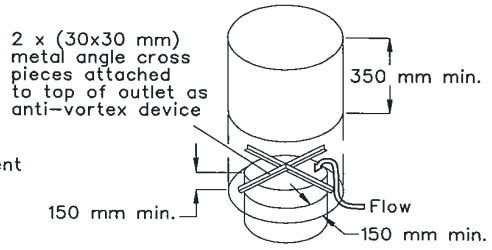
GABION SEDIMENT BASIN

(APPLIES TO 'TYPE C' SOILS ONLY)

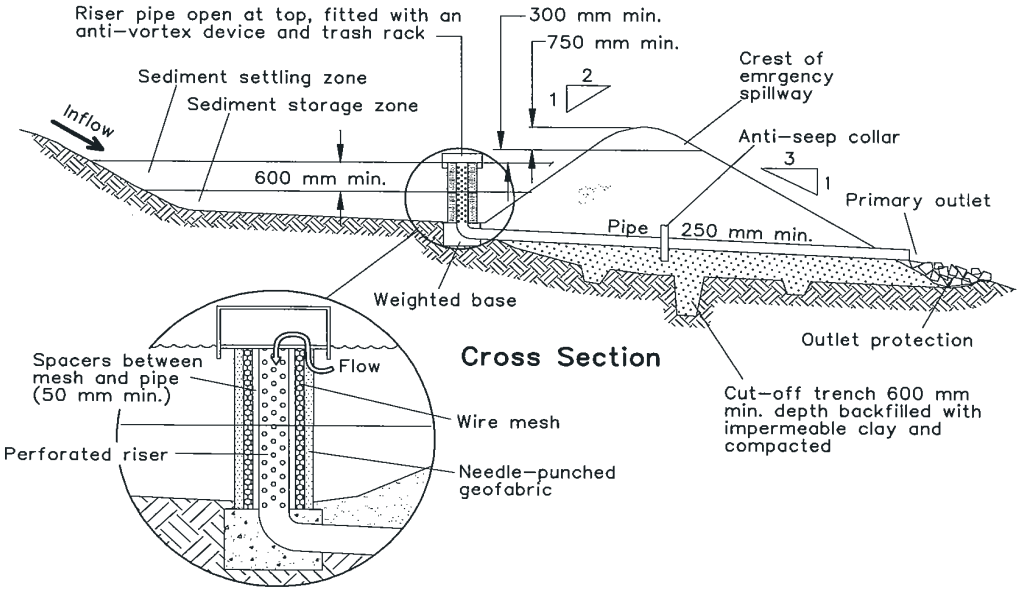
SD 6-2



Plan View



Trash Rack/ Anti-vortex Device



Cross Section

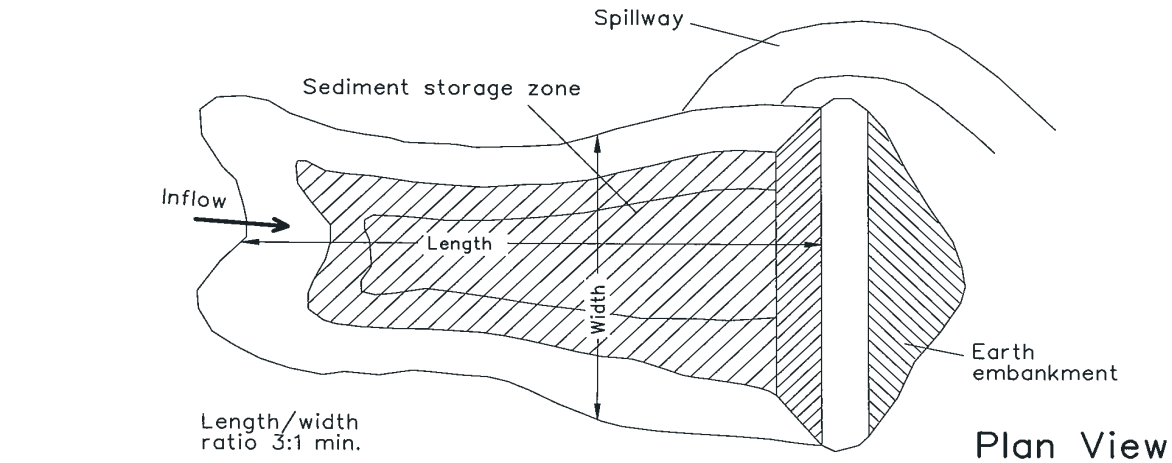
Construction Notes

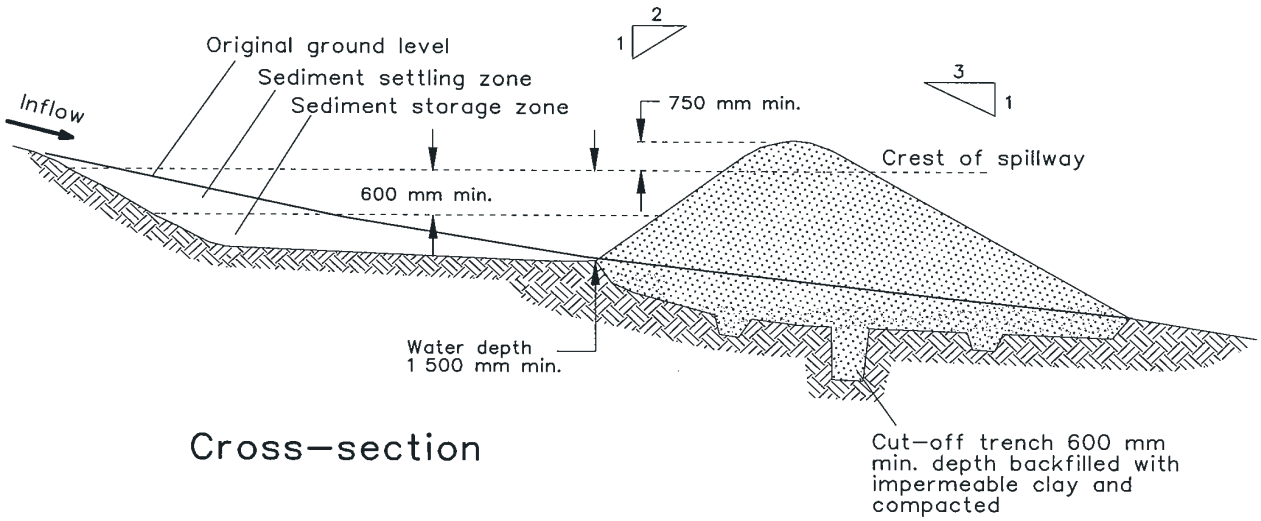
1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Form a cut off trench under the centreline of the embankment 600 mm deep and 1,200 mm wide, extending to a point on the watercourse wall above the riser sill level.
3. Maintain the trench free of water and 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





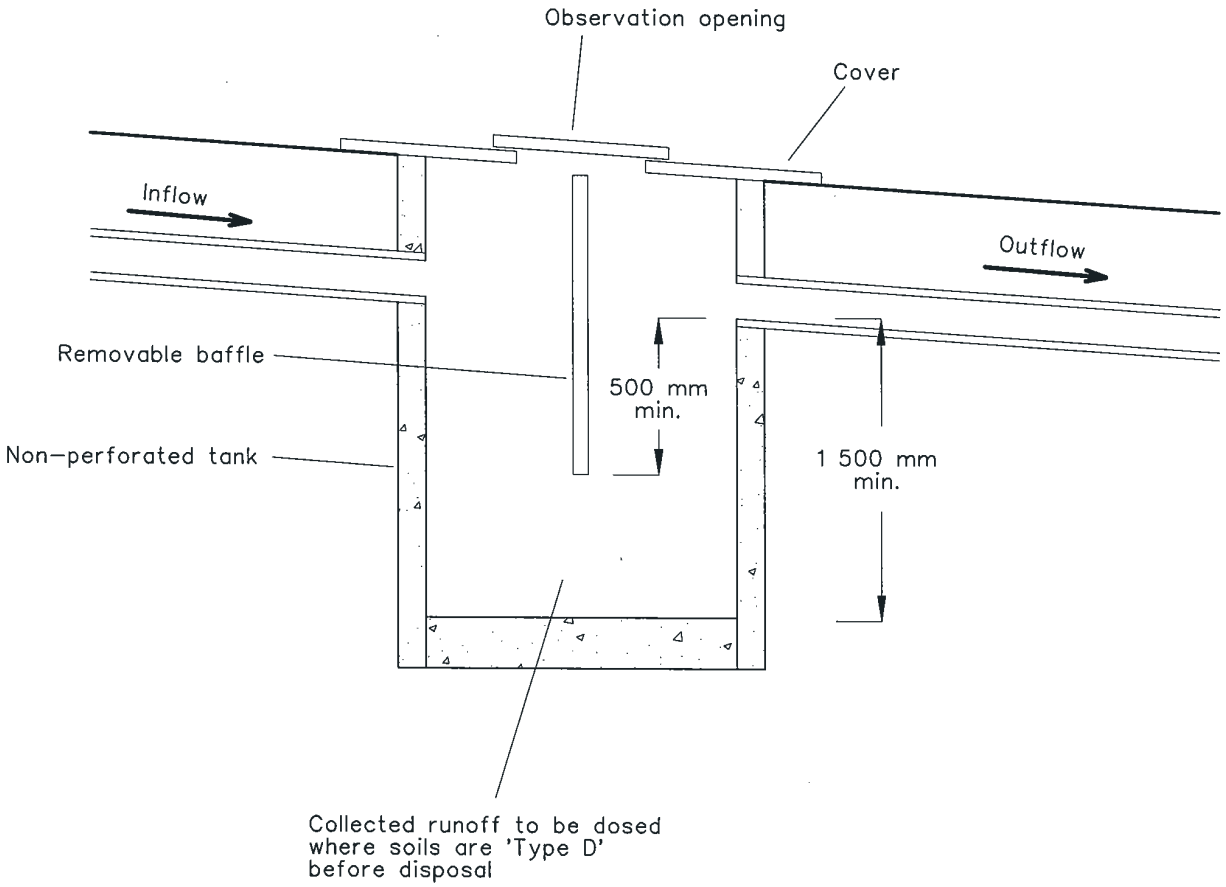
Construction Notes

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)

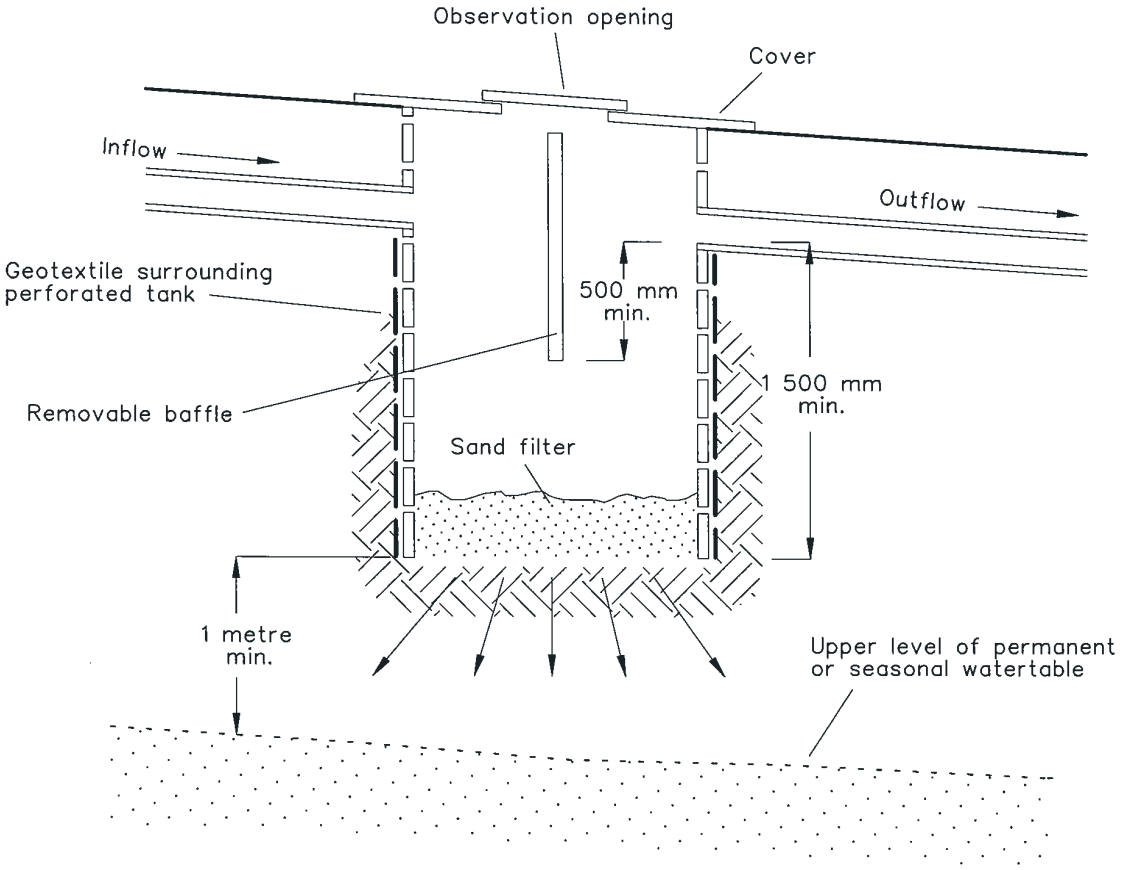
SD 6-4



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.

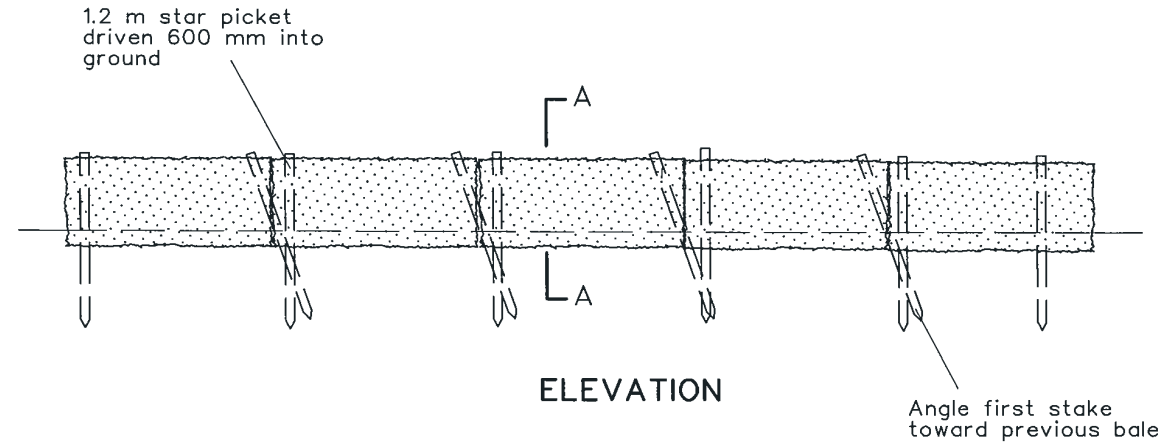
LINED TANK SD 6-5

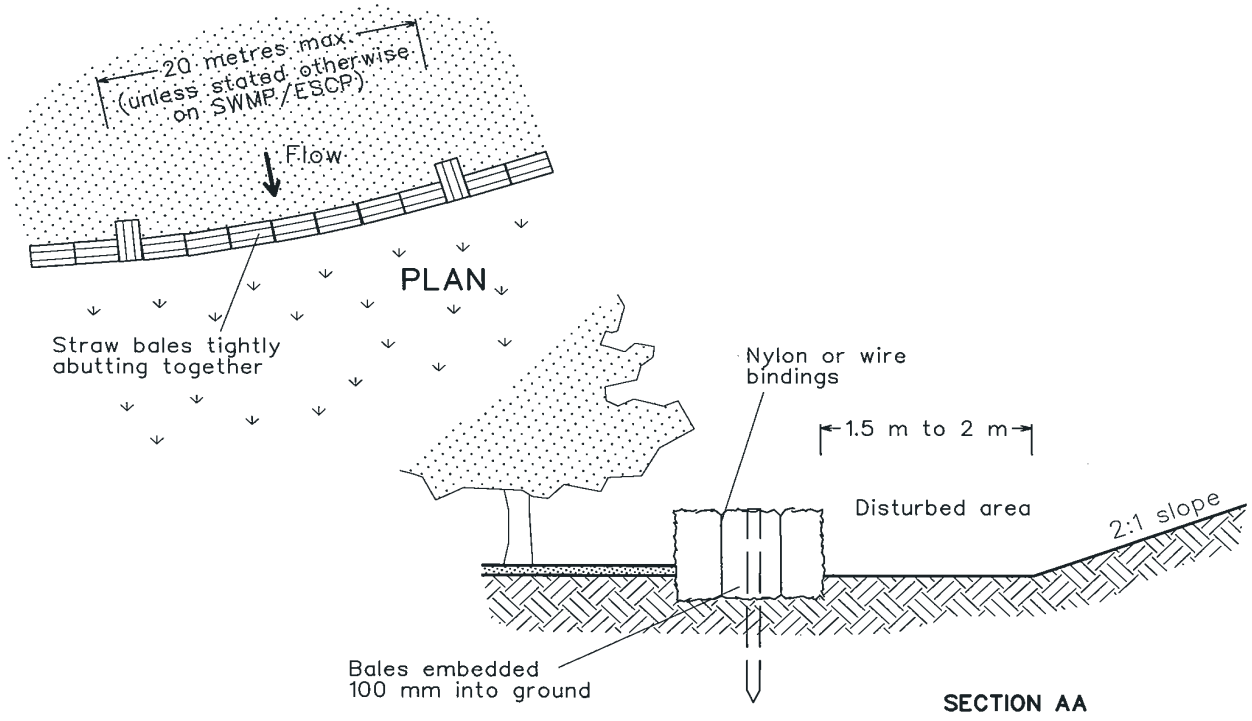


Construction Notes

1. Join the inlet to the polluted supply taking any suitable step to remove bulky material before it can enter the sump.
2. Connect the outlet to a safe disposal area following the ESCP/SWMP.
3. Place a geotextile liner on the outside of the pit.
4. 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.
5. Install a cover over the pit with an observation port and access cover.

INFILTRATION SUMP — SD 6-6

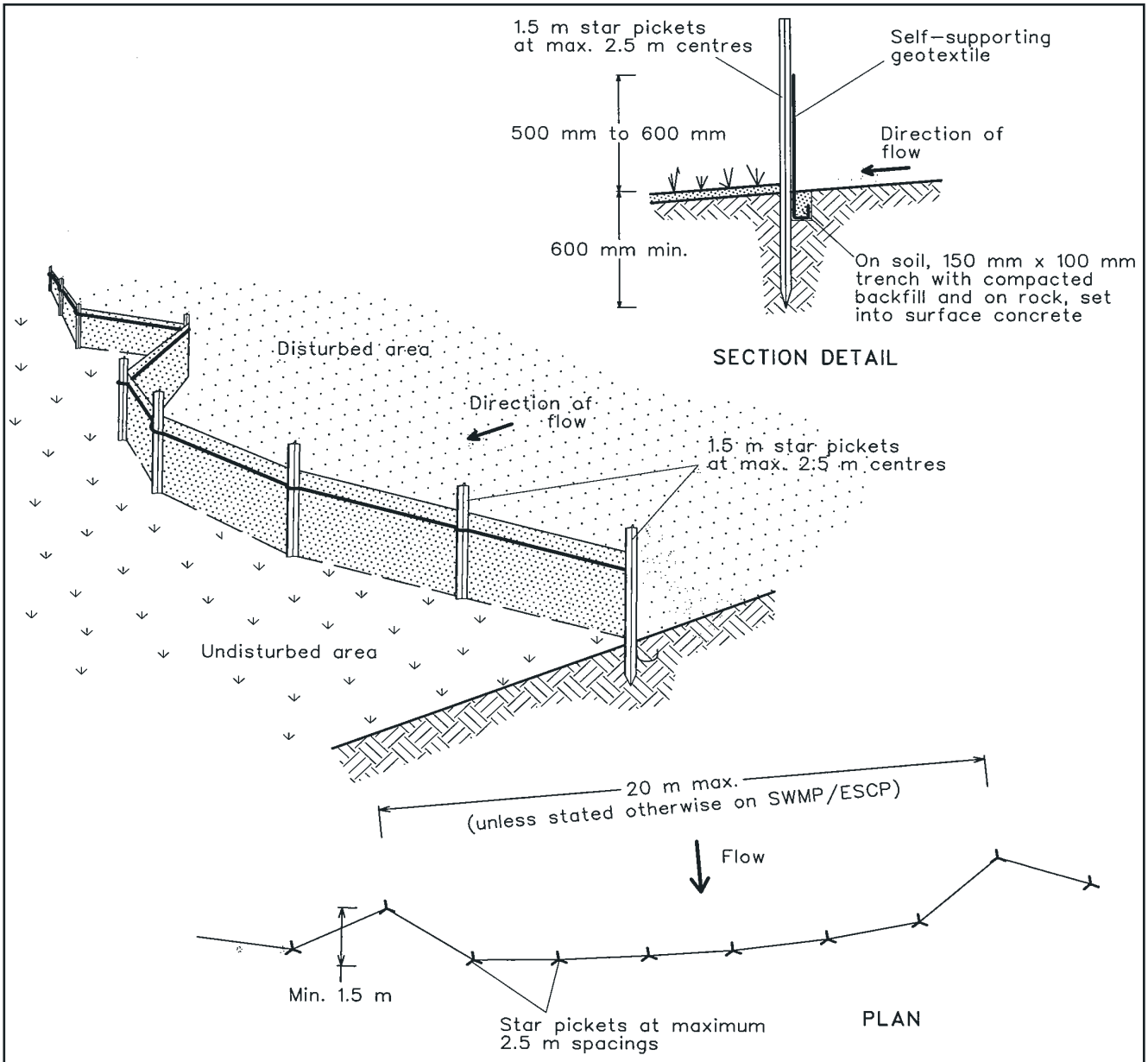




Construction Notes

1. Construct the straw bale filter as close as possible to being parallel to the contours of the site.
2. Place bales lengthwise in a row with ends tightly abutting. Use straw to fill any gaps between bales. Straws are to be placed parallel to ground.
3. Ensure that the maximum height of the filter is one bale.
4. Embed each bale in the ground 75 mm to 100 mm and anchor with two 1.2 metre star pickets or stakes. Angle the first star picket or stake in each bale towards the previously laid bale. Drive them 600 mm into the ground and, if possible, flush with the top of the bales. Where star pickets are used and they protrude above the bales, ensure they are fitted with safety caps.
5. Where a straw bale filter is constructed downslope from a disturbed batter, ensure the bales are placed 1 to 2 metres downslope from the toe.
6. Establish a maintenance program that ensures the integrity of the bales is retained - they could require replacement each two to four months.

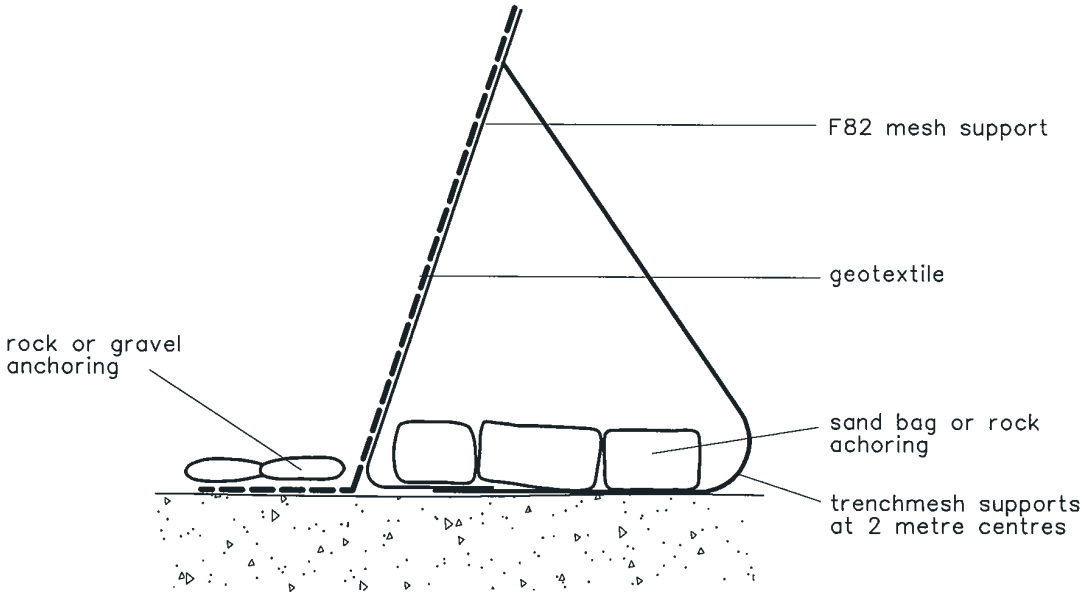
STRAW BALE FILTER SD 6-7



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.

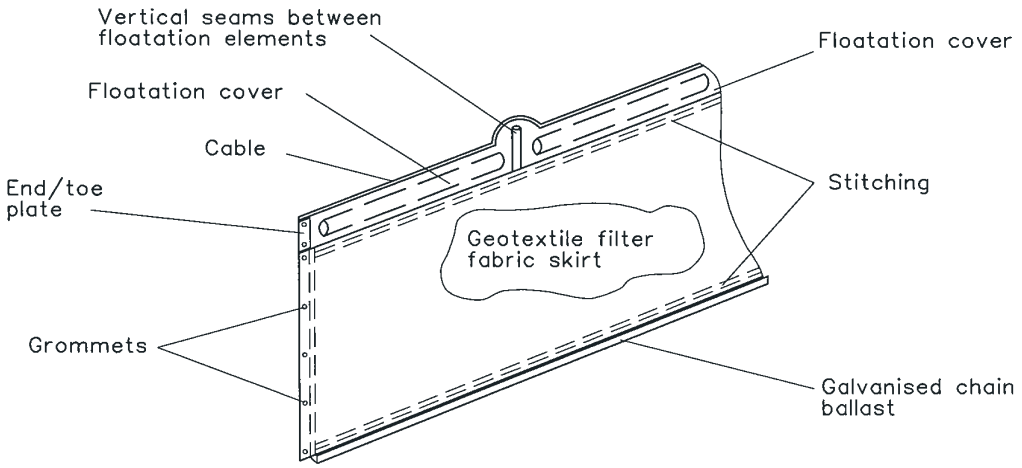
SEDIMENT FENCE — SD 6-8

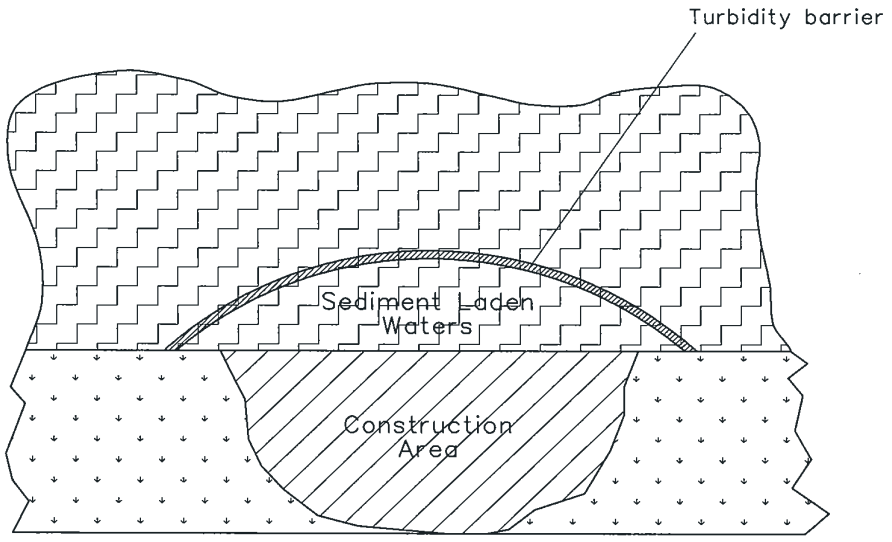


Construction Notes

1. Install this type of sediment fence when use of support posts is not desirable or not possible. Such conditions might apply, for example, where approval is granted from the appropriate authorities to place these fences in highly sensitive estuarine areas.
2. Use bent trench mesh to support the F82 welded mesh facing as shown on the drawing above. Attach the geotextile to the welded mesh facing using UV resistant cable ties.
3. Stabilise the whole structure with sandbag or rock anchoring over the trench mesh and the leading edge of the geotextile. The anchoring should be sufficiently large to ensure stability of the structure in the design storm event, usually the 10 year event.

ALTERNATIVE SEDIMENT FENCE SD 6-9

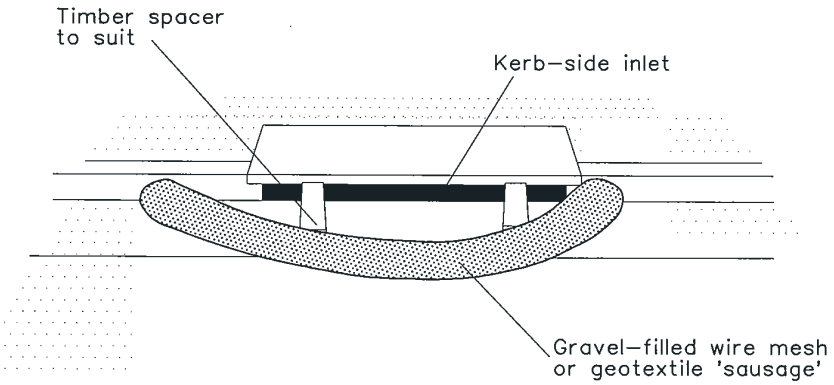


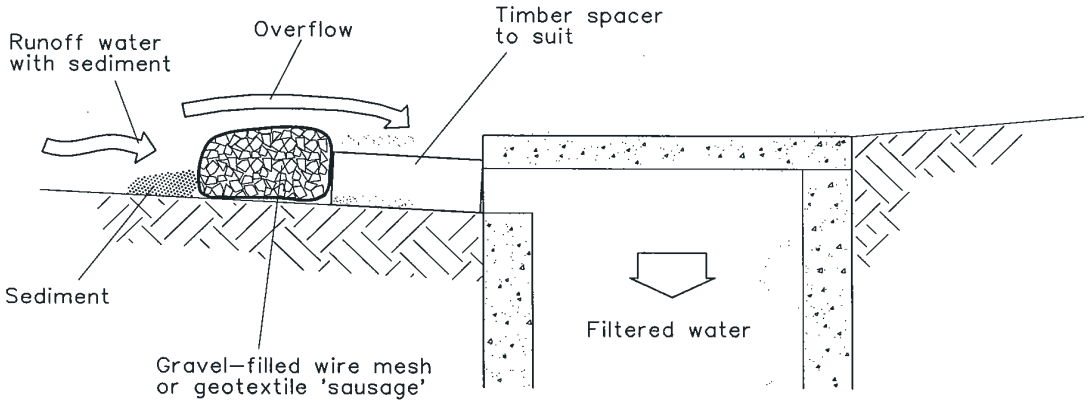


Construction Notes

1. Use turbidity barriers only where high flows are unlikely to remove accumulated sediment and/or move the curtain significantly.
2. Where the barrier is to remain in place for more than one month, ensure the floatation cover is a UV-resistant, durable material.
3. Use only closed cell foam or foam-filled PVC piping as floatation elements. Do not use unfilled pipes.
4. Use only woven or heat-set non woven geotextiles. Needle-punched, non woven geotextiles can become fouled with debris that fray and delaminate them as they move with the waves or currents.
5. Remove captured sediment before the barrier is decommissioned.
6. In tidal areas, ensure the barrier can rise and fall without being moved from its position.

TURBIDITY BARRIER SD 6-10



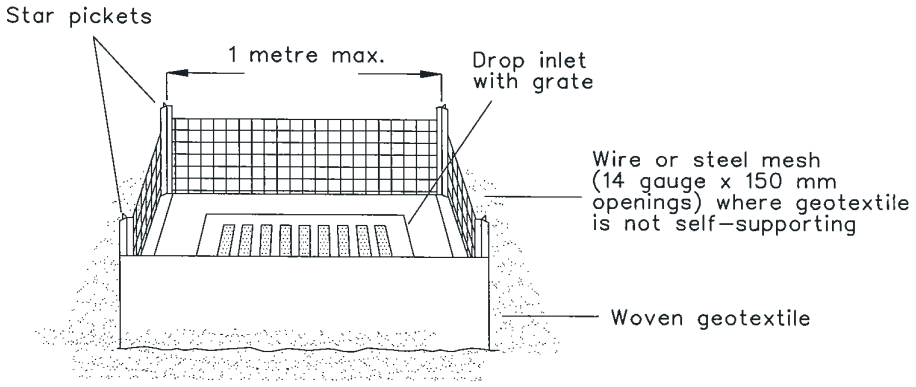


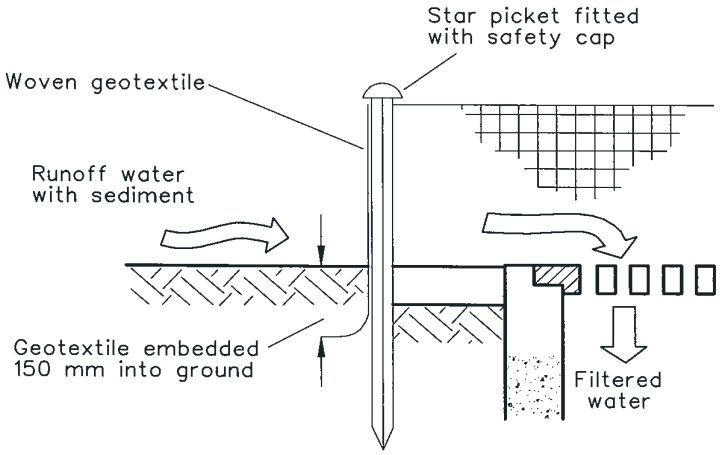
NOTE: This practice only to be used where specified in an approved SWMP/ESCP.

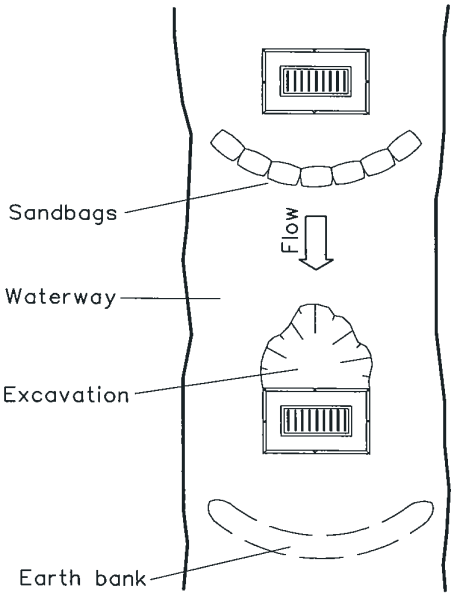
Construction Notes

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





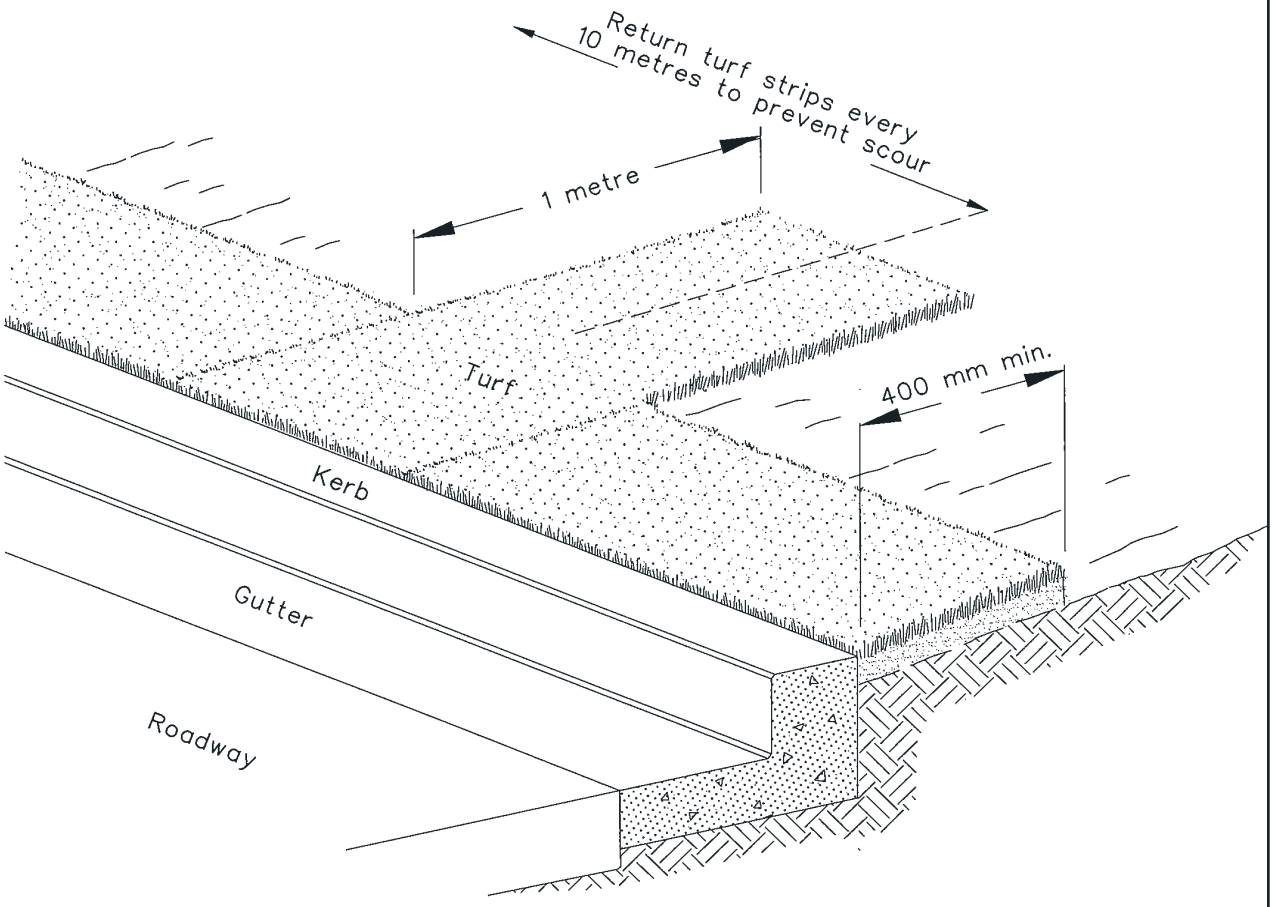


For drop inlets at non–sag points, sandbags, earth bank or excavation used to create artificial sag point

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

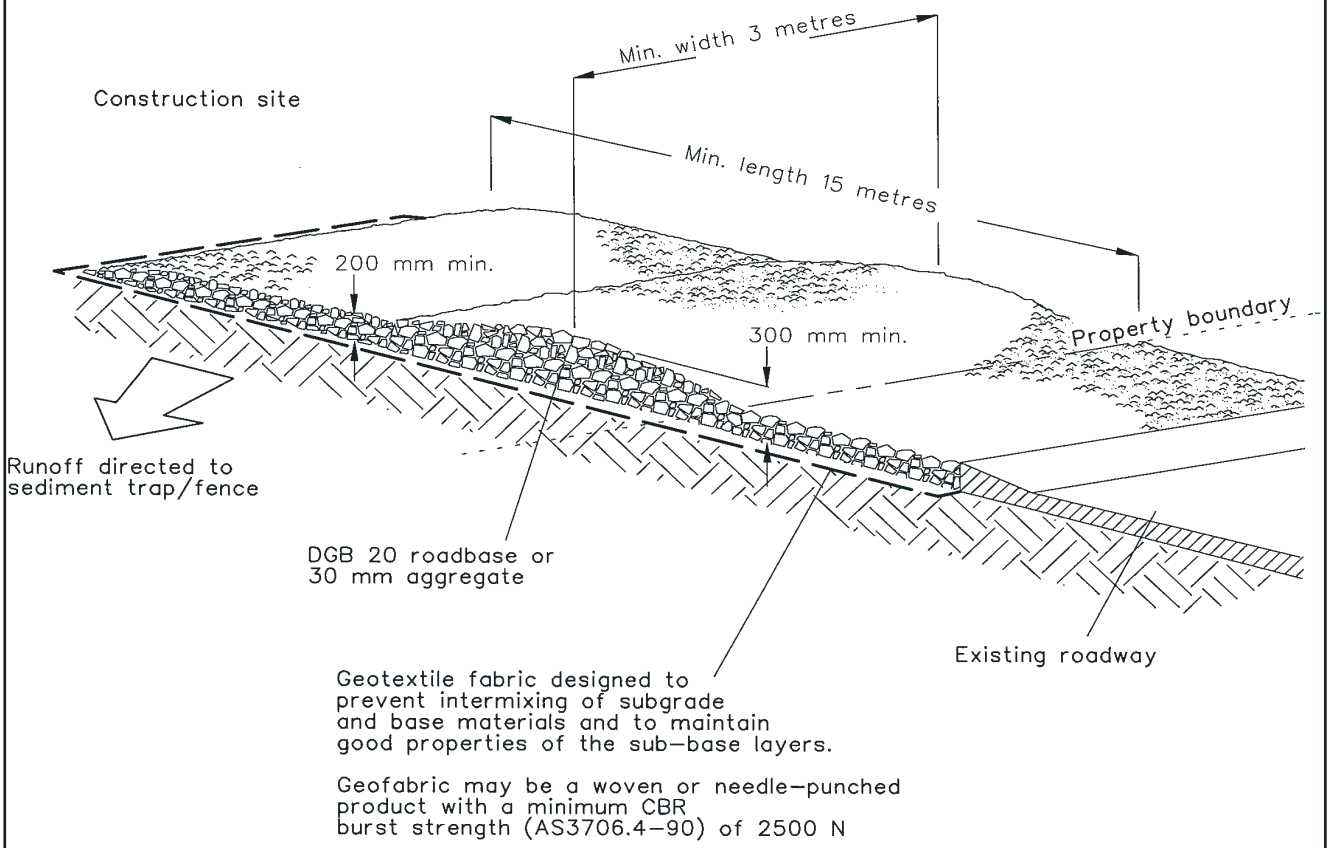


Construction Notes

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

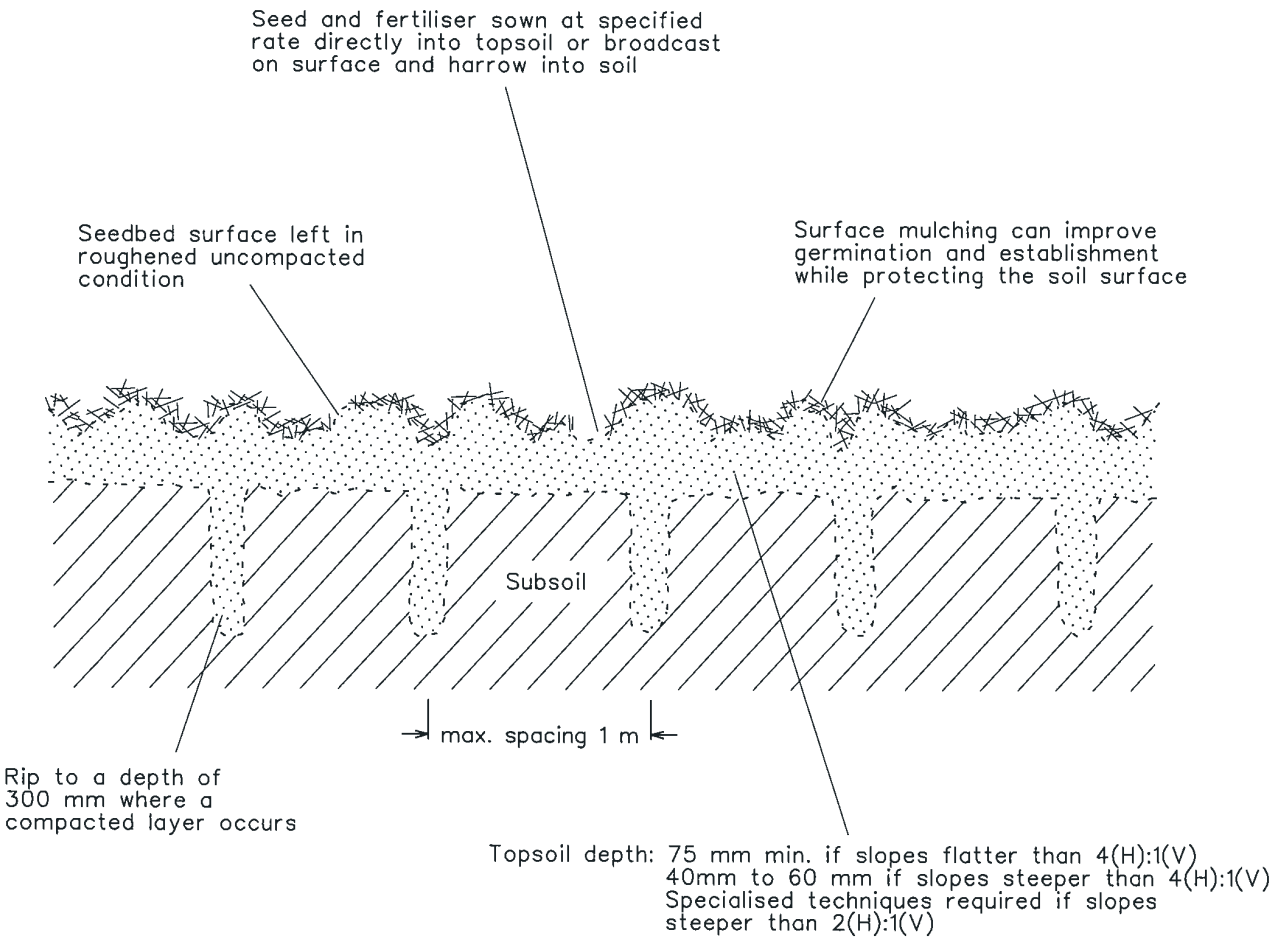
SD 6-13



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

Appendix B Construction water quality monitoring program

Construction water quality monitoring program

1. Background

WSP was engaged by Transport for NSW (formerly Roads and Maritime Services) to prepare a baseline water quality monitoring program for the project. Transport for NSW (formerly Roads and Maritime Services) commenced baseline monitoring of surface water quality and groundwater quality in November 2017 at various sites along the project alignment. Transport for NSW (formerly Roads and Maritime Services) will continue to monitor background conditions until commencement of construction. Baseline monitoring data reports (including results) are provided by WSP to Transport for NSW (formerly Roads and Maritime Services) on a monthly basis separate to this SWMP. The reports are available upon request. Upon completion of baseline monitoring, surface water and groundwater results recorded will be incorporated in a baseline monitoring program summary report. This report will include a discussion of observed baseline trends in water quality and groundwater levels (WSP, 2018 p20). Once the baseline monitoring program summary report has been completed, statistical assessment of the data will be undertaken to confirm the trigger levels presented in Table B-1.

It is noted that the baseline monitoring program provides information about general ecosystem health, rather than impacts from road construction activities.

The baseline water quality monitoring program (WSP, 2018) is contained in Annexure B1 and has been considered in the development of this construction water quality monitoring program.

2. Construction monitoring locations

During the construction phase of the project, surface water and groundwater quality will be monitored at the same locations as for the baseline monitoring program with the exception of SW1 as it is not influenced by Stage 2 works. Surface water quality will be monitored at eight locations (i.e. SW2-SW4, SW5A, SW6 to SW9) and groundwater quality will be monitored at six locations (i.e. BH318 and GW1 to GW5). It is noted that WSP (2018, p3-5) gave consideration to the location of groundwater dependent ecosystems when siting the groundwater monitoring wells.

In addition to the eight surface water monitoring locations identified for the baseline program (WSP, 2018), surface water quality will be monitored downstream of the bridge works at Duck Creek (i.e. SW2DS) and upstream of the bridge works at Macquarie Rivulet (i.e. SW3US) following feedback from DPI Fisheries during a consultation meeting on 26 June 2018. As a result, there will now be a total of 10 construction surface water quality monitoring locations for the project.

All construction water quality monitoring locations are shown in Figure B-1 and on the Sensitive Area Plans contained in Appendix A6 of the CEMP.

The precise location (easting and northing) of each water sampling location will be determined once the project team mobilises to site and agrees the location with the various landowners (where relevant). The location of the ground water monitoring points will be chosen to ensure they are clear of permanent and temporary works areas and confirmed on site with survey to ensure they are not destroyed during the project. This is a requirement of Transport for NSW (formerly Roads and Maritime Services) Scope of Works and Technical Criteria (SWTC) Appendix 14 Clause 14.4.2. They will also be assessed with the construction team to ensure they will remain accessible throughout the project.

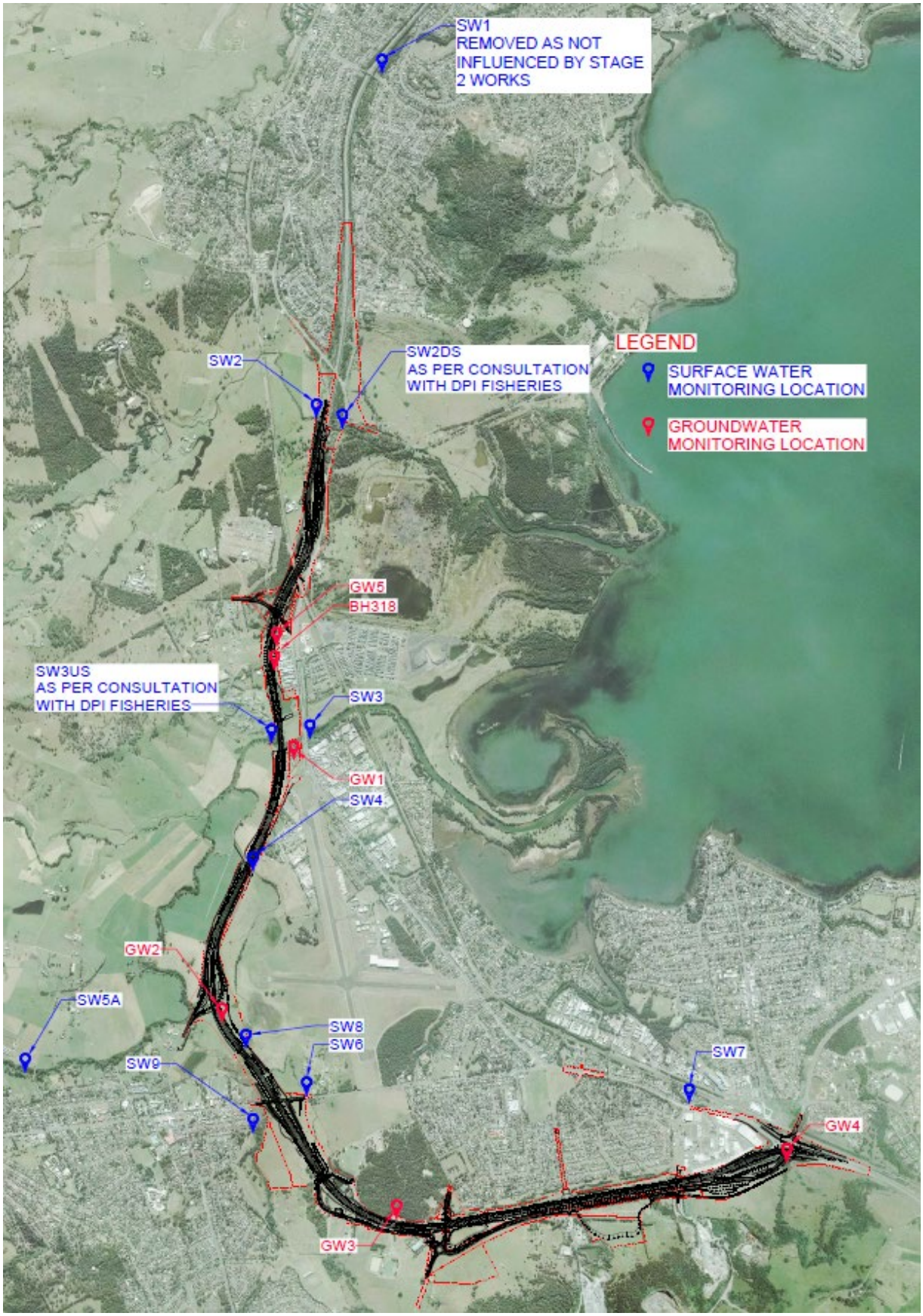


Figure B-1 Construction monitoring network (WSP, 2018) as amended to include two additional surface water monitoring locations (i.e. SW2DS and SW3US)

3. Construction monitoring parameters

The purpose of water quality monitoring during the construction phase is to determine impacts resulting from construction of the project only (i.e. road construction) and not other unrelated sources, such as agricultural operations. The potential impacts from road construction activities will most likely result from erosion and sediment control loss and spills. Nutrients from construction activities are not anticipated. The construction surface water and groundwater parameters are listed below.

In accordance with G38 Clause 2.3, a NATA accredited laboratory will be used for all testing of water quality.

Surface water

Surface water monitoring focuses on the parameters associated with road construction and include:

- Total suspended solids
- pH
- Oil and grease.

Groundwater

Groundwater monitoring focuses on the parameters associated with road construction and include:

- pH
- electrical conductivity
- temperature
- no visible oil and grease
- dissolved metals for GW2 only, which is located in a PASS risk area

Groundwater levels will also be measured at each groundwater monitoring location identified in Figure B-1.

4. Construction monitoring trigger levels

Following consultation with DPI Water, trigger levels have been included in the construction water quality monitoring program. Refer to Table B-1 below. The trigger levels identify when construction impacts are approaching the EPL criteria where relevant.

Monitoring results will be checked against the trigger levels (refer to Table B-1) and EPL criteria (refer to mitigation measure ID SWMM60) to identify any exceedances.

Refer to point 5 below for the procedures to be implemented when a monitoring result is outside of the water quality trigger level and/or EPL criteria.

5. Procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory

Implementation of the standard mitigation measures listed in Table 6-1 will ensure surface water and groundwater impacts are minimised during construction. In the event that complaints about surface water and/or groundwater are received or an exceedance of the EPL criteria (refer to mitigation measure ID SWMM60) or trigger levels (refer to Table B-1) has been identified through monitoring, site inspections or audits, Fulton Hogan will implement the following procedure:

- The Environmental Manager will investigate the issue to determine possible causes of the non-conformance (in accordance with Section 7.5) and to develop appropriate mitigation measures on a case-by-case basis.
- Surface water and/or groundwater complaints will be managed in accordance with complaints management process described in Sections 2.3 and 2.4 of the Community Communication Strategy. Where investigation confirmed clear and unambiguous impact resulting from the

construction of the project, the Environmental Manager, in consultation with the project team, will identify additional mitigation measures which may include, but not necessarily be limited to:

- Modification of the construction methods used
- Conduct unscheduled monitoring to further verify exceedance trend, where relevant

It is the responsibility of the Environmental Manager to ensure that the identified contingency measures are implemented.

6. Construction water quality monitoring program

Table B-1 summarises the construction water quality monitoring program for the Project. Information regarding non-conformances and reporting requirements are documented in Section 7.5 and 7.8 respectively of this SWMP.

Table B-1 Construction water quality monitoring program

Monitoring details	Area	Record	Responsibility	Monitoring parameters	Frequency	Trigger Level
SURFACE WATER						
Construction surface water quality at SW4, SW6, SW7, SW8, SW9.	Refer to the surface water monitoring locations identified in Figure B-1	Monthly Report Water quality sampling field record Chain of custody form (for environmental samples)/ Laboratory results	Environment Manager	Total suspended solids	Monthly	2 consecutive exceedances of the monthly average for TSS determined through assessment of the baseline data contained in the baseline monitoring program summary report
				pH	Monthly	Less than 6.6 and greater than 7.9
				Oil and grease	Monthly visual inspection and as required in response to spills on site. Laboratory testing only if sheen is visually present.	Greater than or equal to 9 mg/L
SW5a	Refer to the surface water monitoring locations identified in Figure B-1	Monthly Report Water quality sampling field record Chain of custody form (for environmental samples)/ Laboratory results	Environment Manager	Total suspended solids	Monthly	N/A. Location is an upstream control site and is not influenced by Stage 2 works.
				pH	Monthly	N/A. Location is an upstream control site and is not influenced by Stage 2 works.
				Oil and Grease	Monthly	N/A. Location is an upstream control site and is not influenced by Stage 2 works.
Upstream and downstream of the bridge works at Duck	Refer to the surface water monitoring locations	Monthly Report Water quality sampling field	Environment Manager	Total suspended solids	Monthly	2 consecutive exceedances of the monthly average for TSS determined

Monitoring details	Area	Record	Responsibility	Monitoring parameters	Frequency	Trigger Level
Creek (i.e. SW2, SW2DS) and Macquarie Rivulet (i.e. SW3US, SW3)	identified in Figure B-1	record Chain of custody form (for environmental samples)/ Laboratory results				through assessment of the baseline data contained in the baseline monitoring program summary report
				pH	Monthly	Less than 6.6 and greater than 7.9 Less than 6.9 and greater than 8.4 (Macquarie Rivulet only - estuarine)
				Oil and grease	Monthly visual inspection and as required in response to spills on site. Laboratory testing only if sheen is visually present.	Greater than or equal to 9 mg/L
Sediment basin discharge water quality	Refer to the discharge points specified in the EPL.	Monthly Report Dewatering record Water quality sampling field record Chain of custody form (for environmental samples)/ Laboratory results	Environment Manager	Total suspended solids (or NTU in accordance with the EPL)	Prior to discharge	48 mg/L TSS (or NTU equivalent in accordance with the EPL)
				pH	Prior to discharge	Less than 6.6 and greater than 8.4
				Oil and grease	Prior to discharge	Visible oil and grease
Monitoring Bureau of Meteorology forecast	All	Email Record to staff	Environment Manager/ Administration	Not applicable	Daily	Not applicable
GROUNDWATER						
Groundwater construction water quality monitoring	Refer to the groundwater monitoring locations identified in Figure B-1.	Quarterly Report Dewatering record Water quality sampling field record Chain of custody form (for environmental samples)/	Environment Manager	pH electrical conductivity temperature no visible oil and grease dissolved metals for GW2 only,	Quarterly	2 consecutive exceedances of the quarterly averages determined through assessment of the baseline data contained in the baseline monitoring

Monitoring details	Area	Record	Responsibility	Monitoring parameters	Frequency	Trigger Level
		Laboratory results		which is located in a PASS risk area		program summary report
Groundwater level	Refer to the groundwater monitoring locations identified in Figure B-1.	Quarterly Report	Environment Manager	Groundwater level	Quarterly	2 consecutive exceedances of the quarterly average level determined through assessment of the baseline data contained in the baseline monitoring program summary report

Annexure B1 Baseline water quality monitoring program (by then, Roads and Maritime)

ROADS AND MARITIME SERVICES

BASELINE MONITORING PROGRAM - ALBION PARK RAIL BYPASS

APRIL 2018

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Baseline monitoring program - Albion Park Rail bypass

Roads and Maritime Services

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[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

	NAME	DATE	SIGNATURE
Prepared by:	Pepijn van Ravesteyn	20/04/18	[redacted]
Reviewed by:	Andrea Madden, Eric Lam	20/04/18	[redacted]
Approved by:	Andrea Madden	20/04/18	[redacted]

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

The Roads and Maritime Services is planning a 9.8 km extension of the Prices Motorway to a four-lane divided motorway between Yallah and Oak Flats, to bypass the suburb of Albion Park Rail, NSW. Key features of the Albion Park Rail bypass (the project) include the provision of interchanges, multiple bridges to carry the motorway over roads and water courses, and improved pedestrian and cycle connections.

An environmental impact statement was prepared for the project in 2015 and a submissions and preferred infrastructure report was submitted in September 2017. The Department of Planning and Environment provided planning approval for the project in early 2018, with major construction anticipated to commence in early 2019 (Roads and Maritime Services, 2018).

The project area consists of rocky hills and ridges to the north and south, an escarpment to the west and the foreshore of Lake Illawarra to the east. The central section of the project area comprises a low-lying floodplain. Much of the central section of the project area is classified as Class 1 (highest risk) for potential acid sulfate soils (Hyder Cardno Joint Venture, 2015).

1.2 OBJECTIVES

The objectives of the surface water and groundwater monitoring program are to obtain baseline monitoring data, which considers seasonality, prior to the commencement of construction for the project. The baseline data will support the development of surface water and groundwater monitoring programs to be used for impact assessment during project construction and operation.

The primary objectives of this document are to detail the baseline surface water and groundwater monitoring program and water quality sampling protocols that are being adopted.

2 CONSULTATION WITH REGULATORS

A framework baseline monitoring program (WSP, 2017a), which provides the basis of this baseline monitoring program, was prepared and sent to the NSW Environment Protection Authority (EPA) and the Division of Crown Lands & Water (Department of Industry, formerly Department of Primary Industries - Water). This section summaries the consultation.

2.1 NSW ENVIRONMENT PROTECTION AUTHORITY

The framework baseline monitoring program (WSP, 2017a) was sent to the NSW EPA in October 2017. The EPA deemed a meeting was not required. An email was sent by the EPA (Jen Byrne) on 26 October 2017, stating the framework was reviewed, especially in relation to surface water. The EPA stated the framework appears to be comprehensive. The following comments were provided for consideration:

- Continuing to monitor the same sample locations during construction and post-construction.
- The University of Wollongong School of Environmental Science may have some data to supplement the study.
- Publishing the monitoring data on the website of the Roads and Maritime Services.
- Including reference to sampling and analysis methods, such as the approved methods for the sampling and analysis of water pollutants in NSW (EPA, 2004).
- Providing the NSW EPA with any monitoring data collected.

2.2 DEPARTMENT OF INDUSTRY

The framework baseline monitoring program (WSP, 2017a) was sent to the Department of Industry (DI) and a meeting held on 7 December 2017. Richard Green and Janne Grose from DI attended the meeting. The following was recommended:

- The production of a flow net and surveying the new monitoring wells.
- Analysing the groundwater in the vicinity of the main cut, which is near an industrial area, for benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN), polycyclic aromatic hydrocarbons (PAH), total recoverable hydrocarbons (TRH) and oil and grease. Recommended as a one-off event for now.
- Analysing the groundwater in the vicinity of the Fire and Rescue site at Albion Park and the alluvium for per- and polyfluoroalkyl substances (PFAS) and pesticides. An assessment for further monitoring to be made following receipt of the results.

Refer to Section 12 in relation to the additional monitoring undertaken in response to the above recommendations.

The groundwater component of the framework was deemed adequate, with internal DI discussion regarding the surface water required prior to determining the surface water monitoring programs adequacy.

The DI provided a letter on 6 February 2018, stating the following:

- The groundwater monitoring program is adequate.
- The proposed surface water sampling of 48 to 72 hours following a rainfall event should be reduced.
- The program should detail how data from sampling is to be stored, analysed, interpreted and reported on.

Refer to Section 5 for further information regarding the sampling time following a rainfall event. Refer to Sections 8, 9 and 10 for details regarding the storage, analysis, interpretation and reporting.

3 OVERVIEW OF ENVIRONMENTAL IMPACTS

3.1 SURFACE WATER

The following information on surface water and potential impacts was summarised from Hyder Cardno Joint Venture (2015).

The project area drains to three main watercourses, all of which are tributaries of Lake Illawarra: Duck Creek, Macquarie Rivulet (which is fed by Marshall Mount Creek and Frazers Creek), and Horsley Creek (Figure 3.1). These watercourses and Lake Illawarra, comprise the receiving waters for the project, and have the potential to be impacted by the project during construction and operation.

The sensitive receiving environments are shown in Figure 3.1. Those that may potentially be impacted by the project, via water quality impacts, are located within and downstream of the project area and include:

— the ecosystems of Duck Creek, Macquarie Rivulet and Horsley Creek

— freshwater wetlands and saltmarsh threatened ecological communities

— State Environmental Planning Policy (SEPP) 14 (Coastal Wetlands)

— groundwater dependent ecosystems (GDEs)

— Lake Illawarra.

The construction phase impacts on water quality are associated with the following:

— leaching of tannins from stockpiled vegetation

— sediment from vegetation clearing and exposure of soils

— earthworks and dewatering, exposing potential and actual acid sulfate soils

— disturbance of contaminated materials

— use of vehicles, plant and machinery

— adjusting Frazers Creek north of the existing Croom Regional Sporting Complex

— activities at ancillary sites, such as storage of chemicals and stockpiling

— construction activities generating waste.

The above has the potential to negatively impact receiving waters by increasing turbidity and sedimentation, changes in acidity, changed in dissolved oxygen and introduction of pollutants such as nutrients, metals, oils and grease.

3.2 GROUNDWATER

The following information on the groundwater systems and potential impacts was summarised from Roads and Maritime Services (2015).

The hydrogeology of the project area consists of an unconfined, unconsolidated alluvium aquifer (Quaternary age) and a deeper unconfined to semi-confined consolidated rock aquifer (shale, siltstone, sandstone and volcanics (latites and tuffs)) (Permian age). Broadly, the geology is dominated by consolidated rock to the north and south and alluvium in the centre of the study area.

Map: PS106112_GIS_001_A7	Author: David.Naiken		
Date: 1/03/2018	Approved by: P.Van Ravesteyn		

Data source , Department of Finaces, Services and Innovation (2017), Data serived from RMS, Hyder, Cardno (2017), ESRI

0 400 800 m

1:28,000

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

Albion Park Rail Bypass

Figure 3.1
Monitoring Network

Groundwater flow in the alluvium and the consolidated rocks is predominantly from west to east, and south to north in the southern part of the study area.

As stated in Roads and Maritime Services (2015), the aquifers were interpreted to support the Macquarie Rivulet GDE, possibly in conjunction with surface water interaction, located at the estuary of the Macquarie Rivulet on Illawarra Lake. The Macquarie Rivulet GDE has been identified as high priority in the NSW regulation. A SEPP 14 freshwater wetland located on Frazers Creek is directly east of the alignment. Reliance on groundwater is uncertain. Deep rooted vegetation of the Illawarra Lowlands Grassy Woodland Endangered Ecological Community (EEC) would be partially reliant on groundwater, including Croom Reserve, located close to the alignment (Figure 3.1).

The project activities, which include a number of bridges, cut and fill areas and soil treatments, have a potential to impact the groundwater regime. There will be several cuts, with one deep cut (Cut 1), to the south of Yallah Road and north of Macquarie Rivulet (Figure 3.1). The cut is 440 m long, up to 15.2 m high, predominantly in siltstone and a predicted outflow for this cut of 21 m^3/day over the distance of 440 m.

The impact assessment identified some key findings, such as the following:

- The Macquarie Rivulet estuary GDE and SEPP14 wetland on Frazers Creek are not anticipated to be impacted by the project, however there is a level of risk to the wetland and the deep rooted GDEs associated with the Illawarra Lowlands Grassy Woodland EEC at Croom Reserve.
- There is some dewatering required due to road cuts on the northern section of the route, particularly associated with Cut 1. There will be no impact on groundwater users or GDEs.
- Fill and soil treatments may locally alter groundwater flow in the alluvium aquifer, associated with the two largest fill areas of Fill 6 and Fill 7(Figure 3.1). This is through the use of wick drains which drain pore water and cause compaction of the sediments.
- There is a risk of groundwater contamination from spills and runoff water.

4 MONITORING NETWORK

4.1 SURFACE WATER

The surface water monitoring network, along with the rationale for selection, is provided in Table 4.1. The location of the network is shown in Figure 3.1. Safety was taken into consideration in the design of the monitoring network, with sampling sites carefully selected to ensure they can be accessed safely during dry weather events and following rainfall.

Table 4.1 Surface water monitoring network

SITE IDENTIFIER	LOCATION	RATIONALE
SW1	Brooks Creek, north of the project area, near Emerson Road	Flowing to the north, past the northern-most section of the project.
SW2	Duck Creek, near the intersection of the Princes Highway and Yallah Bay Road.	One of the main watercourses in the project area; a tributary of Lake Illawarra.
SW3	Macquarie Rivulet, east of the Princes Motorway (bridge)	One of the main watercourses in the project area; a tributary of Lake Illawarra. Contributes flow to the Macquarie Rivulet GDE.
SW4	Frazers Creek, east of Terry Street (Illawarra Highway), Albion Park Rail	Macquarie Rivulet is fed by Frazers Creek. Location is downstream from freshwater wetlands, including a SEPP 14 wetland. The preferred location for SW4 is at the downstream (western) side of the project boundary, however site access has made this unfeasible. Thus, the upstream location was selected.
SW5	Macquarie Rivulet, on the western edge of the project area, by the Illawarra Highway	One of the main watercourses in the project area; a tributary of Lake Illawarra. Contributes flow to the Macquarie Rivulet GDE. SW5 was to be sampled further upstream as a control site, however property access was not obtained. SW5 was sampled from November 2017 to mid-February 2018. This location was replaced in late February 2018 with SW5A.
SW5A	Macquarie Rivulet, on the western edge of the project area, by the Illawarra Highway	This is a control site (unaffected by the project) and one of the main watercourses in the project area; a tributary of Lake Illawarra. Contributes flow to the Macquarie Rivulet GDE. SW5A replaces SW5, and was sampled from late February 2018.
SW6	Frazers Creek, south of Tongarra Road, Croom	Macquarie Rivulet is fed by Frazers Creek. The location is downstream from Croom Reserve, an Illawarra Lowlands Grassy Woodland EEC and GDE.

SITE IDENTIFIER	LOCATION	RATIONALE
SW7	Horsley Inlet, between Princes Highway and Pioneer Drive, Albion Park Rail. North of the south-eastern edge of the project area.	One of the main watercourses in the project area; a tributary of Lake Illawarra. Flowing to the northwest, through the project area to Lake Illawarra.
SW8	Frazers Creek, just upstream of a SEPP14 (freshwater) wetland, east of Terry Street, Albion Park.	Just upstream of a SEPP14 wetland on Frazers Creek, which feeds Macquarie Rivulet.
SW9	Tributary of Frazers Creek, southeast of O'Gorman Street, Albion Park	Flowing to the north, into the project area. Macquarie Rivulet is fed by Frazers Creek. SW9 may occasionally be affected by backwater from downstream and thus may not always be considered as a control site. The preferred location was further upstream, to ensure this site as a control site, however this is unfeasible as there is no surface flow.

4.2 GROUNDWATER

4.2.1 EXISTING GROUNDWATER MONITORING NETWORK

A groundwater monitoring network was installed by Golder Associates (2017) in late 2014 and early 2015 (Figure 3.1). All existing monitoring wells, except BH301, are likely to be destroyed during construction as they are located on or in close vicinity of the alignment. BH301 is in the northern portion of the project and comprises part of the current monitoring network.

In addition to BH301, monitoring an existing monitoring well near Cut 1 was recommended given the predicted dewatering and drawdown in this area, even though it may be destroyed during construction. This would supplement the data obtained from monitoring well GW5 (Section 4.2.2). Of the existing monitoring wells in the vicinity of the cut (BH312A, BH314, BH317, BH318, GA-BH102 and GA-BH219), BH318 was recommended to comprise part of the current monitoring network given the following:

- it is located further from GW5 than BH312A and GA-BH102, and thus would provide a better spread of data
- it is located on the edge of the cut and thus has a higher potential to survive construction than the monitoring wells located in the centre of the cut (BH314 and GA-BH219)
- it appears to be well constructed (Golder Associates, 2017).

4.2.2 ADDITIONAL GROUNDWATER MONITORING NETWORK

The additional monitoring network, along with the rationale and target formation, is provided in Table 4.2. Along with the rationale listed in the table, main considerations for all sites included locations outside construction activities, so that they can be utilised ongoing during project operations, site access/land ownership, and locations within the project boundary.

The location of the network is shown in Figure 3.1. The five monitoring wells were drilled and developed in November 2017 (WSP, 2018).

Table 4.2 Groundwater monitoring network

SITE IDENTIFIER	LOCATION	RATIONALE	TARGET FORMATION
GW1	West of the Princes Motorway, south of Macquarie Rivulet, Yallah	Obtain baseline groundwater information in the northern portion of the project area. Nearby existing monitoring well, GA-BH211, will be destroyed during construction activities.	Consolidated rock aquifer
GW2	Near the freshwater wetland on Frazers Creek and Fill 7	There is potential impact from compaction of the alluvium at Fill 7, potentially affecting groundwater flow to the SEPP 14 wetland.	Alluvium aquifer
GW3	Croom Reserve	Croom Reserve contains deep rooted vegetation of the Illawarra Lowlands Grassy Woodland EEC which would be partially relying on groundwater. There is a level or risk associated with the project. Nearby existing monitoring well, BH330, will be destroyed during construction activities.	Consolidated rock aquifer
GW4	South of East West Link, Croom	Obtain baseline groundwater information in the southern portion of the project area. Nearby existing monitoring well, BH334, will be destroyed during construction activities.	Consolidated rock aquifer
GW5	Directly east of Cut 1	Cut 1 is the deepest cut with a predicted outflow for this cut of 21 m^3/day over the length of the cut. The existing monitoring network in the vicinity of the cut is expected to be destroyed during construction. Monitoring the baseline conditions and drawdown due to dewatering during construction are required.	Consolidated rock aquifer

5 MONITORING FREQUENCY

The baseline monitoring frequency is outlined below and summarised in Table 5.1:

- Monthly for surface water – dry events.
- Following 15 mm or more of rainfall within 24 hours for surface water – wet weather events. Sampling is to be undertaken within 24 to 48 hours of the wet weather event. For a long rain event (e.g. 1-2 weeks duration), sampling may occur more than once.
- Quarterly for groundwater.

Table 5.1 Monitoring frequency

SAMPLING	2017		2018									
	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
Surface water	X	X	X	X	X	X	X	X	X	X	X	X
Groundwater		X			X			X			X	

The monitoring frequency will be reassessed following 12 months of monitoring. Monitoring will also be required during the construction and operational phases.

Note, rainfall will exceed 15 mm in 24 hours approximately 17 times per year. This is based on the rainfall records from January 2000 to December 2017 from the Bureau of Meteorology (BOM) rainfall station at Albion Park (site number 0680241; refer to Section 7.3).

6 ANALYTICAL SUITE AND METHODS

6.1 ANALYTICAL SUITE

A base analytical suite for surface water is analysed monthly (Type A), with a more extensive analytical suite analysed on a quarterly basis (Type B). The surface water samples collected during the wet weather events are analysed for the Type A parameters. The analytical suite for surface water and groundwater is summarised in Table 6.1.

Table 6.1 Analytical suite

	ANALYSIS	SURFACE WATER – DRY AND WET WEATHER EVENTS TYPE A	SURFACE WATER – QUARTERLY DRY WEATHER EVENTS TYPE B	GROUND-WATER
pH	In the field	X	X	X
Electrical conductivity	In the field	X	X	X
Temperature	In the field	X	X	X
Oxidation-reduction potential	In the field	X	X	X
Dissolved oxygen	In the field	X	X	
Turbidity	Laboratory	X	X	
Total suspended solids	Laboratory	X	X	
Total oils and grease[1]	Visual and olfactory inspection	X	X	X
Total nitrogen	Laboratory	X	X	X
Total phosphorus	Laboratory	X	X	X
Total dissolved solids	Laboratory			X
Total recoverable hydrocarbons	Laboratory		X	
Total metals[2]	Laboratory		X	
Dissolved metals[2]	Laboratory			X[3]
Major cations[4]	Laboratory			X
Major anions[5]	Laboratory			X

(1) Oil and grease is to be analysed by the laboratory only if total oils and grease are visually or olfactorily present.

(2) Total and dissolved metals comprise aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver and zinc.

(3) Dissolved metal analysis for GW2 only, which is located in a potential acid sulfate soil risk area.

(4) Major cations comprise calcium, sodium, magnesium and potassium.

(5) Major anions comprise chloride, sulphate, alkalinity and bicarbonate.

6.2 LABORATORY METHODS

Laboratory analysis is undertaken by Australian Laboratory Services (ALS). ALS has been accredited by an independent accreditation body acceptable to the NSW Environment Protection Authority (EPA), the National Association of Testing Authorities (NATA).

Laboratory methods used by ALS for the project are compared with the NSW EPA (2004) approved methods for the sampling and analysis of water pollutants. The laboratory methods used by ALS and the EPA-approved methods per analyte are listed in Table 6.2.

Table 6.2 Laboratory methods per analyte

ANALYTE	EPA-APPROVED METHOD	ALS METHOD
Alkalinity (total)	APHA 2320	APHA 2320 B
Aluminium	USEPA 6020	USEPA 6020
Arsenic (As III)	USEPA 6020	USEPA 6020
Bicarbonate	APHA 2320	APHA 2320 B
Cadmium	USEPA 6020	USEPA 6020
Chromium	USEPA 6020	USEPA 6020
Copper	USEPA 6020	USEPA 6020
Iron	USEPA 6020	USEPA 6020
Lead	USEPA 6020	USEPA 6020
Manganese	USEPA 6020	USEPA 6020
Mercury	APHA 3112	APHA 3112 - Hg B
Nickel	USEPA 6020	USEPA 6020
Oil and grease	APHA 5520 D	APHA 5520 D
Silver	USEPA 6020	USEPA 6020
Suspended solids	APHA 2540 D	APHA 2540 D
Total dissolved solids	APHA 2540 C	APHA 2540 C
Total nitrogen	APHA 4500 N-C	APHA 4500-Norg
Total phosphorus	APHA 4500 P F	APHA 4500 P F
TRH (C_6-C_{40})	USEPA 8015B	USEPA 8015A
Turbidity	APHA 2130	APHA 2130 B
Zinc	USEPA 6020	USEPA 6020

The methods used by ALS are generally consistent with the EPA-approved methods. Slight differences may occur when the EPA-approved methods relate to an older version of the American Public Health Association (APHA) Standard Methods for the Examination of Water and Wastewater, such as the 1998 version. ALS informed WSP that the specification of an APHA number without a letter suggests any of the equivalent lettered methods are permissible (refer to alkalinity (total), bicarbonate, mercury, total nitrogen and turbidity). ALS also stated that the letter following the USEPA 8015 method for TRP (C_6-C_{40}) does not denote the actual method for TRH, and thus the ALS method is consistent with the EPA-approved method.

7 MONITORING METHODOLOGY

7.1 EQUIPMENT

7.1.1 GENERAL EQUIPMENT

The following equipment is used for the majority of sampling tasks and is applicable to groundwater and surface water sampling:

- personal protective equipment and other safety equipment as identified in the health, environment and safety plan for the project
- sampling record sheets (Appendix A)
- chain-of-custody (COC) forms (Appendix B)
- multi-parameter water quality instruments and calibration solutions
- appropriate sample containers with the required preservatives as specified by the laboratory
- storage containers for the samples (such as an esky)
- decontamination equipment including clean buckets, phosphate-free detergent such as Decon 90, liquid chlorine and potable water
- nitrile gloves, syringes and water filters for filtering samples (e.g. dissolved metals)
- mobile phone with camera.

7.1.2 SURFACE WATER EQUIPMENT

Surface water samples are collected using a grab sample technique. Samples are collected directly into laboratory-supplied sample containers that do not contain preservatives with the use of a telescopic sampling pole if there is moderate to high surface flow or steep banks. The sampled water is then decanted into the appropriate bottles. The submerged portion of the telescopic sampling pole is cleaned using phosphate-free detergent and potable water, followed by a solution of 200 mg/L of chlorine, which is left on the pole for one minute. The chlorine is then rinsed off with potable water. The use of chlorine is an additional precaution due to the Epizootic Haematopoietic Necrosis (EHN) virus.

7.1.3 GROUNDWATER EQUIPMENT

7.1.3.1 PURGING AND SAMPLING

A range of methods can be used to purge groundwater and collect groundwater quality samples from the monitoring wells. The most appropriate method for each monitoring well is selected based on the depth of the well, the depth to groundwater, and the permeability of the formation at the screened zone. Higher yielding monitoring wells are purged and sampled using a submersible (high-flow) pump. Lower yielding wells or wells with limited purge volume are sampled using a disposable bailer or a grab sampler.

SUBMERSIBLE (HIGH-FLOW) PUMP

A high-flow pump (12-volt Monsoon pump) is deployed in high yielding wells. Typically a minimum of three well volumes are extracted before a water quality sample is collected, however abstracting this volume is not required when field parameters (particularly pH and EC) have stabilised (refer to Section 7.2.4).

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- multi-parameter water quality instruments and calibration solutions
- appropriate sample containers with the required preservatives as specified by the laboratory
- storage containers for the samples (such as an esky)
- decontamination equipment including clean buckets, phosphate-free detergent such as Decon 90, liquid chlorine and potable water
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BAILING

Disposable bailers with a single stop valve are used to collect samples from shallow wells with limited purge volume and/or low yielding wells. Monitoring wells screened in low yielding aquifers with a slow recovery are bailed dry and samples are collected once the monitoring well has sufficiently recovered to obtain a groundwater sample.

GRAB SAMPLER

A no-purge (passive) grab sampler (e.g. HydraSleeve®) may be used for extremely slowly recovering monitoring wells. The grab sampler will be deployed and retrieved in the well in accordance with the manufacturer's instructions. With this method, groundwater samples are collected directly from the screened zone without having to purge the monitoring well prior to sample collection. It is a single-use (disposable) sampler (HydraSleeve, 2016).

7.1.3.2 GROUNDWATER LEVELS

An electronic groundwater level dipper is used to measure the static groundwater level. Solinst Leveloggers will be deployed to continuously monitor groundwater levels in the current monitoring network. Two barometric loggers will also be installed to correct for atmospheric pressure. Data loggers will be:

- Suspended from the surface using stainless steel cable and swages.
- Suspended below the standing groundwater level. Potential groundwater level variations in the monitoring well and individual logger specifications (different loggers have different pressure thresholds) are considered before the depth at which the logger is to be installed is determined, as the logger must remain below the groundwater level.
- Programmed and then lowered into the monitoring well. Data logging intervals are to be set at six-hourly intervals (00:00, 6:00, 12:00 and 18:00).

7.2 SAMPLING AND MONITORING

Surface water and groundwater monitoring are conducted in general accordance with WSP's standard operating procedure. The procedure outlines the general protocols, procedures and work practices to be applied when collecting surface water and groundwater samples and downloading data loggers.

7.2.1 SURFACE WATER SAMPLING

The surface water sampler is carefully lowered into the surface water body to obtain the samples. The grab sampler is lowered approximately 100-500 mm below the surface of the water body, depending on the depth of water. Disturbing the sediment and surface debris is avoided as much as possible when collecting a sample. Following collection, the surface water sample is decanted into the laboratory supplied sample containers.

The appearance of the surface water body is recorded, such as colour, turbidity, water flow, odour, surface crusts, films or floating material, vegetation and algae. Notes are also made of any other relevant observations such as dead, decaying or distressed vegetation, surface rubbish, and surface sheen. Refer to Section 8.4.1.

Should the sampling location be considered unsafe due to changed conditions, such as following a large rainfall event, then a suitable nearby location will be selected, and any change recorded on the sampling record sheets (Section 8.4.1).

7.2.2 GROUNDWATER LEVELS

Groundwater levels are manually measured by an electronic groundwater level dipper and data loggers will be installed at each monitoring well to automatically measure the groundwater level at a predetermined time interval (refer to Section 7.1.3.2).

Manual groundwater levels are recorded prior to purging or sampling. The groundwater level is measured from the top of casing and is measured to the nearest millimetre. The depth of the monitoring well is also recorded. These levels are recorded on the groundwater sampling record sheets (refer to Section 8.4.1).

The data logger can then be retrieved from the monitoring well for download by pulling up the stainless steel wire attached to the data logger. Data loggers will then be downloaded using appropriate software for storage and data processing. The following diagnostics are performed regularly to ensure data loggers are functioning properly:

- visual inspection and cleaning the data logger if necessary
- inspection of swages and connections to ensure the data logger is secured at the surface
- real time data is checked to ensure water levels recorded by the data logger are accurate before redeploying
- recording data logger battery levels.

7.2.3 GROUNDWATER SAMPLING

Following the measurement of static groundwater levels, typically three well volumes are purged prior to sampling. Less than three well volumes can be removed prior to sampling in the following circumstances:

- A well is purged dry and will not yield sufficient water for further continuous purging. As such, the recovery water is then sampled.
- At least one well volume has been removed and field parameters stabilise, principally pH, EC and temperature. Field parameters are considered to have stabilised when three consecutive sets of the selected field parameters are within 10%.
- No-purge sampling equipment is used (e.g. HydraSleeve or similar) for very low yielding monitoring wells, that may not sufficiently recover overnight.

The purged water colour, turbidity, any odours and other observations are assessed and recorded. Characteristics of how these change as pumping progresses over time are also noted on the groundwater sampling record sheet (refer to Section 8.4.1).

7.2.4 COLLECTION OF FIELD PARAMETERS

The field parameters listed in Section 6.1 are measured using a calibrated water quality meter, which is calibrated daily. Field parameters are measured from samples collected with a laboratory supplied plastic sample collection container for surface water samples. Groundwater samples are measured in the pumped water stream as purging progresses or from a sample collected with a disposable bailer (depending on sampling technique). The readings stabilise before being recorded on the surface water or groundwater sampling data record sheets (refer to Section 8.4.1).

7.2.5 COLLECTION OF SAMPLES FOR LABORATORY ANALYSIS

Surface water and groundwater samples are collected using the methods outlined above and decanted into laboratory-supplied containers. The following procedures are used:

- All fields are completed on the label of the sample container using a xylene free marker.
- Sampling personnel wear a new pair of nitrile disposable gloves for each sample location.
- All bottles are filled and capped as quickly as practicable to reduce exposure of the sample to the atmosphere. Care is taken when handling sample container lids to avoid contact with any surfaces that may compromise the integrity of the sample.
- When collecting samples for volatile analysis, all bottles are filled as far as practicable to minimise the headspace within the container and avoid potential loss of volatiles.
- Where filtering of samples is required to remove fine suspended particles, for example for dissolved metals analysis, disposable disc filters (0.45 µm) are used with disposable syringes. Filtering equipment is not reused between sampling locations.

7.3 METEOROLOGY

The rainfall from the BOM rainfall station located closest to the project is monitored on a daily basis, that is, Albion Park (Wollongong Airport) (site number 068241). Following 15 mm or more of rainfall within 24 hours, sampling is undertaken within 24 to 48 hours after the wet weather event.

8 QUALITY MANAGEMENT

8.1 QUALITY CONTROL

One blind replicate (field duplicate) water sample is collected for every 10 samples during each monitoring round and is collected to provide an indication of the precision (repeatability) of the laboratory's analysis and sampling procedures, as well as the heterogeneity of the sampling material. Duplicate samples are labelled ‘QA#’ with the first QA sample labelled QA1 and the second labelled QA2 etc. in order of collection. When a duplicate sample is taken, a note is made on the sampling record sheet of the parent sample. Duplicate samples are submitted to a NATA accredited laboratory for analysis.

Where appropriate, dedicated sampling equipment is used to eliminate the risk of cross-contamination as much as possible. Examples of such equipment are disposable bailers, HydraSleeves, filters and syringes. For reusable sampling equipment, such as submersible pumps, they are cleaned using phosphate-free detergent and rinsed with potable water between sample locations. The submerged portion of the telescopic sampling pole is cleaned using phosphate-free detergent and chlorine, which is an additional precaution due to the EHN virus. Refer to Section 7 for further information.

8.2 QUALITY ASSURANCE

8.2.1 RECORDS

Surface water and groundwater sampling record sheets are completed for each sampling location, providing a record of relevant information at each location. Sampling record sheets for the project are provided at Appendix A. Some of the information contained in these sheets are listed below:

— well number or sampling identification

— date and time

— sampling method

— samplers name

— specific field parameters and their units

— comments, such as colour, odour and turbidity

— purge volume (for groundwater only)

— quality assurance/quality control details

— general environmental/climatic conditions.

8.2.2 CHAIN OF CUSTODY

A COC form is completed following sampling and sent with the samples to the laboratory. The COC is a record of the sampling undertaken and the analysis required. A COC is shown at Appendix B. Some of the information contained within a COC is listed below:

— sample ID

— sample date and time

— analysis required

— sampler and project manager's names and contact details

— date and time the samples were relinquished by the sampler and received by the laboratory

— project number.

8.2.3 SAMPLE STORAGE, TRANSIT AND DELIVERY

The following additional quality measures are undertaken:

— Immediately following sampling, all samples are placed into an esky pre-packed with ice in a bag to prevent leakage or with ice bricks.

— To reduce the potential for breakage, samples are placed upright on the firm base of the esky. Samples are arranged to minimise lateral movement during transport.

— A quality control check is completed of the labels of all samples to be submitted to the laboratory against the sample ID's on the COC.

— The esky containing the samples for transport to the laboratory are sealed.

— All samples (temperature below 6°C) are picked up by a courier or delivered directly to the laboratory as soon as practical with the completed and relinquished COC.

9 ANALYSIS AND INTERPRETATION

Analysis and interpretation of the data collection during this pre-construction period will focus on establishing the baseline conditions. During construction and operation of the project, the baseline results will be used for comparison, to enable any potential impacts to be identified.

The Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ, 2000) will be used to compare with the baseline water quality results from the surface water and groundwater monitoring. The water quality guidelines for the protection of freshwater aquatic ecosystems are used, with:

- Default trigger values for physical and chemical stressors for south-eastern Australia for slightly disturbed ecosystems. The lowland river trigger values have been adopted for the majority of surface water (see next point) and groundwater.
- Default trigger values for physical and chemical stressors for south-eastern Australia for slightly disturbed ecosystems. The estuarine trigger values for SW3 only, Macquarie Rivulet, have been adopted due to the tidal nature of Macquarie Rivulet at this location.
- Freshwater trigger values for toxicants at a 95% level of protection are also adopted for groundwater and surface water.

The guideline values per analyte are listed in Table 9.1. Guideline values trigger values are not available for temperature, redox, TSS, TDS, calcium, sodium, magnesium, potassium, chloride, sulphate, alkalinity or bicarbonate.

Table 9.1 Guideline values

	UNITS	ANZECC/ARMCANZ (2000) GUIDELINES		
		SURFACE WATER (EXCEPT SW3)	SW3 – MACQUARIE RIVULET	GROUNDWATER
pH	pH units	6.5-8.0[1]	7.0-8.5[2]	6.5-8.0[1]
EC	µS/cm	125–2200[1]	N/A	125–2200[1]
Dissolved oxygen	% saturation	85-110[1]	80-110[2]	N/A
Turbidity	NTU	6-50[1]	0.5-10[2]	N/A
Total nitrogen	mg/L	0.35[1]	0.3[2]	0.35[1]
Total phosphorus	mg/L	0.025[1]	0.03[2]	0.025[1]
Aluminium	mg/L	0.055[3,4]	0.055[3,4]	0.055[3,4]
Arsenic (As III)	mg/L	0.024[3] (As III)	0.024[3] (As III)	0.024[3] (As III)
Cadmium	mg/L	0.0002[3]	0.0002[3]	0.0002[3]
Chromium	mg/L	0.001[3] (Cr VI)	0.001[3] (Cr VI)	0.001[3] (Cr VI)
Copper	mg/L	0.0014[3]	0.0014[3]	0.0014[3]
Iron	mg/L	ID[3]	ID[3]	ID[3]
Lead	mg/L	0.0034[3]	0.0034[3]	0.0034[3]
Manganese	mg/L	1.9[3]	1.9[3]	1.9[3]
Mercury	mg/L	0.0006[3] (inorganic Hg)	0.0006[3] (inorganic Hg)	0.0006[3] (inorganic Hg)

	UNITS	ANZECC/ARMCANZ (2000) GUIDELINES		
		SURFACE WATER (EXCEPT SW3)	SW3 – MACQUARIE RIVULET	GROUNDWATER
Nickel	mg/L	0.011[3]	0.011[3]	0.011[3]
Silver	mg/L	0.00005[3]	0.00005[3]	0.00005[3]
Zinc	mg/L	0.008[3]	0.008[3]	0.008[3]

(1) Default trigger values for physical and chemical stressors for south-eastern Australia for slightly disturbed ecosystems (lowland river).

(2) Default trigger values for physical and chemical stressors for south-eastern Australia for slightly disturbed ecosystems (estuarine).

(3) Freshwater trigger values for toxicants at a 95% level of protection.

(4) pH>6.5, otherwise there is no trigger value at pH <6.5.

ID – Insufficient data to derive a reliable trigger value.

The baseline surface water quality data and groundwater levels will also be assessed in consideration of the weather, particularly rainfall.

10 RECORDING AND REPORTING OF MONITORING RESULTS

10.1 RECORDING RESULTS

The following documents and files are placed on the electronic project folder as soon as possible upon completion of the fieldwork:

- surface water and groundwater sampling record sheets (for templates refer to Appendix A)
- completed COC (for template refer to Appendix B)
- logger data files
- signed health, environment and safety plan for the project.

10.2 REPORTING RESULTS

Surface water and groundwater monitoring results are reported monthly in a brief report. The contents of the report include a summary of the monitoring activities undertaken that month, the monitoring results with values outside the guidelines highlighted, rainfall and temperature data for the month, and calculated relative percentage differences for the duplicate and primary samples.

Upon completion of 12 months of baseline monitoring, surface water and groundwater results recorded during the previous 12 months will be incorporated in a baseline monitoring program summary report. This report will include a discussion of observed baseline trends in water quality and groundwater levels and in relation to rainfall. In addition, recommendations for any alterations to the monitoring program will be included.

11 ROLES AND RESPONSIBILITIES

The role of the project manager is to oversee and manage the project and is the primary contact for the Roads and Maritime Services. In general, the project manager is responsible for project scope, schedule, costs, personnel, safety and quality. The project manager is supported by WSP and the project management processes that are based on industry best practice and externally accredited safety and quality systems.

The project manager is also a technical specialist, allowing for review and assessment of the technical and quality aspects of the project on an ongoing basis. The project manager, a Principal Hydrogeologist, typically undertakes the technical review of tasks and reports, and is also supported by other Principal Hydrogeologists and Principal Hydrologists as required.

The project manager familiarises field personnel with the project scope and requirements, including the analytical suite, holding times, sample security procedures and other project requirements. Safety is an integral part of our day-to-day business, with safety protocols in place for all field activities.

Fieldwork staff are nominated by the project manager. The staff are technically qualified, have undertaken the relevant safety training and are first-aid certified. Before staff use any sampling equipment, they are trained and competent in the use of the equipment, and be familiar with the operation and safe work method statements for the tasks to be performed. Prior to a new field staff member undertaking the monitoring, the new personnel will shadow the current personnel, to ensure they are familiar with the specific requirements of the project, including all site locations and access.

Some of the responsibilities of the fieldwork staff are as follows:

- adhere to the health, environment and safety plan for the project
- follow the sampling protocols outlined within this report
- ensure representative samples are collected, appropriately stored, and transported to the laboratory
- monitor the daily rainfall
- record and save the required information, such as the sampling record sheets
- draft the monthly reports

12 ADDITIONAL ONE-OFF GROUNDWATER SAMPLING

12.1 SAMPLE ORIGINAL MONITORING NETWORK

To allow for the commencement of baseline groundwater monitoring prior to installing the new groundwater monitoring network, 13 existing groundwater monitoring wells were sampled in November 2017 for the quarterly analytical suite, as listed in Section 6.1. Manual groundwater levels were measured and where data loggers were installed, these were downloaded.

The results were included in the November 2017 monthly report (WSP, 2017b).

12.2 SAMPLE THE NETWORK NEAR THE INDUSTRIAL AREA AND MAIN CUT

Consultation with Crown Lands and Water on 7 December 2017 (Section 2) resulted in the one-off sampling of the monitoring wells near the industrial area and main cut, that is GW1, BH312A, BH314, BH317, BH318, GA-BH102 and GA-BH219 (Figure 3.1). The groundwater samples were analysed for BTEXN, TRH, PAH, dissolved metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) and oil and grease.

The results were included in the December 2017 quarterly report (WSP, 2017c).

12.3 SAMPLE THE NETWORK IN AGRICULTURAL AREA AND NEAR THE FIRE & RESCUE SITE

Consultation with Crown Lands and Water on 7 December 2017 (Section 2) resulted in the one-off sampling of the monitoring wells to the east of the Fire & Rescue NSW site at Albion Park, that is GW2, GA-BH239, GA-BH241, BH321A and BH327 (Figure 3.1). The groundwater samples were analysed for per- and poly-fluoroalkyl substances (PFAS) (full suite – 28 analytes), organochlorine pesticides and organophosphorus pesticides (OC/OP pesticides).

The results were included in the December 2017 quarterly report (WSP, 2017c).

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APPENDIX A

SAMPLING RECORD SHEETS

Surface Water Sampling Record Sheet

Job. number: PS106112	**Sampling date:**	**Water quality meter ID:**
Client:	**Sampling method:**	**Calibration date:**

Sample ID.	Time	Temp. (°C)	EC (uS/cm)	TDS (mg/L)	Redox (mV)	DO		pH	Bottles collected:	Comments: Including colour, turbidity, water flow, odour, surface crusts, films or floating material, vegetation, algae, gauge reading and environmental/climatic conditions.
						% sat	mg/L			

Sampler's name:	Signature:	**QA/QC details:**

Version: A	**Reviewer: P van Ravesteyn**	**Date: 27/02/18**	**Approver: Andrea Madden**	**Date: 27/02/18**

Surface Water Sampling Record Sheet

Sample ID.	Time	Temp. (°C)	EC (uS/cm)	TDS (mg/L)	Redox (mV)	DO		pH	Bottles collected:	Comments: Including colour, turbidity, water flow, odour, surface crusts, films or floating material, vegetation, algae, gauge reading and environmental/climatic conditions.
						% sat	mg/L			
Sampler's name:					Signature:				QA/QC details:	

Groundwater Sampling Record Sheet

Job Number: PS106112	**Well Number:**
Property name/owner: **Contact details:**	**Purging Date:** **Sampling Date:**
Depth to groundwater from TOC (m):	PVC Stickup (m):
Well depth from TOC (PVC) (m):	Casing diameter (mm):

Purging Information

Purging method: ○ Micropurge ○ Grundfos ○ 12V pump ○ Bailer ○ Flowing ○ Grab sample	Calculated bore volume (m^3) = $\pi r^2 h$ π = 3.14 r = 0.5 x casing diameter (m) h = well depth – depth to GW (m)
Logger download: ○ YES ○ NO	1 bore volume (L): 3 bore volumes (L):
Start time:	$1m^3$ = 1000L
Finish time:	Purging depth:

Field Results While Purging

Time	Vol (L)	Temp. °C	EC (uS/cm)	TDS (g/L)	DO		pH	Redox (mV)	Colour/odour/ turbidity
					%sat	mg/L			
	CO_2 (mg/L) = mL in syringe x 10 =								

Measurements for pH should be within 0.1 pH units and measurements for conductivity, salinity and dissolved oxygen should be within 10% and temperature within 0.5 °C before the well is sampled.

Sampling Details

Sampling method (*if different from purging* method): ○ Micropurge ○ Grundfos ○ 12V pump ○ Bailer ○ Flowing ○ Grab sample	Bottles collected:
Sampling time:	QA/QC details

Other comments and observations (environmental/climatic conditions):

Sampler's name:	Signature:

Groundwater Sampling Record Sheet

Field Results While Purging (continued)									
Time	Vol (L)	Temp. °C	EC (uS/cm)	TDS (g/L)	DO		pH	Redox (mV)	Colour/odour/ turbidity
					%sat	ppm			

Other comments:

APPENDIX B

CHAIN OF CUSTODY

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

❑ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

❑BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

❑GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

❑MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

❑MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

❑MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

❑NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com

❑NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com

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❑SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

❑TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townesville.environmental@alsglobal.com

❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT WSP	**TURNAROUND R** ☐ Standard TAT **(List due date)**	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE L27, 680 George St. Sydney 2001	(Standard TAT may be longer for some ☐ Non Standard or urgent TAT **(List due date)**	Custody Seal Intact?	Yes No N/A
PROJECT	**ALS QUOTE NO.**	Free ice / frozen ice bricks present upon receipt?	Yes No N/A
ORDER NUMBER	**COC SEQUENCE NUMBER (Circle)** COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt:	˚C
PROJECT MANAGER **CONTACT PH**	OF: 1 2 3 4 5 6 7	Other comment:	

SAMPLER **SAMPLER MOBILE**	**RELINQUISHED BY**	**RECEIVED BY**	**RELINQUISHED BY**	**RECEIVED BY**
COC emailed to ALS? **EDD FORMAT (or default) .csv**				
Email Reports to:	DATE/TIME:	DATE/T ME:	DATE/T ME:	DATE/T ME:
Email Invoice to:				

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL

ALS USE	SAMPLE DETAILS MATRIX SOLID (S) WATER (W)				ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).																		Additional Information		
LAB ID	**SAMPLE ID**	**DATE / TIME**	**MATRIX**	**TOTAL CONTAINERS**																			**Sampled by**	**Signature**	**Remarks**
		TOTAL																							

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Pres
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Appendix C Acid Sulfate Soil Management Procedure

Acid Sulfate Soil Management Procedure

1. Purpose

This procedure details the actions to be taken when actual acid sulfate rock (ASR), acid sulfate soils (ASS) or potential acid sulfate Soils (PASS) are encountered during excavation/ construction activities. This procedure is prepared to demonstrate compliance with the following standards and guidelines:

- The Acid Sulfate Soils Manual (1998)
- Acid Sulfate Soils Assessment Guidelines (1998)
- Laboratory Methods Guidelines (2004), and
- EPA Waste Classification Guidelines (2014), Part 4: Acid Sulfate Soils.

2. Scope

This procedure applies to all construction activities undertaken as part of the Project that have the potential to uncover / disturb ASR / ASS / PASS.

3. Induction and training

All site personnel and subcontractors working in areas of high probability ASR / ASS risk will be trained in the relevant parts of this procedure.

4. Procedure

Identification of ASS treatment areas

The design and location of ASR / ASS treatment areas will be marked on PESCPs and any other relevant plans. Potential areas of acid sulfate material are tabulated below. These areas and the type of material will be confirmed via additional geotechnical investigation during the detailed design phase.

Table C-1 Potential areas of acid sulfate material

Area	Approximate Chainage (m)	Construction Activity	ASS probability
Northern and southern banks of the Macquarie Rivulet	18400-18750	Minor excavation and bridge piles	High risk 1-2m
South of Macquarie Rivulet	18750-19500	Minor cuts and excavation for drainage, footings, etc	Low risk above 4m AHD
Norther and southern bank of Frazer Creek	19500-19870	Minor excavation and bridge piles	High risk 2-4m AHD
South of Frazer Creek	19870-21400	Minor excavation for bridge foundations drainage, footings, etc.	Low risk above 4m AHD

Unexpected actual ASR / ASS or PASS encountered during excavation / construction activities

If ASR / ASS / PASS is encountered during excavation/construction activities the Foreman must:

- STOP ALL WORK in the immediate/ affected area and contact the Environmental Officer (EO)
- Recommence works in alternate area where practicable.

The EO is responsible for testing of ASR / ASS / PASS and will undertake testing to determine the acidity (field pH test) and potential for acidity (field 30 per cent peroxide test) of the material encountered.

Any of the following characteristics indicate the presence of ASR / ASS:

- Soil pH of less than four
- A sulphurous smell following soil disturbance
- Pale yellow surface encrustations;
- Excessive iron staining on drain surfaces or stream banks, or iron stained drain water and orange red ochre deposits around water bodies
- Excessive corrosion of concrete and / or steel structures exposed to ground or drainage waters, or rapid corrosion of fresh steel in the soil; and
- Blue-grey, blue-green or grey waterlogged soils which smell of rotten egg gas.

High risk indicators for PASS could include:

- Low position in the landscape
- Soil from beneath the water table
- Heavy textures
- Dark colours; and
- Sulfur odour (rotten egg odour).

Action criteria for management intervention

Table C-2 details the texture based action criteria for management of ASR / ASS disturbance. Where soils containing concentrations at or above the action criteria are disturbed, management of spoil is required.

For the purposes of the Project, both action criteria have been included for reference purposes, ie less than 1,000 tonnes for fine texture soils, and greater than 1,000 tonnes for all soil types. As the project will disturb spoil greater than 1000 tonnes, the action criteria of greater than 1000 tonnes disturbed should be used.

Table C-2 Action criteria based on the ASS analysis for three broad texture categories

Type of material	Clay content	Action criteria 1 to 1000 tonnes disturbed		Action criteria >1000 tonnes disturbed	
Texture range (McDonald et al. (1990)	Approx clay content (%<0.002 mm)	Sulphur trail % S oxidisable e.g. STOS or SPOS	Acid trail mol H+/tonne e.g. TPA or TSA	Sulphur trail % S oxidisable e.g. STOS or SPOS	Acid trail mol H+/tonne e.g. TPA or TSA
Coarse Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium Texture Sandy loams to light clays	5 – 40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≤40	0.1	62	0.03	18

Source: Ahern *et al.* 1998

Neutralisation of excavated acid sulfate materials (ASM) from earthworks

If field tests are positive or inconclusive, laboratory analysis using the Chromium Suite will be required to determine if the material is in fact ASS and/or the required treatment rates based on the net acidity.

Neutralising agents must be incorporated within all ASR / ASS / PASS. All cut batters shall be coated with fine aglime at the rate of five kg/m and the lime coating should be checked and re-limed as necessary on a daily basis during periods of dewatering during construction excavation. The base of all fill areas where treated material is to be placed shall be treated with a neutralising agent forming a guard layer prior to the placement of any fill soils to neutralise downward seepage of acidic

drainage water. This application may need to be increased depending on stockpile height and actual and potential acidity of the ASM developed through detail assessment.

Aglime rates will be as determined through analytical assessment to establish per cent of sulfur present (S%) to determine an indicative level of treatment as specified in Table C-3. Interpretation of analytical data must be conducted by an appropriately qualified and experienced in dealing with ASS/PASS management.

ASS/PASS must be sufficiently dry before neutralising is commenced so that the lime can be thoroughly mixed through the soil. Where moisture levels in soil are high, the soil must be dried by spreading and leaving open to the atmosphere. Drying can be accelerated by regular aeration by turning with an excavator or backhoe. Drying should be carried out on a guard layer and protected from stormwater ingress.

Mixing of ASS/PASS with neutralising agent shall be carried out by spreading the soil in layers of not more than 300mm to 400mm thick using an agricultural spreader and disc plough, rotary hoe or similar. Care shall be taken to ensure that mixing occurs throughout the depth of the layer prior to placement of new material.

Following the successful treatment of the lot (as determined through the validation testing), the material shall be compacted and the next layer of excavated material to be treated shall be placed over the already treated material. This process shall be continued until the required site elevation is achieved.

Even when neutralised, excavated and processed ASR will not be used for upper pavement layers above Upper Zone Formation (UZF), including Selected Material Zone (SMZ) and verge and other layers with the potential to be exposed.

Table C-3 Treatment levels and aglime required to treat total weight of disturbed ASS (Source: Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines 2002)

Disturbed ASS (tonnes) (=m^3×BD) †	Soil Analysis* – Existing Acidity plus Potential Acidity (converted to equivalent S% units)													
	0.03	*0.06*	*0.1*	*0.2*	*0.4*	*0.6*	*0.8*	*1*	*1.5*	*2*	*2.5*	*3*	*4*	*5*
1	0	0	0	0	0	0.03	0.04	0.05	0.1	0.1	0.1	0.1	0.2	0.2
5	0	0	0	0.05	0.1	0.1	0.2	0.2	0.4	0.5	0.6	0.7	0.9	1.2
10	0	0.03	0.05	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.2	1.4	1.9	2.3
50	0.1	0.1	0.2	0.5	0.9	1.4	1.9	2.3	3.5	4.7	5.9	7.0	9.4	12
100	0.1	0.3	0.5	0.9	1.9	2.8	3.7	4.7	7.0	9.4	12	14	19	23
200	0.3	0.6	0.9	1.9	3.7	5.6	7.5	9.4	14	19	23	28	37	47
250	0.4	0.7	1.2	2.3	4.7	7.0	9.4	12	18	23	29	35	47	59
350	0.5	1.0	1.6	3.3	6.6	10	13	16	25	33	41	49	66	82
500	0.7	1.4	2.3	4.7	9.4	14	19	23	35	47	59	70	94	117
600	0.8	1.7	2.8	5.6	11	17	22	28	42	56	70	84	112	140
750	1.1	2.1	3.5	7.0	14	21	28	35	53	70	88	105	140	176
900	1.3	2.5	4.2	8.4	17	25	34	42	63	84	105	126	168	211
1000	1.4	2.8	4.7	9.4	19	28	37	47	70	94	117	140	187	234
2000	2.8	5.6	9.4	19	37	56	75	94	140	187	234	281	374	468
5000	7.0	14	23	47	94	140	187	234	351	468	585	702	936	1170
10000	14	28	47	94	187	281	374	468	702	936	1170	1404	1872	2340

L	**Low treatment:** (≤0.1 tonnes lime)
M	**Medium treatment:** (>0.1 to 1 tonne lime)
H	**High treatment:** (>1 to 5 tonnes lime)
VH	**Very High treatment:** (>5 to 25 tonnes lime)
XH	**Extra High treatment:** (>25 tonnes lime)

Notes

1. The tonnes (t) of pure fine aglime, CaCO3 required to fully treat the total weight/volume of ASS can be read from the table at the intersection of the weight of disturbed soil [row] with the existing plus potential acidity [column]. Where the exact weight or soil analysis figure does not appear in the heading of the row or column, use the next highest value
2. An approximate soil weight (tonnes) can be obtained from the calculated volume by multiplying volume (cubic m) by bulk density (t/m3). (Use 1.7 if B.D. is not known.) Dense fine sandy soils may have a BD up to 1.7, and hence 100 cubic metres of such soil may weigh up to 170 t. In these calculations, it is necessary to convert to dry soil masses, since analyses are reported on a dry weight basis.
3. Potential acidity can be determined by Chromium Reducible Sulfur (SCR), Peroxide Oxidisable Sulfur (SPOS) and Total Oxidisable Sulfur (STOS). For samples with pH less than 5.5, the existing acidity must also be determined by appropriate laboratory analysis eg. Titratable Actual Acidity (TAA). Soils with retained acidity eg. jarosite or other similar insoluble compounds have a less available acidity and will require more detailed analysis. The amount of treatment required may be reduced if the self-neutralising capacity of the soil is appropriately measured.

Neutralising materials

For management or neutralisation of ASS/PASS soils, medium-fine Aglime will be used. Dolomitic Aglime, or magnesium-blend Aglime, will not be used. In general, a finer grind is better. The Aglime purity should preferably be 90 per cent or better, (that is, neutralising value (NV) greater than 90), unless there is a significant savings to be made by use of less pure Aglime. In the latter case, however, the individual lime dosing rates will need to be increased accordingly. The requirement for greater amounts of Aglime of lower purity should be borne in mind when assessing the supplies of this material, as the cost savings from less pure material may be offset by the need for more, and correspondingly higher total transport costs.

ASS/PASS treatment will occur within an ASS treatment area. Material which is transported to treatment cells must be completely treated and removed from the treatment area before new material is introduced. This will ensure that treated material remains segregated and is not mixed with contaminated material. Aglime or other suitable treatment material will be stored at the treatment area in sufficient quantities to enable the treatment of all ASS/PASS material expected to be treated in the upcoming few weeks/months and will be determined by the expected delivery schedule of treatment material. The management of onsite treatment is the responsibility of the Site Foreman, with assistance from the Environmental Officer (EO).

Aglime is non-corrosive, and requires no special handling – it may be necessary to cover the stockpile with a tarpaulin or cover the stockpile with plastic, to minimise dust generation and prevent wetting, since it is then more difficult to spread. Intermittently, until such time as field testing suggests otherwise, a small quantity of Aglime will be stored on site, in the order of 200 kilograms or so. This will enable the regular treatment of soil and cater for any unexpected occurrences of ‘hotter’ ASS/PASS.

Dolomitic aglime, or magnesium-blend aglime, should not be used as these materials impose environmental risks from overdosing with the potential to damage estuarine ecosystems. A reasonable quantity of calcium hydroxide solution (hydrated lime) shall be kept on site at all times for treatment of acidic waters. The supply shall be stored in a covered and bunded area to prevent accidental release to waters. Neutralising agents must be replenished and or replaced regularly to remain effective against loss by wind or water erosion.

Validation of ameliorated ASR / ASS / PASS

Samples of the treated soil should be taken and laboratory analysed to demonstrate compliance with the performance criteria (ie. verification testing). These performance criteria equate to there being no net acidity in the soil following neutralisation. Soil that has been treated by neutralisation techniques and has not met these criteria must be retreated until the above performance criteria are met.

The objective of ameliorating ASR / ASS / PASS materials is to ensure that there is no chance that net acidity will be produced. Validation testing only occurs when soils have been treated (with a neutralising agent) to prevent any future acidification. If results of the validation testing indicate a failure to comply with the performance criteria, soil may need to be re–treated with an additional application of neutralising agent.

Soils that have been mixed with aglime will be analysed by either the SPOCAS or SCR Suite test methods at a rate of one sample per 250 cublic metre. All validation samples are to be recorded by GPS or survey, clearly marked on a map/sketch or otherwise recorded.

Where large quantities (greater than 1,000 cubic metres) of ameliorated soils are involved and ‘net acidity’ rates are generally low (18 mol H+/t to less than 125 mol H+/t or 0.03 to 0.20 per cent sulfur), a reduced rate of sampling may be appropriate subject to approval. A rate of one sample per 1,000 cubic metre may be suitable for example.

The following performance criteria must be attained for soil that has been treated using neutralisation:

- The neutralising capacity of the treated soil must exceed the existing plus potential acidity of the soil

- Post-neutralisation, the soil pH is to be greater than 5.5
- Excess neutralising agent should remain within the soil until all acid generation reactions are complete and the soil has no further capacity to generate acidity.

If ameliorated ASS is going to be reused on site, due environmental regard for areas of placement should be assessed, documented and approved by the Fulton Hogan Environment Manager (EM). Assessment measures may include:

- Location of proposed placement areas and potential receptors (waterways, sensitive flora and fauna, structures)
- Stability and suitability of materials as select fill (especially clays), and
- Suitability of soil type for plant growth.

In the unlikely event that the treated material is unable to be reused on-site for other purposes, the material will need to be disposed of to an appropriately licensed waste disposal facility. The EM/ EO will liaise with a licensed waste facility and coordinate the process.

Large-scale dewatering or drainage

Earthworks and/or pumping that result in localised drainage or lowering of groundwater and the exposure of sulfidic soils to the ingress of oxygen may generate acidity as a function of soil type(s), sulfide contents, area exposed, and length of time the excavation remains ‘dry’. The scale of the dewatering or drainage should be defined by the size of the cone of depression rather than the size of the void. Activities of this type are high-risk, and should not be undertaken without technical risk assessment by qualified personnel and the formulation of management measures sufficient to reduce risk to levels acceptable by the administering authorities.

Neutralising acid leachate and drain water using lime

The liming rate for treating acid water should be carefully calculated to avoid the possibility of "overshooting" the optimum pH levels of 6.5 to 8.5. This can occur quite easily if more soluble or caustic neutralising agents such as hydrated lime (pH 12) or magnesium hydroxide (pH 12) are used. It should be noted that when neutralising acid water, no safety factor is used. However, monitoring of pH should be carried out regularly during neutralisation procedures.

Agricultural lime (pH 8.2) is the safest neutralising agent. It equilibrates around a pH of 8.2 that is not generally harmful to plants, stock or humans and most aquatic ecology species. The main shortcoming associated with the use of lime is its insolubility in water.

When using alkaline materials, strict protocols must be established for the use, handling and monitoring of these materials. Prior to any ASR / ASS / PASS management, appropriate personal protective equipment (PPE) is to be worn as per relevant SDS (eg for Lime). This may include:

- Eye goggles and/or face masks
- Hard Hat
- Rubber boots, gloves
- Appropriate clothing (e.g. long sleeved shirts).

Calculating the quantity of lime

The current pH is measured with a recently calibrated pH detector. The desired pH is usually between 6.5 and 8.5 with pH 7 is normally targeted. The volume of water can be calculated by assuming one cubic metre of acid water is equivalent to one kilolitre (1000 litre) and 1,000 cubic metre is equivalent to one megalitre (ML).

As a general guide, Table C-4 shows minimum quantities of pure lime, hydrated lime or sodium bicarbonate needed to treat dams or drains of one ML (1,000 cubic metre) capacity.

Table C-4 Quantity of pure neutralising agent required to raise from existing pH to pH 7 for one megalitre of low salinity acid water

Current water pH	[H+] {mol/L}	H+ in 1 Megalitre {mol}	Lime to neutralise 1 Megalitre {kg pure CaCO3}	Hydr. lime to neutralise 1 Megalitre {kg pure Ca(OH)2}	Pure NaHCO3/ 1 Megalitre {kg }
0.5	0.316	316,228	15,824	11,716	26,563
1.0	0.1	100,000	5,004	3705	8390
1.5	0.032	32,000	1,600	1185	2686
2.0	0.01	10,000	500	370	839
2.5	0.0032	3,200	160	118	269
3.0	0.001	1,000	50	37	84
3.5	0.00032	320	16	12	27
4.0	0.0001	100	5	4	8.4
4.5	0.000032	32	1.6	1.18	2.69
5.0	0.00001	10	0.5	0.37	0.84
5.5	0.0000032	3.2	0.16	0.12	0.27
6.0	0.000001	1	0.05	0.037	0.08
6.5	0.00000032	.32	0.016	0.12	0.027

Notes on Table C-3:

- 1 m3 = 1,000 litre = 1 kilolitre = 0.001 megalitre
- Agricultural lime has very low solubility and may take considerable time to even partially react
- Hydrated lime is more soluble than aglime and hence more suited to water treatment. However, as Ca(OH)2 has a high water pH, incremental addition and thorough mixing is needed to prevent overshooting the desired pH. The water pH should be checked regularly after thorough mixing and time for equilibration before further addition of neutralising product
- Weights of lime or hydrated lime are based on theoretical pure material and hence use of such amounts of commercial product will generally result in under treatment
- To more accurately calculate the amount of commercial product required, the weight of lime from the table should be multiplied by a purity factor (100/ Neutralising Value for aglime) or (148/ Neutralising Value for hydrated lime).
- Calculations are based on low salinity water acidified by hydrogen ion, H+ (acid) and do not take into account the considerable buffering capacity or acid producing reactions of some acid salts and soluble species of aluminium and iron. For example, as the pH increases towards 4, the precipitation of soluble ferric ion occurs, liberating more acid:
- $Fe3+ + 3H2O \rightarrow Fe(OH)3 + 3H+$
- If neutralising substantial quantities of ASS leachate, full laboratory analysis of the water will be necessary to adequately estimate the amount of neutralising material required.

Application of lime to water

To increase the efficiency, lime should be mixed into a slurry before adding. A slurry can be prepared in a concrete truck, cement mixer or large vat with an agitator. Methods of application of the slurry include:

- Spraying the slurry over the water with a dispersion pump
- Pumping the slurry into the water body with air sparging (compressed air delivered through pipes) to improve mixing once added to water
- Pouring the slurry out behind a small motorboat and letting the motor mix it in
- Incorporating the slurry into the dredge line (when pumping dredge material)
- Using mobile water treatment equipment such as the 'Neutra- mill' and 'Aqua Fix' to dispense neutralising reagents to large water bodies.

A change in pH will not be instantaneous. The rate of neutralisation will vary with the solubility, fineness of the lime, the application technique and the acidity (pH) of the water. The finer the lime (preferably microfine with the consistency of white dust) and the more agitated the water, the faster the lime will dissolve and become effective. The pH must be carefully monitored even after the desired pH has been reached. If the water has not reached the desired pH within two weeks, more lime may need to be added. Before additional lime is added, the lack of success should be investigated. Issues to consider may include:

- The quality of the lime being used
- The effectiveness of the application technique
- The existence of additional sources of acid leaching into the water body further acidifying the water, and
- The lime has become lumpy and is sitting on the bottom

Neutralisation may be faster if higher rates are used, but is not recommended as it is expensive and resource wasteful. Moreover, over-dosing may result, though this is unlikely to be a concern with agricultural lime.

Appendix D Heavy rainfall event procedure

Heavy Rainfall Event Procedure

Purpose

To detail the actions to be taken in the event of a 'heavy' or 'violent' rainfall forecast as defined by the Australian Government Bureau of Meteorology. The procedure outlines how to monitor rainfall forecasts and prepare site to minimise impacts as much as practicable.

For management measures and procedures to be implemented prior to a flooding event, including timeframes for securing work sites and moving plant and equipment, refer to the Flooding and Hydrology Management Sub-plan (FHMP).

Table D-1 Definition of rain or showers intensity

Category	Description
Light	Up to 2 mm per hour. Individual drops easily identified, puddles form slowly, small streams may flow in gutters.
Moderate	2.2 mm to 6 mm per hour. Rapidly forming puddles, down pipes flowing freely, some spray visible over hard surfaces.
Heavy	6.2 mm to 50mm mm per hour. Falls in sheets, misty spray over hard surfaces, may cause roaring noise on roof.
Violent	Over 50mm per hour. Gutters and downpipes overflowing, spray to height of several centimetres over hard surfaces, may cause roaring noise on roof.

Source: Australian Government Bureau of Meteorology website http://www.bom.gov.au/info/wwords

Induction and training

All Fulton Hogan Superintendents, Foremen and Engineers will be trained in this procedure.

Procedure

1. Monitoring of 'heavy' or 'violent' rain or shower events (through the Australian Government Bureau of Meteorology):
2. On each working day, the Environmental Manager (EM)/ Environment Officer (EO) or delegate will log on to the Australian Government Bureau of Meteorology website http://www.bom.gov.au/weather/nsw review the weather forecast for the next three days and notify the Project team of the same by email. When rain or showers are described as 'heavy' or 'violent', the EM/EO or delegate will highlight that:
    - rain or showers are described as 'heavy' or 'violent' (as applicable)
    - the Heavy Rainfall Event Procedure must be followed.
3. The EM/ EO or delegate will keep a record of all weather forecast emails.
4. The daily weather forecast may be discussed at Prestart Meetings as deemed required by the Fulton Hogan Foreman/ Superintendent.
5. When rain or showers are described as 'heavy' or 'violent' the Fulton Hogan Superintendent will notify the Project team of personnel who will monitor and maintain erosion and sediment controls if required.
6. The Foremen will ensure that there is an adequate supply of erosion and sediment control measures on site.
7. Prior to the 'heavy' or 'violent' rainfall or shower event, the Foremen and the EM/ EO or delegate will inspect erosion and sediment control measures, focusing on the critical areas first. These may include stockpile areas, chemical storage areas and sediment basins.
8. Additional temporary erosion and sediment controls will be installed as required.

Appendix E Stockpile Management Protocol

Stockpile Management Protocol

Purpose

This protocol provides a process for the establishment of *temporary* stockpile areas within the approved project boundary and any approved ancillary facility to ensure that environmental impacts associated with stockpiling are minimised during construction.

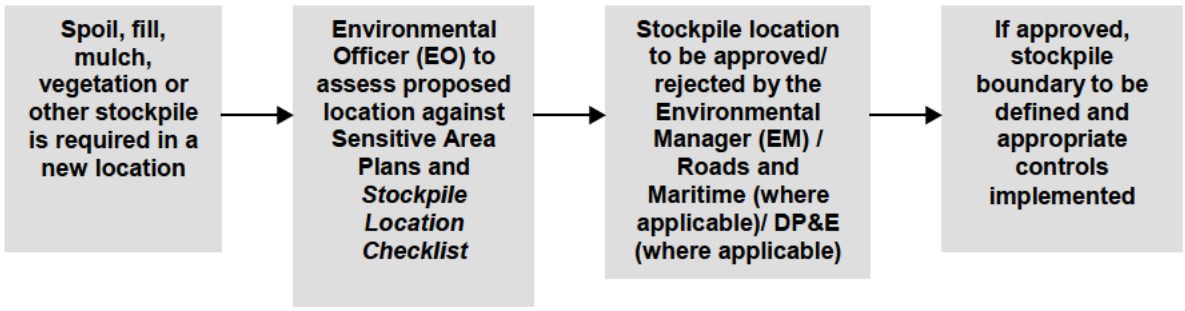
Stockpile sites may typically be required to store material including, but not limited to:

- Excavated materials to be used in fill embankments and other design features
- ASS subject to treatment prior to reuse
- Excavated material unsuitable for reuse in the formation
- Excess concrete, pavement, rock, steel and other material stored for either future use in the Project or prior to removal from site, and
- Topsoil, mulch, excess timber for landscaping and revegetation works.

Scope

This protocol and associated *Stockpile location checklist* describe the environmental criteria/ factors to be considered to ensure stockpiles are located in areas where potential environmental harm is minimised.

To avoid duplication, refer to the relevant Sub-plan e.g. AQMP, WEMP, FFMP, NVMP, HMP and this SWMP for the mitigation measures that will be implemented to avoid/ minimise air quality; waste management; flora and fauna; noise; heritage; and erosion and sediment impacts respectively from stockpiles.



Induction and training

All site personnel and subcontractors will be trained in this procedure.

Procedure

Proposed stockpile information

Prior to requesting the assessment of a stockpile location from the EO, the person requesting the new stockpile location should check approved stockpile locations to ensure current approved stockpile sites cannot be better utilised. Minimise the number of stockpiles sites wherever practicable.

If existing sites cannot be used, the expected quantity of material, expected dimensions required, expected stockpiling timeframes, destination of the stockpiled material, whose land the stockpile will be located on and the type of material to be stockpiled must be detailed. Once this information is known, the EO shall be contacted for an assessment of the proposed stockpile location.

Assessment of stockpile site

The EO shall utilise the **Stockpile Location Checklist** (included in this Protocol, Table E-1) to assess the stockpile location.

Note stockpiles within the approved project boundary are intrinsic to and undifferentiated from the bulk earthworks operations, these stockpiles are assessed in accordance with the section below of this protocol below.

Approval of stockpile site

Stockpiles within the approved project boundary

The EO shall give the completed *Stockpile Location Checklist* (Table E-1) to the EM for review and assessment. Following this review, the EM shall either approve or reject the proposed stockpile location and notify the EO of the decision.

A register of all stockpile sites (Table E-2, included in this Protocol) shall be kept on file by the EO and they shall also ensure that any additional erosion and sediment control measures are included in the relevant progressive erosion and sediment control plan (PESCP).

Preparing stockpile site

If the proposed stockpile site is approved, the boundaries will be agreed between the person proposing the stockpile and the EO (or Roads and Maritime where required). The proposed stockpile site will be marked out and appropriate erosion and sediment controls installed. Stockpile sites will also be signposted to clearly identify and delineate between other stockpiles. The erection of signs will be agreed with the Site Foreman.

Details of stockpile management in regard to erosion and sediment control will be included in the relevant ESCP/ PESCP.

Mulch stockpiles

Locate and manage mulch stockpiles to minimise and manage tannin generation. Refer to Appendix F of this SWMP for **Roads and Maritime Environmental Direction: Management of Tannins from Vegetation Mulch.**

Stockpile location checklist

Proposed Stockpile number:	
Chainage:	
Location sketch is attached? (mandatory)	☐ Yes
Stockpile type and dimensions (HxWxD):	

The location of stockpile sites will be determined following review of the following documents and requirements:

- CEMP and Sub-plans including review of relevant mitigation measures
- Sensitive Area Plans
- Stockpile Management Protocol
- Revised environmental management measure REMM SW02
- Roads and Maritime Specification D&C G36, G38 and G40
- Roads and Maritime Stockpile Site Management Guideline.

Where proposed sites do not comply with the criteria below, provide justification and additional mitigation measures to demonstrate how potential impacts will be managed.

Table E-1 Stockpile location criteria

Criteria		Source of requirement	Does the proposed site meet the criteria?	If proposed site does not meet the criteria, provide justification/ additional mitigation measures to demonstrate how potential impacts will be managed
Vegetation	Site should minimise damage to natural vegetation and trees	G40 cl 5.2		
	Site should be located outside of the 'dripline' of trees	G 40 cl 2.4.1(ii)		
	Site should be located outside of the tree protection zone of trees or native vegetation identified for retention. Refer to AS 4970.	G 38 cl 3.2		
	Site should avoid clearing native *Ficus* and *Eucalyptus* species	SWTC App 14 cl 14.3		
	Site must not result in any clearing of native vegetation beyond that which is otherwise required for the project.	SWTC App 4 cl 4.21		
	Site should be located so that the removal of threatened species, endangered ecological communities (EECs) or roosting habitat for listed threatened fauna species is not required	SWTC App 4 cl 4.21		

Criteria		Source of requirement	Does the proposed site meet the criteria?	If proposed site does not meet the criteria, provide justification/ additional mitigation measures to demonstrate how potential impacts will be managed
Drainage and water quality	Site should be located away from drainage lines and watercourses	G40 cl 5.2		
	Site should be located at least 50 m from a waterway unless an ESCP/PESCP is prepared and implemented so as not to adversely affect water quality in the waterway[1]	SWTC App 4 cl 4.21		
	Site should be located at least five metres from likely areas of concentrated water flows and at least 10 metres from waterways that are classified as Class 1 and Class 2 from the DPI Fisheries guideline "Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings"	G 38 cl 3.2 SWTC App 4 cl 4.21		
	Site should be located on land with a slope less than 10 per cent.	SWTC App 4 cl 4.21		
Dust and noise	Site should be located away from dust sensitive locations	G36 cl 4.4.2(o)		
	Site should be located away from noise sensitive locations	G36 cl 4.6.1(f)		
Access	Site must be positioned with ready access to the road network or direct access to the construction corridor	SWTC App 4 cl 4.21		
	Site must be positioned so that the stockpiled material is access ble at any time	G40 cl 5.2		
Heritage	Site be located in areas of low heritage conservation significance (including areas identified as low Aboriginal Cultural value) so as to not impact upon heritage sites beyond those already impacted by the Project.	SWTC App 4 cl 4.21		
Flooding and hydrology	Where stockpiles are to be located in the floodplain, site located and sized to ensure temporary impacts are not greater than those specified in the design criteria.	REMM HF02 G 38 cl 3.2		

[1]**"Waterway" is defined in SWTC Appendix 4 Clause 4.21(a)(ii) as "any Class 1 or Class 2 fish habitat waterways (as described in the Department of Primary Industries Fisheries guidelines); and waters that are used for the purpose of human consumption."**

Prepared by Environment Officer: ..... Date:.....
Environmental Manager: ..... Date:.....
Approved / Rejected (please circle) by: ..... Date: .....

Table E-2 Approved stockpile location register

Stockpile number/ identifier	Date approved	Location description	Chainage	Issued To	Updated PESCP? (yes/ no/ not required)

Appendix F Roads and Maritime environmental direction: management of tannins from vegetation mulch

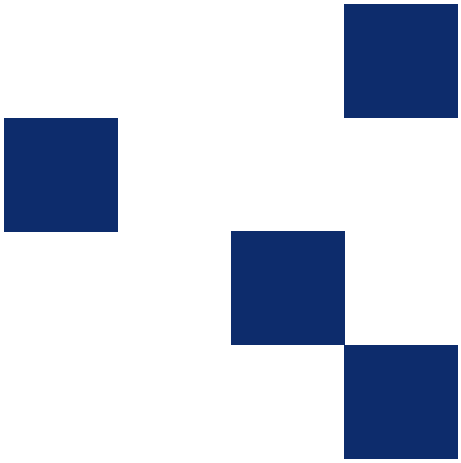
Transport Roads & Maritime Services

NSW GOVERNMENT

ENVIRONMENTAL DIRECTION

Management of Tannins from Vegetation Mulch

JANUARY 2012



ABOUT THIS RELEASE

Environmental Direction number	25
Environmental Direction title	Management of Tannins from Vegetation Mulch
Author	Environment Branch (Environmental Policy)

Issue	Date	Revision description
1	December 2011	Final draft
2	January 2012	Final

CONTENTS

1 PURPOSE

The purpose of this environmental direction is to set RMS's minimum management measures to minimise the generation and discharge of tannins from vegetation mulch on Roads and Maritime Services (RMS) construction projects. Additional background information on tannins and the use of mulch on construction sites is included in section 3 of this direction.

2 MANAGEMENT MEASURES

The primary focus must be to minimise tannin generation on construction sites.

2.1 General mulch management measures

These general mulch management measures are to be followed for all RMS construction projects.

2.1.1 Planning and works staging

The first step in planning and works staging is to identify the amount of mulch to be generated. With this information, a strategy can be prepared to manage mulch on site. Staging of chipping, tub grinding and/or mulching activities should be planned to reduce the volume of mulch to be managed at any one time. The volume of excess mulch can then be assessed and plans made to dispose of this off site.

Other general considerations at the planning and works staging phase are as follows:

- Mulch stockpile sites should be established with appropriate controls in place before the main site clearing activities commence. Limited clearing may be required earlier for establishment of stockpile areas and access.
- Stage the mulching of cleared vegetation to ensure that mulch can be progressively moved to elevated, or otherwise suitable, stockpile locations. It is preferred that mulch should be transferred to a stockpile or reused on the day of mulching.
- Plan to efficiently reuse mulch in progressive works to reduce the time that mulch is concentrated in stockpile locations.
- Excess mulch can be managed by community giveaway. This takes considerable time and mulch needs to be suitably located and managed as this occurs. The conditions for community giveaway of mulch are included as Appendix 3.
- Any other form of bulk offsite mulch disposal (eg to Council parkland or a development site) must be assessed to ensure waste management provisions are adhered to for off site disposal.

2.1.2 Stockpile location and management

- Mulch stockpile sites should be established on elevated ground where possible.
- Stockpile sites with a duration of not more than 1 month should be constructed not less than 20 metres from a watercourse, including floodplains.
- Stockpile sites with a duration of more than 1 month should be constructed not less than 50 metres from a watercourse, including floodplains.
- Mulch stockpiles should be designed and constructed to divert upgradient water to prevent it from entering the stockpile site.

2.1.3 Management measures for the use of mulch on site

- Do not use mulch for surface cover or sedimentation controls in any low lying areas of the site that remain consistently wet. Alternative controls such as geofabric (for surface protection) or sediment fence will be required in these areas.
- Do not spread surface mulch in thicker than 100mm layers. Mixing mulch with topsoil is encouraged for batters to prevent loss of topsoil during initial stabilisation. It should be noted that mulch will generally cause nitrogen draw down which may inhibit plant growth, unless mulch has been composted first.
- Care is to be taken to ensure that excessive mulch is not applied for sedimentation controls such as perimeter bunds or catch dams.

2.1.4 Monitoring and response

- Monitor the site for generation of tannins. Tannin impacts can be readily identified visually as dark coloured ponded water. Site staff should be trained to identify and report potential impacts to the site project management or environment staff.
- Review management practices where required to prevent the generation of tannins in identified problem areas.

2.2 Mulch management methods for high risk sites

2.2.1 High risk sites

High risk sites, where additional management measures may be required, include:

- where large quantities of mulch will be generated and stockpiled.
- where high tannin generating vegetation types are to be mulched (see 3.1).
- where the receiving environment is identified as sensitive (eg Marine Park, threatened aquatic species habitat).
- where tannins have been observed to be generated or discharged from an operating site with standard management controls.

2.2.2 Stockpile management measures for high risk sites

- Mulch stockpiles for high tannin generating vegetation types should incorporate an impermeable bund to capture stockpile leachate or tannin impacted water. Impervious bunds must be a minimum of 300 mm high, preferably higher to capture tannin impacted water. All bunded stockpiles that are in place for a period longer than one month must include a lined discharge point for overflow in extreme rainfall events.
- Stockpiles established on sloping sites must be designed to provide temporary stormwater containment equivalent to a 300 mm minimum height bund on a flat site.
- Tannin impacted water should be pumped out of bunded stockpiles within 5 days of the end of a rainfall event to maintain the storage capacity. This water should be used for on site purposes including dust suppression and landscape watering. These activities must be managed to prevent any pooling or runoff of tannin impacted water.
- Bunded stockpiles must be inspected within 24 hours of cessation of any rainfall event greater than 10mm to ensure tannin impacted water does not overflow.

2.3 Site management procedures

Site management procedures must be prepared for all sites where tannins are identified as a potential issue. Site management procedures should be based on the management measures provided in this Environmental Direction.

3 BACKGROUND

3.1 Tannin generation from vegetation mulch

See Plates 1 – 3 in Appendix 1.

Tannins are naturally occurring plant compounds. Tannin generation from vegetation mulch is likely to be highest from low-lying coastal floodplain areas. The species of vegetation (eg *Melaleuca*) will have a major impact on the likelihood of tannin generation.

Tannin generation is generally highest from mulched vegetation that is stockpiled in areas that are subject to inundation. Placement in wet areas will result in accelerated leaching of tannins into water, concentration of tannins in pooled water, and greater impacts on water quality.

3.2 Tannin impacts on water quality

See Plates 4 – 5 in Appendix 1.

The main concern with the discharge of water that is high in tannins is that it may increase the biological oxygen demand (BOD) of the receiving environment. Increases in BOD may result in a decrease in available dissolved oxygen. A lack of dissolved oxygen is identified as the main cause of about 80 percent of fish kills in NSW rivers and estuaries.

Tannin impacts may result in dark coloured water discharge from construction sites. This impact can be obvious and may raise the concern of the community and other stakeholders including regulatory authorities. Once discharged to the environment, tannins may reduce visibility and light penetration and change the pH of receiving waters. These impacts may affect aquatic ecosystems in receiving environments.

Tannins cannot be readily treated with standard construction site water quality controls. Once water on site is impacted with tannins it is not possible to treat effectively with currently approved flocculants. Minimisation of tannin generation in the first place is the management strategy that must be applied.

3.3 Use of mulch on construction sites

See Plates 10 – 16 in Appendix 2.

The RMS Biodiversity Guidelines provide guidance on the benefits of reusing various sizes of vegetation for different purposes. Mulch is a readily available and cheap source of material for temporary site stabilisation and sedimentation control. The re-use of mulch reduces the need to transport this material off-site and reduces handling and disposal costs for construction contracts.

Unprotected mulch sedimentation controls should not be placed in concentrated flow lines where mulch may be washed away. Mulch may be protected by wrapping it with geofabric or other materials to provide a stable control. All temporary catch dams constructed from mulch must have a stable outlet to minimise the washing away of mulch in high rainfall events, and the possible failure of the control.

4 ADDITIONAL RESOURCES

- RTA Biodiversity Guidelines- Protecting and Managing Biodiversity on RTA Projects, 2011
- Pacific Highway Mulch Protocol 2011

5 APPENDICES

Appendix 1: Plates showing tannin generation & water quality impacts

Plate 1: Melaleuca vegetation community – mulch from this vegetation type will generally produce high amounts of tannins.

Plate 2: Vegetation mulching activity – mulch should be progressively moved into prepared stockpile areas.

Plate 3: Tannin generation from recently felled and partially mulched vegetation in an area subject to localised inundation. Mulched vegetation should be progressively moved to prepared stockpiles to manage tannin impacted water.

Plate 4: Tannin impact in stormwater at the discharge point from a road construction site. The discharge of impacted water may be obvious to community and other stakeholders.

Plate 5: Tannins in a drainage line generated from very thickly applied mulch on the batter above. Note that the sedimentation fence is not effective in treating the tannins.

Appendix 2: Plates showing the use of mulch for erosion & sedimentation controls

Plate 6: Mulched vegetation stockpiled in a low-lying area subject to inundation. This is not an appropriate stockpile location and may increase the generation of tannins from stockpiled mulch.

Plate 7: Mulch being placed as batter erosion control. Mulch should not be applied in layers more than 100 mm thick for surface stabilisation.

Plate 8: Site showing recent application of a mulch/topsoil mix on batters (40% mulch to 60% topsoil). Mulch mixes are used to provide temporary stabilisation to prevent the loss of topsoil from batters in heavy rainfall events. Mulch use is also shown as a mounded sedimentation control to prevent sediment entering the median drain.

Plate 9: A mulch/topsoil mix used to provide temporary batter stabilisation and to assist cover crop establishment.

Plate 10: Successful establishment of cover crops on batters where mulch has been used with topsoil to assist temporary stabilisation.

Plate 11: Geofabric wrapped mulch bunds used for sedimentation control

Plate 12: Mulch used as a bund for a temporary sedimentation catch dam. Mulch is effective as it can provide both containment and filtering of site water. Mulch should not be used as a control in areas of concentrated flow where it may be washed away. Any mulch containment control should have a defined and lined outlet that allows discharge from the control without washing mulch away. Note that this control does not have a defined discharge outlet which should be installed to prevent failure of the control in heavy rainfall events.

Appendix 3: Minimum requirements for community mulch giveaways

The purpose of community mulch giveaways is to provide mulch for residential landscaping purposes.

The activities of a community mulch giveaway are permissible under the *Protection of the Environment Operations (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A* (the Raw Mulch Exemption 2008). However, the activities remain subject to other relevant environmental regulations within the Act and Regulations. The Raw Mulch Exemption 2008 is subject to the following conditions:

- The raw mulch can only be applied to land for the purposes of filtration or as a soil amendment material or used either singularly or in any combination as input material(s) to a composting process.
- The consumer must land apply the raw mulch within a reasonable period of time.

Further information can be found at: www.environment.nsw.gov.au/resources/waste/ex08mulch.pdf

It is the mulch generators responsibility to ensure that the mulch is reused in an environmentally responsible manner.

A safe work method statement (SWMS) must be prepared that identifies potential OHS risks and all prevention and mitigation measures. The SWMS must apply to both the community and site workers involved in the mulch giveaway.

Each member of the community who participates in the mulch giveaway must read and understand a site specific information sheet. A template information sheet is attached as Appendix 4.

The site occupier must maintain written records for each load of mulch that is taken away and to ensure that each community participant understands the conditions of the community mulch giveaway information sheet. A suggested template to record this information is attached as Appendix 5.

Appendix 4: Community mulch giveaway information sheet

The following community mulch giveaway information sheet must be populated with site specific information.

Community Mulch Giveaway
Information Sheet

Details of Mulch Supply	
Site Occupier	<insert name of contractor / alliance etc>
Project Name	<insert project name>
Location	<insert location of mulch stockpile>
Mulch stockpile access directions	<insert adequate directions for community members to find the stockpile location>

Background

- This information sheet supports the non-commercial giveaway of mulch for local residents.
- The product is raw vegetation mulch from <insert project location / name>.

Conditions

- Any one individual may only take a maximum of 5 trailer loads from this project.
- The mulch may only be used for residential landscaping purposes.
- Mulch must not be placed in or immediately adjacent to waterways.
- The raw mulch can only be applied to land for the purposes of filtration or as a soil amendment material or used either singularly or in any combination as input material(s) to a composting process.
- The consumer must apply the raw mulch to land within a reasonable period of time.

Community Safety Requirements

- <add in any safety requirements or mitigation measures from the SWMS that apply to the community>
- <add in any safety requirements or mitigation measures from the SWMS that apply to the community>
- <add in any safety requirements or mitigation measures from the SWMS that apply to the community>
- <add in any safety requirements or mitigation measures from the SWMS that apply to the community>

Appendix 5: Records template for community mulch giveaway

The records in the following suggested template must be kept as a minimum.

Community Mulch Giveaway Record Sheet				
Date	**Car Registration**	**I have read and understand the 'Community Mulch Giveaway Information Sheet'**	**Name**	**Signature**
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		