



APPENDIX B4

Soil and Water Quality Management Sub Plan

Toolijooa Road Fill Works stage of Foxground and Berry bypass

JANUARY 2014



Document control

File name	FBB TRFW Soil and Water Quality Management Sub Plan
Report name	Toolijooa Road Fill Works stage of Foxground and Berry bypass - Soil and Water Quality Management Sub Plan
Revision number	Rev 4

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Revision history

Revision	Date	Description	Approval
4	21/01/2014	2 nd Draft for RMS review (DP&I comments addressed)	
3	7/11/2013	Draft for DP&I review	
2	30/10/2013	Draft for ER review	
1	08/10/2013	Draft for RMS review	
0	03/10/2013	Initial draft for internal review	

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Appendix C	Not used
Appendix D	Not used
Appendix E	Not used
Appendix F	Stockpile Management Protocol
Appendix G	Acid Sulfate Material Management Sub-Plan
Appendix H	Not used
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Glossary / Abbreviations

ANZECC	The Australian and New Zealand Environment Conservation Council
ASS	Acid sulfate soils
CEMP	Construction Environmental Management Plan
CoA	Condition of Approval
DEC	Department of Environment and Conservation
DECCW	Department of Environment, Climate Change and Water
DLWC	Department of Land and Water Conservation
DNR	Department of Natural Resources
DPI	Department of Primary Industries (Fishing and Aquaculture)
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
EA	Environmental Assessment
EEC	Endangered Ecological Community
EPA	Environment Protection Authority
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPL	Environmental Protection Licence
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESCP	Erosion and Sediment Control Plan
EWMS	Environmental Work Method Statements
FM Act	<i>Fisheries Management Act 1994</i>
NOW	NSW Office of Water
OEH	Office of Environment and Heritage
PASS	Potential acid sulfate soils
PESCP	Progressive Erosion and Sediment Control Plan
POEO Act	<i>Protection of the Environment Operations Act 1997</i>
Project, the	The Princes Highway Upgrade - Foxground and Berry Bypass Project, defined as “ <i>The construction and operation of approximately 11.6 kilometres of two lane divided carriageways (with the exception of the cutting through Toolijooa Ridge which comprises two lanes plus a climbing lane in each direction), with provisions for the possible future widening to three lanes within the road corridor (if required in the future).</i> ”
RMS	Roads and Maritime Services
RTA	Roads and Traffic Authority (now RMS)
SoC	Revised Statement of Commitments included in the Submissions Report
SWMP	Soil and Water Quality Management Plan
VENM	Virgin Excavated Natural Material
Water Act	<i>Water Act 1912</i>
WM Act	<i>Water Management Act 2000</i>

1 Introduction

1.1 Context

Fulton Hogan is currently constructing the Gerringong upgrade project on behalf of the RMS, which involves the upgrade of the Princes Highway between Mount Pleasant and Toolijooa Road (adjacent to the start of the Foxground and Berry Bypass Project).

Fulton Hogan wish to use excess cut material from the Gerringong upgrade project to commence fill works required for a small portion of the Foxground and Berry Bypass Project totalling approximately 151,000m³ of material, on the western side of Toolijooa Road, at its intersection with the Princes Highway (Toolijooa Road Fill Works) (refer to Figure 1-1). The Toolijooa Road Fill Works is proposed to commence in late November 2013 and be completed in March 2013, weather permitting. The Toolijooa Road Fill Works will be constructed as a separate package of works from the rest of the Foxground and Berry Bypass Project. The Staging Report should be referred to for a full description of the proposed Toolijooa Road Fill Works stage of the Project.

This Soil and Water Quality Management Sub Plan (SWMP or Plan) forms part of the Construction Environmental Management Plan (CEMP) for the Toolijooa Road Fill Works stage of the Foxground and Berry bypass Project (the Project).

This SWMP has been prepared to address the relevant requirements of the Minister's Conditions of Approval (CoA), the RMS Statement of Commitments (SoC), the mitigation measures listed in the Foxground and Berry bypass Environmental Assessment (EA) and all applicable legislation.

This SWMP, and the Erosion and Sediment Control Plan (ESCP) have been prepared to address construction activities and sequencing as described in Table 1-1.

Table 1-1 Toolijooa Road Fill Works construction activities and sequencing

Component	Typical activities
Site establishment	<ul style="list-style-type: none">- Fencing of the road corridor- Construction of site access and wheel wash bays- Installation of temporary traffic controls- Pre-clearing flora and fauna survey
Relocation of services	<ul style="list-style-type: none">- Consultation with relevant service providers on service relocation- Relocation of services including electricity, water and telecommunications infrastructure
Demolition works	<ul style="list-style-type: none">- Demolition of one dwelling and sheds
Site preparation	<ul style="list-style-type: none">- Vegetation clearing and grubbing- Installation of the environmental controls, i.e. erosion and sediment controls and exclusion fencing- Stripping and stockpiling of topsoil for reuse
Earthworks	<ul style="list-style-type: none">- Inspection of foundation and carrying out of foundation treatment- Placement and compaction of fill and embankment materials as per D&C R44
Finishing works	<ul style="list-style-type: none">- Removal of temporary works- Restoration and landscaping of disturbed areas- Site clean-up

1.2 Background

Section 7.4, 7.5 and 8.1 of the *Princes Highway upgrade – Foxground and Berry bypass Environmental Assessment* (AECOM, 2012) assessed the impacts of construction and operation of the Project on soil and water.

As part of the EA development, detailed water quality, flooding and soils assessments were prepared to address the Director General's Requirements. The surface water, groundwater and flooding assessment was included in the EA as:

- *Volume 2 Appendix H Technical paper: surface water, groundwater and flooding.*

Parts of the Environmental Assessment and Appendix H relevant to the Toolijooa Road Fill Works stage have been used in preparation of this SWMP.

1.3 Environmental management document system

The Project Environmental Management document system is described in the Construction Environmental Management Plan (CEMP).

The SWMP is part of Fulton Hogan's environmental management framework for the Project. In accordance with the requirements of CoA B36(d), this SWMP has been developed in consultation with the NSW Office of Environment and Heritage (OEH), Environmental Protection Authority (EPA), Department of Primary Industries (DPI) – Fisheries and Aquaculture and NSW Office of Water (NOW). Further details of the consultation are provided in Chapter 4 of this SWMP.

Management measures identified in this SWMP will be incorporated into the Contractor's site or activity specific Environmental Work Method Statements (EWMS), the Erosion and Sediment Control Plan (included in Appendix B), and any subsequent Progressive Erosion and Sediment Control Plans (PESCP).

EWMSs will be developed and signed off by environment and management representatives prior to the commencement of the associated works. Construction personnel will be required to undertake works in accordance with the safeguards identified in the EWMSs.

PESCPs provide detailed site-specific erosion and sediment control measures. PESCPs will be developed by the Contractor's environment team in consultation with construction personnel and the Project Soil Conservationist. PESCPs will be updated or modified as required when there are changes in site conditions, flow paths or construction activities that affect ground conditions.

The combination of the CEMP, sub plans, strategies, procedures, EWMS and PESCPs identify the required environmental management actions for implementation Fulton Hogan's personnel and sub-contractors.

The review and document control processes for this SWMP are described in Chapter 10 of the CEMP.



Source: Toolijooa Road Fill Works Staging Report (Element Environment, 2013)

Figure 1-1 Location map - Toolijooa Road Fill Works Project

2 Purpose and objectives

2.1 Purpose

The purpose of this SWMP is to describe how Fulton Hogan proposes to manage and protect soil and water quality during the construction of the Toolijooa Road Fill Works stage of the Project.

2.2 Objectives

The key objective of the SWMP is to ensure that impacts on soil and water quality during construction of the Toolijooa Road Fill Works stage are minimised and within the scope permitted by the Planning Approval.

To achieve this objective, Fulton Hogan will undertake the following:

- ensure best management practice controls and procedures are implemented during construction to avoid or minimise erosion / sedimentation impacts and potential impacts to water quality in creeks near the works;
- ensure appropriate measures are implemented to address the relevant CoA and SoC outlined in Table 3.1 and Table 3.2, and the safeguards detailed in the EA; and
- ensure appropriate measures are implemented to comply with all relevant legislation and other requirements as described in Section 3.1 of this SWMP.

2.3 Targets

The following targets have been established for the management of soil and water impacts during the construction of the Toolijooa Road Fill Works stage of the Project:

- ensure full compliance with the relevant legislative requirements, CoA and SoC;
- meet water quality discharge parameters for all planned basin discharges (i.e. those within design capacity); and
- ensure training on best practice soil and water management is provided to all construction personnel through site inductions.

3 Environmental requirements

3.1 Relevant legislation and guidelines

3.1.1 Legislation

Legislation relevant to soil and water management includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- *Environmental Planning and Assessment Regulation 2000*;
- *Protection of the Environment Operations Act 1997* (POEO Act);
- *Water Management Act 2000* (WM Act);
- *Fisheries Management Act 1994* (FM Act);
- *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); and
- *Water Act 1912* (Water Act).

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A1 of the CEMP.

3.1.2 Guidelines and standards

The main guidelines, specifications and policy documents relevant to this SWMP include:

- Acid Sulfate Soil Manual (ASSMAC 1998);
- *Acid Sulfate Soil and Rock* – Victorian EPA Publication 655.1 – July 2009;
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000);
- *National Water Quality Management Strategy* (NWQMS) (Department of Sustainability, Environment, Water, Population and Communities (DSEWPC), 1994);
- *NSW Water Quality and River Flow Objectives* (DECCW, 2006);
- Department of Environment and Conservation (DEC): *Bunding & Spill Management. Insert to the Environment Protection Manual for Authorised Officers - Technical section "Bu" November 1997*;
- *Managing Urban Stormwater: Soils and Construction*. Landcom, (4th Edition) March 2004 (reprinted 2006) (the "Blue Book"). Volume 1 and Volume 2;
- *Volume 2A Installation of Services* (DECCW 2008);
- *Volume 2C Unsealed Roads* (DECCW 2008);
- *Volume 2D Main Roads Construction* (DECCW 2008);
- DIPNR *Roads and Salinity Guideline, 2003*;
- DLWC, 1998. *Constructed Wetlands Manual*;
- Fairfull, S. and Witheridge, G. (2003) *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*. NSW Fisheries, Cronulla, 16 pp.;
- NSW Fisheries, November 2003. *Fishnote – Policy and Guidelines for Fish Friendly Waterway Crossings* (Ref: NSWF – 1181);
- RMS Pacific Highway Practice Note for Dewatering.
- RTA's *Code of Practice for Water Management – Road Development and Management* (1999);

- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (EPA, March 2004);
- *Guidelines for the Management of Acid Sulphate materials: Acid Sulphate Soils, Acid Sulphate Rock and Monosulphidic Black Ooze* (RTA 2005);
- *RMS Environment Direction Management of Tannins from Vegetation Mulch*;
- *RMS Technical Guideline: Temporary stormwater drainage for road construction*
- *Stockpile Site Management Guideline*, RMS 2011;
- *Environmental Best Management Practice Guideline for Concreting Contractors* (DEC, 2004);
- *RMS Road Design Guideline: Section 8 Erosion and Sedimentation* (RTA, 2003);
- *RMS Guideline for Construction Phase Water Quality Monitoring* (RTA, n.d.);
- *RMS Erosion and Sedimentation Management Procedure* (RTA, 2009);
- *Procedures for Selecting Treatment Strategies to Control Road Runoff* (RTA, 2003a);
- *RMS Water Policy* (RTA, 1997);
- *Road Runoff and Drainage: Environmental Impacts and Management Options, AP-R180* (Austroads, 2001);
- *Floodplain Development Manual* (NSW Government, 2005);
- *RMS Technical Guideline: Environmental Management of Construction Site Dewatering* (RTA, 2011);
- *Coastal Lakes: Independent Inquiry into Coastal Lakes and Statement of Joint Intent* (Healthy Rivers Commission of NSW, 2002);
- The relevant targets within the *State Water Management Outcomes Plan* (NOW, 2003);
- *State Groundwater Policy Framework Document* (Department of Land and Water Conservation (DLWC), 1997);
- *The NSW State Groundwater Quality Protection Policy* (DLWC, 1998);
- (Draft) *NSW State Groundwater Quantity Management Policy* (DLWC, n.d.);
- *NSW State Groundwater Dependent Ecosystems Policy* (DLWC, 2002);
- *National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia* (Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and ANZECC, 1995);
- *Guidelines for Treatment of Stormwater Runoff from Road Infrastructure, AP-R232* (Austroads, 2003); and
- *Guidelines for the Assessment and Management of Groundwater Contamination* (NSW DEC, 2007).

Note that not all these guidelines and standards will apply to the Toolijooa Road Fill Works stage of the Project.

3.2 Minister's Conditions of Approval

The CoA relevant to this SWMP are listed Table 3-1 below. A cross reference is also included to indicate where the condition is addressed in this SWMP or other project management documents. CoA that are applicable to the Project, but are not relevant to the Toolijooa Road Fill Works stage are noted. Refer to Appendix A of the Staging Report for further discussion on those CoA that are not relevant to the Toolijooa Road Fill Works stage of the Project,

Table 3-1 Conditions of Approval relevant to the SWMP

CoA No.	Condition Requirements	Document Reference
CoA B15	<p>Prior to the commencement of construction, unless otherwise agreed by the Director General, the Proponent shall in consultation with the EPA and NOW, undertake groundwater modelling on the concept design for the Project, subject to the modelling being revised should the detailed design have a significantly different impact on groundwater than the concept design. The modelling shall be undertaken by a suitably qualified and experienced groundwater expert and assess the construction and operational impacts of the proposal on the groundwater resources, groundwater quality, groundwater hydrology and groundwater dependent ecosystems and provide details of contingency and management measures in the groundwater management strategy required under condition B36(d).</p>	<p>Not relevant to the Toolijooa Road Fill Works stage.</p> <p>The Toolijooa Road Fill Works does not involve any cutting of slopes or excavation. Therefore it is unlikely that groundwater will be intercepted during construction of this stage.</p>
CoA B16	<p>The Proponent shall prepare and implement a Water Quality Monitoring Program to monitor the impacts of the project on surface and groundwater quality and resources and wetlands, during construction and operation. The Program shall be developed in consultation with the OEH, EPA, DPI (Fishing and Aquaculture) and NOW and shall include but not necessarily be limited to:</p> <ul style="list-style-type: none"> (a) identification of surface and groundwater quality monitoring locations (including watercourses, waterbodies and SEPP14 wetlands) which are representative of the potential extent of impacts from the project; (b) the results of the groundwater modelling undertaken under condition B15; (c) identification of works and activities during construction and operation of the project, including emergencies and spill events, that have the potential to impact on surface water quality of potentially affected waterways; (d) development and presentation of parameters and standards against which any changes to water quality will be assessed, having regard to the <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000</i> (Australian and New Zealand Environment Conservation Council, 2000); (e) representative background monitoring of surface and groundwater quality parameters for a minimum of twelve months (considering seasonality) prior to the commencement of construction, to establish baseline water conditions, unless otherwise agreed by the Director General; (f) a minimum monitoring period of three years following the completion of construction or until the affected waterways and / or groundwater resources are certified by an independent expert as being rehabilitated to an acceptable condition. The monitoring shall also confirm the establishment of operational water control measures (such as sedimentation basins and vegetation swales); (g) contingency and ameliorative measures in the event that adverse impacts to water quality are identified; and 	<p>Not relevant to the Toolijooa Road Fill Works stage.</p> <p>The Toolijooa Road Fill Works stage is located at the top of a minor ridgeline. As there is no perennial water flow in the adjacent drainage line it is not possible to implement a water quality monitoring program.</p> <p>A Water Quality Monitoring Program will be prepared in accordance with this condition, prior to commencement of construction of subsequent stage(s).</p>

CoA No.**Condition Requirements****Document Reference**

(h) reporting of the monitoring results to the Department, OEH, EPA and NOW.

The Program shall be submitted to the Director General for approval 6 months prior to the commencement of construction of the Project, or as otherwise agreed by the Director General. A copy of the Program shall be submitted to the OEH, EPA, DPI (Fishing and Aquaculture) and NOW prior to its implementation.

CoA B35(e)	<p>The following performance issues shall be addressed (in the CEMP):</p> <p>(ii) measures to minimise hydrology impacts, including measures to stabilise bed and bank structures as required,</p> <p>(iv) measures to monitor and manage spoil, fill and materials stockpile sites including details of how spoil, fill or material would be handled, stockpiled, reused and disposed and a stockpile management protocol detailing location criteria that would guide the placement of stockpiles and management measures that would be implemented to avoid / minimise amenity impacts to surrounding residents and environmental risks (including to surrounding water courses). Stockpile sites that affect heritage, threatened species, populations or endangered ecological communities require the approval of the Director General, in consultation with the OEH;</p>	CEMP
CoA B36	<p>As part of the CEMP for the project required under condition B35, the Proponent shall prepare and implement the following sub plan(s):</p> <p>(d) a Construction Soil and Water Quality Management Sub plan to manage surface and groundwater impacts during construction of the project. The sub-plan shall be developed in consultation with the OEH, EPA, DPI (Fishing and Aquaculture) and NOW and include, but not necessarily be limited to:</p> <p>(i) identification of potential sources of erosion and sedimentation, and water pollution (including those resulting from maintenance activities);</p> <p>(ii) details of how construction activities would be managed and mitigated to minimise erosion and sedimentation consistent with condition C20;</p> <p>(iii) where construction activities have the potential to impact on waterways or wetlands (through direct disturbance such as construction of waterway crossings or works in close proximity to waterways or wetlands), site specific mitigation measures to be implemented to minimise water quality, riparian and stream hydrology impacts as far as practicable, including measures to stabilise bed and / or bank structures where feasible and reasonable, and to rehabilitate affected riparian vegetation to existing or better condition. The timing of rehabilitation of the waterways shall be identified in the sub-plan;</p> <p>(iv) a contingency plan, consistent with the Acid Sulfate Soils Manual, to deal with the unexpected discovery of actual or potential acid sulfate soils, including procedures for the investigation, handling, treatment and management of such soils and water seepage;</p> <p>(v) a tannin leachate management protocol to manage the stockpiling of mulch and use of cleared vegetation and mulch filters for erosion and sediment control;</p>	<p>Chapter 7 Appendix F – Stockpile Management Protocol CEMP</p> <p>This SWMP</p> <p>Chapter 4</p> <p>Chapter 6</p> <p>Chapter 7</p> <p>Not relevant to the Toolijooa Road Fill Works stage, as there is no potential to impact on waterways or wetlands.</p> <p>SWMP Appendix G - Acid Sulfate Materials Management Sub-Plan</p> <p>Not relevant to the Toolijooa Road Fill Works stage, as there is minimal woody vegetation that requires clearing. Mulch will not</p>

CoA No.**Condition Requirements****Document Reference**

be stockpiled, or vegetation filters used for erosion and sediment control.

Water quality monitoring of discharges from construction sediment basins, consistent with the Blue Book (Landcom, 2004), is addressed in Section 8.3 of this SWMP.

(vi) construction water quality monitoring requirements consistent with condition B16; and

(vii) a groundwater management strategy, including (but not necessarily limited to):

- i. description and identification of groundwater resources (including depths of the water table and water quality) potentially affected by the project based on baseline groundwater monitoring undertaken in accordance with condition B15;
- ii. identification of surrounding licensed bores, dams or other water supplies and groundwater dependant ecosystems and potential groundwater risks associated with the construction of the project on these groundwater users and ecosystems;
- iii. measures to manage identified impacts on water table, flow regimes and quality and to groundwater users and ecosystems;
- iv. groundwater inflow control, handling, treatment and disposal methods; and
- v. a detailed monitoring plan to identify monitoring methods, locations, frequency, duration and analysis requirements; and

Not relevant to the Toolijooa Road Fill Works stage, as it is located in an elevated position, immediately south of the existing Princes Highway alignment, which is located near the top of a minor ridgeline. The Toolijooa Road Fill Works stage does not involve any cutting of slopes or excavation and therefore it is unlikely that groundwater will be intercepted. A groundwater management strategy will be prepared prior to the commencement of construction of subsequent stage(s) of the Foxground and Berry Bypass Project.

CoA C20

Soil and water management measures consistent with *Managing Urban Stormwater - Soils and Construction* Vols 1 and 2, 4th Edition (Landcom, 2004) and *Managing Urban Stormwater Soils and Construction* Vols 2A and 2D Main Road Construction (DECC, 2008) shall be employed during the construction of the project for erosion and sediment control.

Chapter 7

CoA C21

Where available, and of appropriate chemical and biological quality, the Proponent shall use stormwater, recycled water or other water sources in preference to potable water for construction activities, including concrete mixing and dust control.

Chapter 7

CoA C22

All surface water and groundwater must be adequately treated prior to entering the stormwater system to protect the receiving water source quality.

Section 8.3 of this SWMP

3.3 Statement of commitments

Relevant SoC are listed Table 3-2 below. This includes reference to required outcomes, the timing of when the commitment applies, and a reference to where the commitment is addressed in this SWMP or other documents.

Table 3-2 Statements of commitment relevant to this SWMP

Outcome	Ref #	Commitment	Timing	SWMP Reference
Minimise erosion and sedimentation	SW1	Management measures will be designed, installed and maintained to minimise erosion and sedimentation from construction activities.	Pre-construction and construction	Chapter 7
	SW2	A soil conservation specialist will be engaged to provide advice on erosion and sedimentation control.	Pre-construction and construction	Chapter 7
	SW3	Stabilisation of exposed areas will be undertaken progressively.	Construction	Chapter 7
Avoid contamination of waterways	SW4	Monitoring of water quality upstream and downstream of the project site will be undertaken before and during construction. Also refer to SG4	Pre-construction and construction	Not relevant to the Toolijooa Road Fill Works stage
Acid sulfate soils (ASS) to be avoided are protected	SW5	Areas of ASS to be avoided will be fenced and signposted as exclusion zones before and during any works in the vicinity.	Pre-construction and construction	SWMP Appendix G - Acid Sulfate Materials Management Sub-Plan
Impact of exposing acid sulfate soils is minimized	SW6	Exposed ASS will be neutralised and protected from surface run-on will be minimised. Any acid runoff or acid material will be contained and treated.	Pre-construction and construction	SWMP Appendix G - Acid Sulfate Materials Management Sub-Plan
Impact of exposing unforeseen occurrences of contaminated soils is minimized.	SW7	Targeted soil contamination investigations will be undertaken during detailed design, if required. A remedial action plan will be developed if contamination is found to pose unacceptable risks to the environment and human health.	Pre-construction and construction	Appendix K – Unexpected Discovery of Contaminated Land Procedure
Minimise impacts to water quality during construction and operation.	SG1	Water quality measures such as water quality basins, swales or bioretention systems at sensitive receiving environments will be designed and installed to respond to the project water quality design criteria.	Pre-construction and construction	Chapter 7 SWMP Appendix B – Erosion and Sediment Control Plan
Minimise water quality impacts to the flow regimes of Town Creek and Bundewallah Creek.	SG2	<p>A design and revegetation strategy for the Town Creek diversion will be developed during detailed design and will include measures to:</p> <ul style="list-style-type: none"> Maintain flushing efficiency. Mitigate erosion risk at the connection with Bundewallah Creek. <p>The design of the diversion will be finalised in consultation with directly affected</p>	Pre-construction and construction	Not relevant to the Toolijooa Road Fill Works stage

Outcome	Ref #	Commitment	Timing	SWMP Reference
		landowners. The Town Creek diversion will be stabilised to mitigate erosion risk prior to operation.		
Minimise impacts on farm dams.	SG3	Permanent losses to farm dam catchments and inflows will be identified during detailed design. Mitigation strategies will be developed in consultation with affected landowners and implemented where reasonable and feasible.	Pre-construction	Not relevant to the Toolijooa Road Fill Works stage
Minimise impacts on drinking water supply.	SG4	Drinking water drawn from Broughton Creek will be maintained through measures identified in commitment AQ1. In the event that water drawn from Broughton Creek does not meet existing drinking water quality standards, an appropriate source of potable water will be made available to affected residents, following consultation.	Construction	Not relevant to the Toolijooa Road Fill Works stage
	SG5	RMS will consult with landholders along the existing Town Creek alignment, below the proposed diversion, to confirm that there are no Basic Landholder Rights (under the <i>Water Management Act 2000</i>) to access water for domestic or stock purposes.	Pre-construction	Not relevant to the Toolijooa Road Fill Works stage
Minimise changes in current flow regimes.	SG6	Waterway structures will be designed to maintain existing flow regimes, where practicable.	Pre-construction	Not relevant to the Toolijooa Road Fill Works stage
Manage the impacts associated with changes to flooding and drainage.	SG7	Detailed design will seek to minimise increases in peak flood levels in the 1 in 100 year flood event.	Pre-construction	Not relevant to the Toolijooa Road Fill Works stage
	SG8	Changes to flood impacts on property will be identified as part of detailed design. Where increased flood impacts to structures, such as residences, are identified, mitigation measures will be proposed and implemented where reasonable and feasible.	Pre-construction and construction	Not relevant to the Toolijooa Road Fill Works stage
Minimise impacts on channel structure.	SG9	Impacts on stream channel structure diversion will be minimised during detailed design. Measures to be considered may include culvert sizing, energy dissipation measures, scour protection and other design features to control flow intensity and direction.	Pre-construction	Not relevant to the Toolijooa Road Fill Works stage
Minimise the impact on groundwater levels.	SG10	Groundwater monitoring of water levels and water quality will be undertaken. Where levels and / or quality indicate that the project is potentially having an adverse impact, mitigation measures will be considered and implemented where reasonable and feasible.	Construction	Not relevant to the Toolijooa Road Fill Works stage
Conservation of water.	SG11	Water efficient work practices, such as water reuse and recycling for road construction and revegetation irrigation will be implemented, where feasible. In the event that surface water from watercourses or groundwater is required to supply water to the project, a site specific impact assessment will be carried out in consultation with the NSW Office of Water and potentially affected stakeholders.	Construction	Chapter 7, Section 7.1

4 Consultation

4.1 Consultation requirements under the Project Approval

CoA B36(d): SWMP to be developed in consultation with the OEH, EPA, DPI (Fishing and Aquaculture) and NOW.

A summary of consultation undertaken during the preparation of this SWMP is provided in Appendix A2 of the CEMP.

4.2 Consultation requirements under the EA

SWMM8: Undertake remedial works in consultation with the EPA if contamination is found to pose unacceptable risks to the environment or human health.

4.3 Consultation requirements under the SoC

No consultation requirements under the SoC are relevant to the Toolijooa Road Fill Works stage of the Project.

5 Existing environment

The following sections summarise the factors influencing soil and water within and adjacent to the Toolijooa Road Fill Works site based on the information provided in Section 7.4, Section 7.5, Section 8.1 and Appendix H of the EA as well as information gathered during a site visit undertaken on 11 September 2013.

5.1 Topography and soil characteristics

5.1.1 Topography

The Toolijooa Road Fill Works is located in an area that is characterised by undulating hills and foothills. The Toolijooa Road Fill Works stage is located in an elevated position, on a south facing slope, immediately south of the existing Princes Highway alignment. The land slopes gradually southwards to a wide valley bottom, which drains south-eastwards to the Crooked River. Geology

The geology of the Toolijooa Road Fill Works site corresponds to the Permian Shoalhaven Group, which can be further divided into the Volcanic Sandstones sub-group (also referred to as the Budgong Sandstone), the Volcanics Facies subgroup and Berry Siltstone formation.

5.1.2 Soils

Table 5-1 lists soil landscape units present within the Toolijooa Road Fill Works area, and/or from fill sources within the Gerringong Upgrade project.

Table 5-1 Soil landscape units

Soil landscape	Description	Source
Kiama landscape unit	<ul style="list-style-type: none"> Occurs in areas close to Toolijooa Road, characterised by sandy clay loams and tuff to hard clays; Moderate to extreme erosion hazard; Low wet bearing strength and potential for localised mass movement. 	<ul style="list-style-type: none"> Toolijooa Road Fill Works area Gerringong upgrade
Shoalhaven landscape unit	<ul style="list-style-type: none"> Corresponds to creeks and floodplain areas in the Crooked River catchment; Consists of alluvial soils, comprised of gravel, sand, silt and clay derived mainly from sandstone and shale that overlay buried estuarine sediments; Slight to low erosion hazard; Subject to seasonal waterlogging and has potential for ASS. 	<ul style="list-style-type: none"> Toolijooa Road Fill Works area Gerringong upgrade
Fountaindale landscape unit	<ul style="list-style-type: none"> Rolling low hills and slopes, with gradients up to 20%; Moderately deep brownish black to mid-brown sandy loams to medium clays. 	<ul style="list-style-type: none"> Gerringong upgrade
Wattamolla Road landscape unit	<ul style="list-style-type: none"> Moderately-inclined slopes and benches on Budgong Sandstone; Slopes up to 15%; Moderately deep brownish black to mid-brown sandy loams to medium clays. 	<ul style="list-style-type: none"> Gerringong upgrade
Seven Mile landscape unit	<ul style="list-style-type: none"> Low-lying, flood-prone dune ridges and swales, swamps and lagoons on marine sediments; Deep, alluvial and estuarine muds and sands. 	<ul style="list-style-type: none"> Gerringong upgrade

5.1.3 Acid sulfate soils

The Toolijooa Road Fill Works site geological conditions are mapped as having no known occurrence of ASS (Department of Land and Water Conservation (DLWC), 1997).

5.1.4 Contamination

The preliminary contamination assessment undertaken did not identify the presence of 'major' potential contamination sites at or within the vicinity of the Toolijooa Road Fill Works stage, such as large waste dumps, landfills, chemical manufacturing plants and fuel depots which may be associated with larger scale contamination issues. There was little obvious evidence of significant land filling or fill stockpiling in areas of rural land use within the Project area, which was confirmed during a site visit undertaken on 11 September 2013.

A search of the NSW OEH website did not identify any notices within the Project area under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*.

5.2 Surface water

5.2.1 Waterways in project area

The Toolijooa Road Fill Works site is within the Crooked River catchment. There are no named waterways that interact with the site, however a small ephemeral drainage line to the south of the site (refer to "existing creek" in the ESCP in Appendix B), flows south-east into a coastal floodplain, before discharging into the ocean via the estuarine Crooked River Lagoon.

5.2.2 Water quality in waterways

The long term agricultural land use in the region has resulted in waterway pollution that is greater than the water quality levels considered sustainable for maintaining ecosystem integrity. The values of total phosphorus within the Crooked River and Broughton Creek catchments are regularly above the ANZECC guidelines. The application of fertilisers and manure from stock are the likely sources of the high nutrient levels.

Previous studies within the Crooked River and Broughton Creek catchments have found that water quality was generally within the ANZECC threshold limits for pH and conductivity, and to a lesser extent, turbidity. Sampling carried out in 2007 during a period of low rainfall found that sites within Crooked River and Broughton Creek catchments were frequently below ANZECC lower limits for dissolved oxygen. Low dissolved oxygen values can be caused by low flow conditions and / or high in-stream organic loads.

Crooked River, Broughton Creek and Broughton Mill Creek have previously been found to be within ANZECC aquatic ecosystem threshold limits for a range of organochlorine pesticides, oxides of nitrogen and trace elements, although all were above the ANZECC guidelines for chloride. Crooked River was also above the ANZECC guidelines for copper and recorded concentrations of oil and grease, and suspended solids, that were much higher than samples taken from sites within the Broughton Creek catchment.

The existing highway, which has no water quality controls, is also likely to contribute pollutant loads to nearby waterbodies particularly at or near creek crossings. This would include oil, grease and other hydrocarbon products generated by general vehicular use of the highway.

A Water Quality Monitoring Program will be developed and implemented during and following the subsequent stages of construction of the Project.

Water quality monitoring will be undertaken within sediment basins, prior to discharge as discussed in section 7 and 8.4.

5.3 Groundwater

The depth of groundwater along the Project alignment is influenced by position in the landscape and proximity to discharge features. Typically, the watertable is a reflection of the topography, deepest beneath hills and shallowest adjacent to creeks and wetlands.

Groundwater along the route is shallow and typically less than 10 m below ground level for all lithologies. The elevation of groundwater is variable, ranging from 6 m AHD in low lying silts and gravels, up to 100 m AHD within latite in topographically elevated areas. The watertable fluctuates naturally in response to climatic variation. Groundwater levels increase following significant rainfall and decline following periods of low rainfall. The degree of the groundwater response is variable and dependent upon landscape position and aquifer type. Low to moderate groundwater fluctuations of less than 1 m were recorded in the siltstone and sandstone aquifers, whereas larger fluctuations (typically 3 - 4 m) were measured in the sandstone and latite aquifers.

Groundwater in the Project area is a valuable resource for stock, domestic and agricultural purposes to supplement surface water supplies collected in dams and pumped from creeks.

The Toolijooa Road Fill Works stage is located in an elevated position, immediately south of the existing Princes Highway alignment, which is located on the top of a minor ridgeline. The Toolijooa Road Fill Works does not involve any cutting of slopes or excavation and therefore it is unlikely that groundwater will be intercepted during the construction of this stage.

5.4 Climate

A summary of the mean month rainfall data is provided in Table 5-2 below. The average annual rainfall recorded at Gerringong is 1,343 mm. March is the wettest month with an average monthly rainfall of 149 mm. September is the driest month with an average monthly rainfall of 74 mm.

Table 5-2 Average monthly rainfall data – Gerringong

	Summer / Autumn						Winter / Spring						Year
	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	
Mean rainfall (mm)	98	125	139	149	136	126	127	91	80	74	94	98	1343

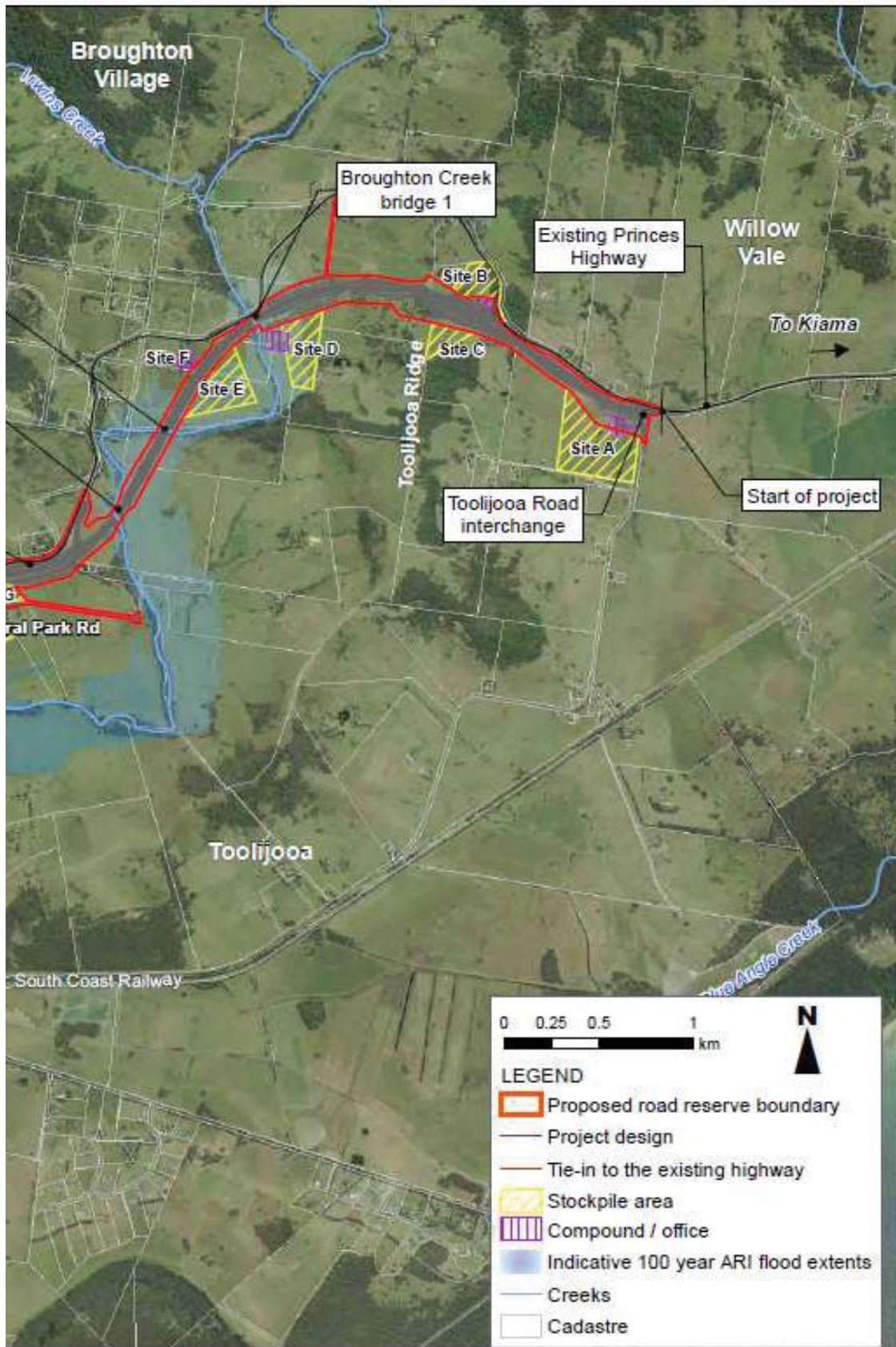
5.5 Rainfall erosivity factor

The rainfall erosivity factor is a measure of the ability of rainfall to cause erosion (referred as “R” in the Revised Universal Soil Loss Equation RUSLE). The rainfall erosivity factor is used to determine the soil loss in tonnes per hectare over one year, and is used in calculations when sizing construction sediment basins.

Information relating to the rainfall erosivity factor is provided in Appendix B – Erosion and Sediment Control Plan.

5.6 Flooding

Indicative 100 year ARI flood extents along the Project alignment are shown in Figure 5-1. Flooding does not impact on the Toolijooa Road Fill Works site.



Source: Foxground and Berry Bypass Environmental Assessment (AECOM, 2012)

Figure 5-1 Indicative 100 year ARI flood extents near the Toolijooa Road Fill Works

6 Environmental aspects and impacts

6.1 Construction activities

Key aspects of the Toolijooa Road Fill Works stage of the Project that could result in adverse impacts to soils and water include:

- vegetation clearing and topsoil stripping;
- bulk earthworks;
- site access;
- drainage works;
- material stockpiles;
- refuelling.

Refer also to the Aspects and Impacts Register included in Appendix A3 of the CEMP.

6.2 Impacts

Potential impacts on soil and water attributable to construction of the Project are identified in the following sections, which is based on information provided in the EA and Submissions Report as well as information obtained during a site visit undertaken on 11 September 2013. Chapter 7 of the SWMP provides a suite of mitigation measures that will be implemented to avoid or minimise the impacts identified below.

6.2.1 Surface Water

Clearing and filling activities associated with the Toolijooa Road Fill Works stage, represent the primary risk to surface water quality during and following construction. These activities have the potential for sediment release and transportation due to runoff from disturbed areas or where sediment has been tracked onto roads by construction vehicles. Increased sedimentation of the unnamed watercourse to the south of the Toolijooa Road Fill Works site, could smother and kill aquatic habitats and organisms and increase the concentration of nutrients, metals and other toxicants that attach to sediment particles. The risk of these impacts and the severity of the impact, should it occur, is dependent on the effectiveness of the erosion and sediment controls implemented during construction.

Other potential risks to surface water as a result of construction include:

- Sediment release from stockpiles that have not been suitably stabilised and earthmoving activities.
- Dust generation during earthworks that could settle in the drainage line to the south of the site and waterbodies on adjacent properties.
- Fuel spills that could pollute the drainage line to the south of the site. This includes fuel or oil leakage from construction equipment and accidental spills during refuelling.
- Construction materials or waste from construction that could enter waterbodies.
- An increase in surface runoff due to an increase in cleared and impervious surfaces.

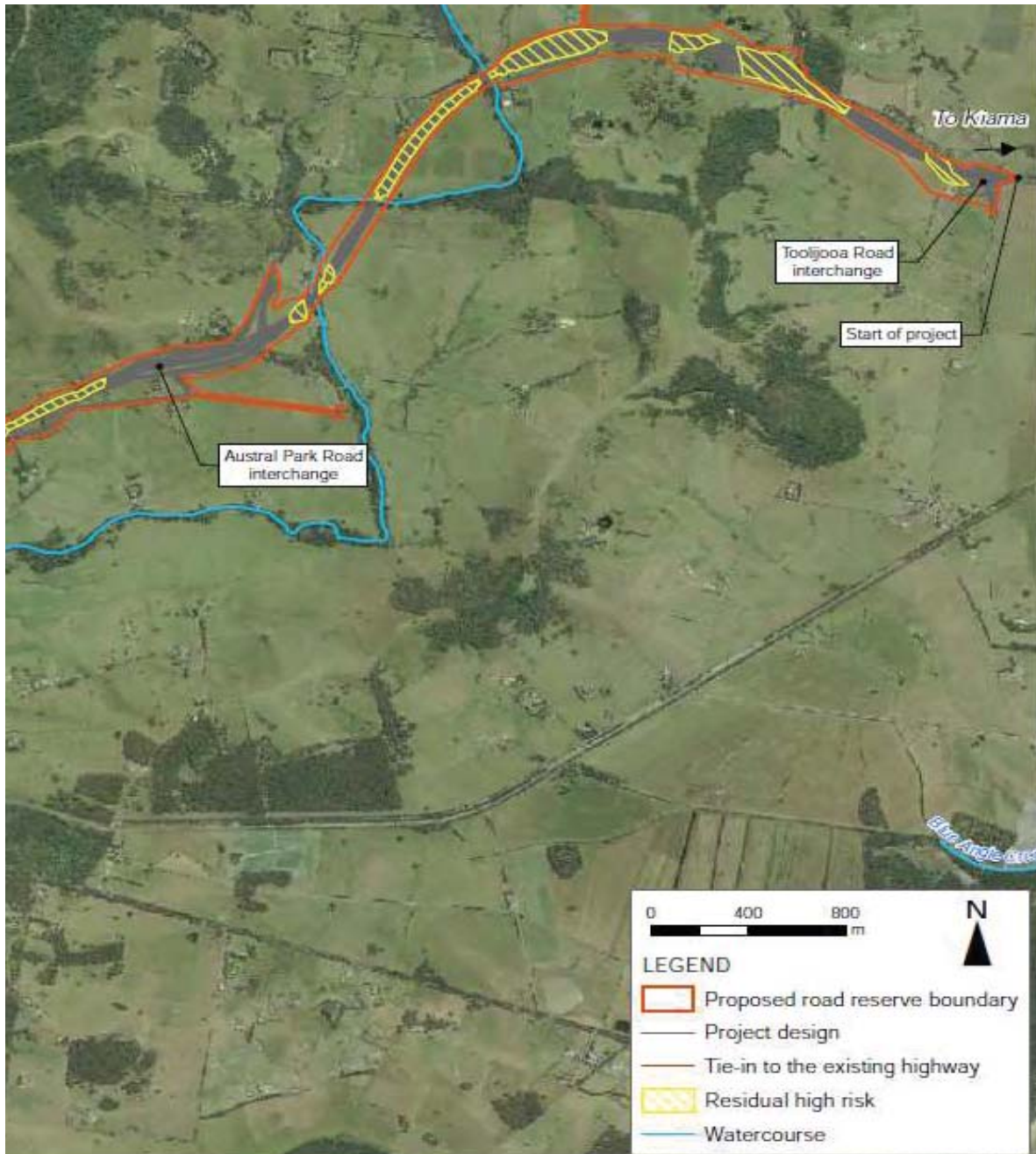
There is no potential to impact on waterways or wetlands through direct disturbance, such as construction of waterway crossings or works in close proximity to waterways or wetlands.

Similarly, there is no potential for tannin in leachate or runoff water, as there is minimal woody vegetation that requires clearing. Mulch will not be stockpiled, or vegetation filters used for erosion and sediment control.

6.2.2 Erosion and sedimentation

The construction of the Toolijooa Road Fill Works stage will result in the disturbance of the soil surface.

A number of locations within the Project footprint have been identified as posing a high risk for erosion and sedimentation during construction, including a portion of the proposed Toolijooa Road Fill Works stage (refer to Figure 6-1). Erosion and sedimentation impacts in these areas will be managed in accordance with mitigation measures in Section 7.



Source: Foxground and Berry Bypass Environmental Assessment (AECOM, 2012)

Figure 6-1 Sedimentation/erosion risk areas near Toolijooa Road Fill Works

The stockpiling of spoil and topsoil would also pose a risk for erosion and sedimentation during construction. Soil loss could occur due to the effects of wind or water in the absence of suitable stabilisation and management measures.

Soil loss during construction and/or operation could have a negative impact on agricultural productivity owing to the mobilisation and loss of soil by wind and water. Increased turbidity and suspended sediment loads in surrounding water bodies and drainage areas could reduce water quality which would impact aquatic ecology. Sediment-laden water also has the ability to block stormwater drainage structures and result in localised flooding, if drainage structures are not adequately maintained.

6.2.3 Groundwater

It is unlikely that construction activities will impact on water quality of groundwater.

Dewatering of groundwater is not required for the Toolijooa Road Fill Works stage.

6.2.4 Acid sulfate soils

Exposure of PASS to air or lowering the watertable due to excavation may lead to development of ASS. The resultant sulfuric acid and iron-rich leachate would potentially have environmental and agricultural impacts in affected areas if not adequately managed.

The potential for these impacts to arise are considered low and if encountered would be adequately managed by implementation of measures included in the Acid Sulfate Material Management Sub-plan (ASMMSP) prepared for the Gerringong Upgrade project and provided in Appendix G of this SWMP. As only VENM from the Gerringong Upgrade project will be used in the construction of the Toolijooa Road Fill Works stage, the ASMMSP is appropriate as it describes processes in place to prevent PASS being imported as fill.

In addition, other procedures used on the Gerringong Upgrade, such as the Soil Screening Protocol, In-Situ Soil Characterisation and stockpile validations, will be implemented to check that spoil sent to the Toolijooa Road Fill Works is VENM, free from contamination and does not contain ASS or PASS.

6.2.5 Contamination

There is a low to moderate likelihood of land in the Toolijooa Road Fill Works stage being affected by contamination including:

- Asbestos, zinc and lead from hazardous building materials, the disposal of wastes at the site or the miscellaneous storage of plant and equipment.
- Herbicides, fungicides and pesticides (including organochlorins and organophosphates) due to application, disposal, leaks and spills at the site.
- Petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAH), volatile organic compounds (BTEX), polychlorinated biphenyls (PCB) and heavy metals where fuel stores may have leaked, spills may have occurred or from fill of unknown origin.
- Elevated nutrients and pathogens where septic tanks have leaked.

Any contamination encountered is likely to be localised and manageable. If contamination is encountered, procedures outlined in Appendix K – Unexpected Discovery of Contaminated Land Procedure – will be followed.

Construction activities also have the potential to cause the contamination of soil due to accidental spills of fuel and oils. Spillages of fuel, oils, and/or other hazardous substances may result in negative impacts on soil and the surrounding environment.

7 Environmental control measures

A range of environmental requirements and control measures are identified in the EA, Statement of Commitments, Conditions of Approval, RMS documents and from recent RMS and Fulton Hogan experience on similar road projects. Specific measures and requirements to address impacts on soil and water are outlined in Table 7-1.

Table 7-1 Soil and water management and mitigation measures

ID	Measure / Requirement	Reference	When to implement	Responsibility	Where addressed
SHORT AND LONG TERM STABILITY OF EMBANKMENTS AND CUTTINGS					
SWMM1	Create cut and fill batters at a maximum of 2:1 slope unless otherwise agreed during detailed design.	EA Table 8-1	Construction	Designer	Tooljooa Road Fill Works - Detailed design
SWMM2	Not used				
DISTURBANCE OF ACID SULFATE SOILS					
SWMM3	Not used				
SWMM4	Implement measures in the ASMMSP (provided in Appendix G of this SWMP) to prevent ASS being used as fill material at the Tooljooa Road Fill Works site.	EA Table 8-1	Construction	Environmental Officer	SWMP Appendix G - Acid Sulfate Materials Management Sub-Plan
CONTAMINATION					
SWMM5	Not used				
SWMM6	Not used				
SWMM7	Not used				
SWMM8	Not used				
SWMM9	Refuel construction vehicles and machinery offsite at a fuel station, within the site compound area or any other agreed location. Use drip trays when refuelling vehicles and/or machinery to capture any spills.	EA Table 8-1	Construction	Foreman	Emergency Preparedness and Response Plan
SWMM10	Store fuel, chemicals and/or other hazardous substances within an appropriately bunded area.	EA Table 8-1	Construction	Foreman	Emergency Preparedness and Response Plan
SWMM11	Provide emergency spill kits.	EA Table 8-1	Construction	Foreman	Emergency Preparedness and Response Plan
SWMM12	Regularly monitor and maintain equipment and vehicles.	EA Table 8-1	Construction	Foreman	
SURFACE AND GROUNDWATER GENERAL CONSTRUCTION IMPACTS					
SWMM13	Prepare a Soil and Water Management Plan (SWMP) prior to construction, which would detail control measures for erosion and sedimentation for implementation before and during construction.	EA Table 7-54 G38	Pre-construction Construction	Environmental Manager Environmental	This SWMP SWMP Appendix B – Erosion and Sediment

ID	Measure / Requirement	Reference	When to implement	Responsibility	Where addressed
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Officer
Control Plan
EWMSs

SURFACE WATER QUALITY

SWMM14	Document the measures listed below in the SWMP and implement them on site:				
SWMM15	Construct and maintain temporary contour and diversion drains in accordance with the Erosion and Sediment Control Plan in Appendix B.	EA Table 7-54 G38	Pre-construction	Design Manager Project / Site Engineer Environmental Manager	SWMP Appendix B – Erosion and Sediment Control Plan
SWMM16	Not used				
SWMM17	Carry out construction in sequence to minimise the extent of disturbed areas and rehabilitate as soon as practicable.	EA Table 7-54 G38	Construction	Designer Construction Manager	SWMP Appendix B – Erosion and Sediment Control Plan
SWMM18	Install permanent clean water diversions and top of cut drains at the start of construction to limit the volume of water on site.	EA Table 7-54 G38	Construction	Environmental Manager Soil Conservation Specialist Superintendent Foreman	SWMP Appendix B – Erosion and Sediment Control Plan
SWMM19	Construct sediment basins prior to clearing activities in each area. Manage and monitor sediment basins as per RMS G38 specification and the ESCP in Appendix B, and dewatering as per practice notes in Appendix L. Clearly identify all sediment basin discharge points, and provide access at all times for inspections or management.	EA Table 7-54 SoC SG1 G38	Construction	Superintendent Foreman	SWMP Appendix B – Erosion and Sediment Control Plan SWMP Appendix L – Dewatering Practice Notes
SWMM20	Establish erosion and sediment controls before or concurrently with clearing activities to enable their use during construction. Maintain erosion and sediment control structures until sufficient vegetative cover is achieved.	EA Table 7-54 G38	Construction	Superintendent Foreman	SWMP Appendix B – Erosion and Sediment Control Plan
SWMM21	Stabilise fill batters progressively as they are constructed.	EA Table 7-54 SoC SW3, G38	Construction	Superintendent Foreman	SWMP Appendix B – Erosion and Sediment Control Plan

ID	Measure / Requirement	Reference	When to implement	Responsibility	Where addressed
SWMM22	Not used				
SWMM23	Use dust management techniques, such as water spraying, to suppress dust.	EA Table 7-54	Construction	Foreman	CEMP
SWMM24	Not used				
GROUNDWATER IMPACTS					
SWMM25	Not used				
SWMM26	Not used				
SWMM27	<ul style="list-style-type: none"> Minimise disturbance and control runoff from construction areas. Provide bunding/spill kits around fuel depots and stockpile areas. Develop response plans to address fuel leaks and spills at machinery compounds or during refuelling, including a hazardous materials plan and spill emergency procedure. 	EA Table 7-54	Construction	Environmental Manager/ Officer Superintendent Foreman	PESCPs EWMs Emergency Preparedness and Response Plan
SWMM28	Not used				
SWMM29	Not used				
SWMM30	Not used				
SWMM31	Not used				
SWMM32	Utilise a soil conservation specialist during the detailed design and construction phases to assist with the management, design and mitigation of soil erosion issues.	Table 7-54 SoC SW2, G38	Pre-construction Construction	Soil Conservation Specialist Environmental manager	SWMP Appendix B – Erosion and Sediment Control Plan PESCPs
POTENTIAL IMPACTS OF ASS					
SWMM33	Not used				
SWMM34	Not used				
SWMM35	Prepare an ASSMP to identify strategies to remove or reduce risks associated with ASS.	EA Table 7-54	Pre-construction Construction	Environmental Manager	SWMP Appendix G - Acid Sulfate Materials Management Sub-Plan
IMPACTS AS A RESULT OF THE TOWN CREEK DIVERSION					
SWMM36	Not used				
SWMM37	Not used				

ID	Measure / Requirement	Reference	When to implement	Responsibility	Where addressed
SWMM38	Not used				
SWMM39	Not used				
SWMM40	Not used				
FLOODING OF ANCILLARY SITES, STOCKPILES AND HAZARDOUS SUBSTANCES					
SWMM41	Not used	EA Table 7-57	Construction	Foreman	
SWMM42	Locate stockpiles above the 1 in 100 year flood level where possible.	EA Table 7-57	Construction	Superintendent Foreman	SWMP Appendix F: Stockpile Management Protocol
SWMM43	Not used				
SWMM44	Not used				
IMPACTS OF SIGNIFICANT WEATHER EVENTS					
SWMM45	Implement on the ground environmental controls and response procedures to mitigate the potential impacts of significant weather events. Procedures typically include relocation of equipment or materials to higher ground, the implementation of erosion and sediment control shut down procedures, installation of additional protection measures, such as scour protection controls, and arrangements for the remediation and re-installation of these controls.	EA Table 7-57	Construction	Project / Site Engineer Superintendent	Emergency Preparedness and Response Plan
SWMM46	Not used				
SWMM47	Undertake appropriate checks of the Bureau of Meteorology weather bulletins.	EA Table 7-57	Construction	Environmental Officer	Emergency Preparedness and Response Plan
SPOIL & FILL MANAGEMENT					
SWMM48	Not used				
SWMM49	Topsoil and mulched vegetation will be stockpiled and reused within the general areas from which it is removed.	G38	Construction	Foreman Environmental Officer	SWMP Appendix B – Erosion and Sediment Control Plan
SWMM50	Disturbed areas will be progressively stabilised during the construction phase e.g. with a cover crop, hydromulch, hydroseeding, topsoil and/or mulch. Wherever possible, permanent landscaping and revegetation works will take place progressively in accordance with the Landscape and Revegetation Management Plan.	G38	Construction	Foreman Environmental Officer	SWMP Appendix B – Erosion and Sediment Control Plan

ID	Measure / Requirement	Reference	When to implement	Responsibility	Where addressed
SWMM51	<p>Implement measures in the Acid Sulfate Material Management Sub-plan (ASMMSP) prepared for the Gerringong Upgrade project to identify and manage any acid sulfate soils prior to stockpiling.</p> <p>Implement measures in the Soil Screening Protocol, In-Situ Soil Characterisation and stockpile validations prepared for the Gerringong Upgrade to check that spoil sent to the Toolijooa Road Fill Works is suitable prior to stockpiling.</p>	CoA B35(e) (iv)	Construction	Environmental Manager	SWMP Appendix G - Acid Sulfate Materials Management Sub-Plan Relevant Gerringong Upgrade documents
SWMM52	<p>Ensure that excess cut from the Gerringong Upgrade project only, is used in the construction of the Toolijooa Road Fill Works stage, using existing controls in place for the Gerringong Upgrade project.</p>	CoA B35(e) (iv)	Construction	Superintendent	
OTHER					
SWMM53	<p>The following EWMS will be prepared and implemented to manage soil and water impacts:</p> <ul style="list-style-type: none"> • Spoil and fill management; • Sediment basin construction and maintenance; and • Sediment basin monitoring and discharge. 	G38	Construction	Superintendent Environmental Manager	EWMS
SWMM54	<p>Hardstand material, rumble grids or similar will be provided at exit points from construction areas onto public roads to minimise the tracking of soil and particulates onto public roads.</p>	G38	Pre-construction / Construction	Superintendent Foreman	ESCP
SWMM55	<p>Loose rock, soil, debris etc. will be removed from road surfaces (including sweeping of the road) at the end of each work shift.</p>	G38	Construction	Superintendent Foreman	ESCP
SWMM56	<p>Stabilise active work areas at the end of each day's work and/or just prior to inclement weather, by means such as grading or smooth drum rolling to create a smooth surface and by installing of temporary "catch" drains to prevent / minimise transport of sediment.</p>	G38	Construction	Superintendent Foreman	ESCP
SWMM57	<p>Where refuelling on site is required, implement the following management practices:</p> <ul style="list-style-type: none"> • Undertake refuelling on level ground at least 20 metres from drainage lines, waterways or environmentally sensitive areas. • Undertake refuelling within the designated refuelling areas with appropriate bunding and/or absorbent material. • Will not be undertaken on or in the vicinity of vegetated areas (even roadside grasses). • Will be attended at all times. • Spill kits will be readily available and personnel trained in their use. A spill kit will be kept on the refuelling truck at all times. 	Good practice	Construction	Foreman	

ID	Measure / Requirement	Reference	When to implement	Responsibility	Where addressed
SWMM58	<ul style="list-style-type: none"> • Hand tools will be refuelled within lined trays of site vehicles wherever possible. 	G38	Construction	Foreman Environmental Officer	Sediment basin monitoring and discharge EWMS
	<ul style="list-style-type: none"> • Maintain records of dewatering activities, including: <ul style="list-style-type: none"> • A copy of the work method statement(s). • Date, time and estimated volume released at each discharge location. • Water quality test results for each discharge. • The personnel approving the dewatering activities. • Evidence of discharge monitoring, or risk assessment and mitigation measures used to eliminate the risks of pollution. 				

7.1 Construction water

Construction water, which would be used for dust suppression, earthwork compaction and planted vegetation maintenance, would be sourced as follows in order of priority, where practicable, and based on the intended use:

- surface water, sourced from on-site detention basins;
- potable water.

The volume of water required would depend on a number of factors including rainfall, wind direction and intensity, soil type and area of ground disturbance at any one time.

8 Compliance management

8.1 Roles and responsibilities

Fulton Hogan's Project Team organisational structure and overall roles and responsibilities are outlined in Section 4.2 of the CEMP. Specific responsibilities for the implementation of environmental controls are detailed in Chapter 7 of this SWMP.

8.2 Training

All employees, contractors and utility staff working on site will undergo site induction training relating to soil and water management issues. The induction training will address elements related to soil and water quality management including:

- existence and requirements of this sub-plan;
- relevant legislation;
- roles and responsibilities for soil and water management;
- the location of ASS or PASS (although unlikely);
- water quality management and protection measures;
- groundwater issues (although unlikely); and
- procedure to be implemented in the event of an unexpected discovery of contamination.

Targeted training in the form of toolbox talks or specific training will also be provided to personnel with a key role in soil and water management. Examples of training topics include:

- ERSED control installation methodology;
- sediment basin construction;
- sediment basin operation;
- sediment basin maintenance;
- working near drainage lines and creeks;
- emergency response measures in high rainfall events;
- preparedness for high rainfall events;
- lessons learnt from incidents and other event e.g. high rainfall / flooding;
- mulch management;
- spill response;
- stockpile location criteria; and
- identification of potentially contaminated spoil and fill material.

Further details regarding staff induction and training are outlined in Chapter 5 of the CEMP.

8.3 Monitoring and inspection

Regular monitoring and inspections will be undertaken prior to, during and following construction. The following monitoring and inspections will be undertaken:

- monitoring and management of spoil, fill and materials stockpile sites including details of how spoil, fill or material would be handled, stockpiled, reused and disposed;
- weekly and post rainfall inspections to evaluate the effectiveness of erosion and sediment controls measures in accordance with Section 8.1.1 of the CEMP; and
- monitoring of sediment basin discharges.

Testing of sediment basin water will occur when the sediment basin water level is above the sediment storage zone. Once acceptable water quality is achieved, as per table 8-1 below, dewatering will occur within five days of the cessation of the rainfall event, back down to the sediment storage zone water level, to ensure adequate capacity for the next rainfall event.

Table 8-1 Discharge water quality criteria

Parameter	Criteria	Sampling method	Analytical method
pH	6.5 –8.5	Probe or Grab Sample	Field analysis and confirmed as required with laboratory assessment
Turbidity	TBA following correlation with TSS results	Grab Sample	Field analysis and confirmed as required with laboratory assessment, regularly updating correlations and having a factor of conservatism.
Total Suspended Solids	50 mg/L	Grab Sample	Laboratory analysis
Oil and Grease	No visible	Grab Sample	Field analysis and confirmed as required with laboratory assessment

Additional requirements and responsibilities in relation to inspections are documented in Section 8.2 and Section 8.5 of the CEMP.

8.4 Licenses and permits

Relevant licenses or permits will be obtained by Fulton Hogan prior to and during construction as required.

8.5 Weather monitoring

Rainfall will be measured and recorded in millimetres per 24-hour period at the same time each day from Fulton Hogan’s Gerringong Upgrade project site office. The project site office is three kilometres from the Toolijooa Road Fill Works and would have similar climatic conditions.

8.6 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this SWMP, CoA and other relevant approvals, licenses and guidelines. Audit requirements are detailed in Section 8.3 of the CEMP.

8.7 Reporting

Reporting requirements and responsibilities are documented in Section 8.2 and Section 8.5 of the CEMP.

9 Review and improvement

9.1 Continuous improvement

Continuous improvement of this SWMP will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement.

The continuous improvement process will be designed to:

- identify areas of opportunity for improvement of environmental management and performance;
- determine the cause or causes of non-conformances and deficiencies;
- develop and implement a plan of corrective and preventative action to address any non-conformances and deficiencies;
- verify the effectiveness of the corrective and preventative actions;
- document any changes in procedures resulting from process improvement; and
- make comparisons with objectives and targets.

9.2 SWMP update and amendment

The processes described in Section 8 and Section 9 of the CEMP may result in the need to update or revise this SWMP. This will occur as needed.

Only the Environment Manager, or delegate, has the authority to change any of the environmental management documentation.

A copy of the updated SWMP and changes will be distributed to all relevant stakeholders in accordance with the approved document control procedure – refer to Section 10.2 of the CEMP.

Appendix A

Not used

Appendix B

Erosion and Sediment Control Plan

GENERAL NOTES

EROSION AND SEDIMENT CONTROL STAGING REQUIREMENTS

- Before commencement of stripping and earthworks, the site is to be secured and the following erosion and sediment control measures installed in order except for item 12 which is to be undertaken regularly (Refer to the Stabilisation notes):
- Barrier fencing should be installed in the locations shown. Refer to the Barrier Fencing notes below.
- Establish a stabilised site access (Standard Drawing SD 6-14) in the locations shown and anywhere where construction vehicles enter a works area from a public road.
- Establish sediment fencing in the locations shown and following Standard Drawing SD 6-8 (Refer to the Sediment Fencing notes below).
- Offsite (dirty) water diversion drains, diversion channels and/or temporary pipes are to be constructed and stabilised. Refer to Table 4, on drawing 13000214_P01_ESCP02.
- Construct the Sediment Basins including their weir overflows and energy dissipaters at their outlets and stabilise any disturbed soils. Refer to Table 5 on drawing 13000214_P01_ESCP02 and the Sediment Basin Notes below.
- Onsite (dirty) water diversion drains are to be constructed and stabilised. Refer to Table 4, on drawing 13000214_P01_ESCP02.
- Stockpile areas are to be established in locations as specified by the site manager and in accordance with the Stockpiling notes below.
- Once all of the above measures are complete and stable, construction works can commence in accordance with the engineering plans.
- Strip topsoil when moist only (not wet or dry).
- Progressively stabilise ground surfaces as works are completed.

STOCKPILING

Stockpile areas are to be established at the locations specified by the site manager and must be within the works area (ie. not the no-go zones). If additional or alternative locations for stockpiling are required then they are to be subject to an environmental assessment and approval prior to establishment. All stockpiles should incorporate clearly defined access controls and comply with the regulations outlined below.

- All stockpiles must be constructed and maintained in accordance with Standard Drawing SD 4-1 and the following regulations:
- Stockpiles must have sediment fencing installed around their bases as per Standard Drawing SD 4-1.
 - Stockpiles are not to be positioned within 5m of any concentrated flow or hazardous area or within 50m of a watercourse of creek.
 - Stockpiles are not to be located within the lower-lying flood prone lands.
 - Mulched vegetation, topsoil and subsoil (if applicable) are to be stockpiled separately.
 - Stockpiles are to be trimmed and sown with permanent pasture species.
 - Stockpiles are to be stabilised to achieve a C-factor of 0.1 (ie. 60 % cover) within 10 days of formation.
 - Stabilisation measures on stockpiles must be employed as per the requirements set out in Table 1.
 - Stockpiles should be constructed to more than 2 meters in height wherever possible.
 - Stockpile should be battered down at a maximum slope of 3:1.

SEDIMENT FENCING

- Install sediment fences in the locations shown.
- All soil sediment fencing in accordance with Standard Drawing SD 6-8
- Sediment fences must be firmly fenced into the ground for their entire length.
- Sediment fences must include small returns at maximum 20m intervals (see Standard Drawing 6-8) to minimise the risk of water flowing along them rather than through them.
- Sediment fences are to be installed around the toe of all stockpiles (Refer to Standard Drawing SD 4-1).

BARRIER FENCING

- Install barrier fences in the locations shown.
- Barrier fencing can simply be made from tape wound around star pickets or stakes. Alternatively, sediment fence or chain wire fences can be used for this purpose if so desired. Existing site fences can also be used where it is present in the relevant locations.
- Barrier and sediment fencing is to be used to ensure that all vehicles entering and leaving the site pass over a stable access point to minimise bogginess in these areas and minimise sediment tracking onto public roads.
- Barrier fencing is to be used to delineate all 'no go' areas.
- The soil erosion hazard on the site will be kept as low as practicable by minimising land disturbance. Some ways of doing this are outlined in Table 2.

DUST SUPPRESSION

- Dust suppression should be carried out whenever necessary to minimise sediments becoming air-borne due to wind erosion.
- The water for dust suppression can be sourced from the sediment basins. However, an alternative water source must be identified prior to starting construction works for periods when the sediment basins are dry.

STABILISATION

- Undertake progressive stabilisation of disturbed ground surfaces as they are completed rather than at the end of the works program (Refer to Table 1).
- Final stabilisation is to achieve the C-factors (ie. 60 % cover) outlined in Table 1.
- Barriers should be stabilised to bring C-factors down to 0.1 within 10 working days of final formation.
- Stabilisation of barriers can be achieved by placing topsoil over them (see Standard Drawing SD 4-2 for instructions regarding topsoil replacement), with mulch placed over the soil, or alternatively, they can be hydro-mulched (or equivalent).
- Appropriate seedbed preparation should be carried out when stabilising lands (See Standard Drawing SD 7-1).
- Diversion drains and table drains are to be stabilised as indicated in Table 1 and Table 4.

- Stockpiles are to be stabilised as per the requirements of Table 1 and as shown in Standard Drawing SD 4-1.
- Sediment dam and culvert outlets are to be stabilised in accordance with Table 1 and energy dissipaters are to be provided as per Standard Drawing SD 5-3.
- Stabilisation measures and products should be in accordance with Tables D1 and A3 (13000214_P01_ESCP03).
- As surfaces are stabilised and permanent drains measures are installed, temporary water management structures can be removed (eg. diversion drains).

SEDIMENT BASINS

- The required sediment basin locations and sizing details are shown on the relevant drawings. Refer to Table 5 on drawing 13000214_P01_ESCP02.
- The construction and maintenance of sediment basins is to be in accordance with RMS Specification D&C G38.
- Sediment basins are to be built to incorporate a primary outlet (weir overflow/spillway) sized to have a capacity to pass the 100 year peak flow.
- During sediment basin construction, internal walls and inlets to be stabilised with gypsum treatment applied at rate of 0.2kg/m². Shallow rip or blend gypsum 100mm deep using excavator bucket teeth into subgrade then lightly tap to compact.
- An energy dissipater is to be constructed on the outlet of the weir overflow. Construct in accordance with SD 5-8.
- Security fencing and water safety control measures must be implemented around the sediment basins.
- Any release of water from the sediment basins will require flocculation to achieve adequate settling of construction site material (Refer below for further details). However, if the water is going to be used within the construction site for dust-suppression purposes and will drain back into the sediment capture system it will not require flocculation.
- Note that, if it is pumped into a tanker truck for later use, it cannot be discharged from the tanker into permanent/temporary drainage line without first being flocculated.
- The sediment basins must be effectively flocculated, settled and discharged within 5-days or less following a rainfall event (unless specified otherwise).
- Sediment basins to include a marker showing the sediment storage zone level within the basin. Basins must be cleaned out when sediment exceeds 60 % of this sediment storage zone (marker to indicate this level).

FLOCCULATION OF SEDIMENT BASINS

- Flocculation is to be achieved by using gypsum at a rate of approximately 30 kg/100 m³ of stormwater to achieve 50mg/L or less of suspended sediment. Alternative flocculating agents can only be used if approval by RMS has been granted. Refer to manufacturers guidelines for dosage details.
- It is essential that the flocculating agent is spread evenly over the entire pond surface for proper treatment of water.
- pH of discharge waters must be in the range of 6.5-8.5, and with no visible oil and grease.

SITE INSPECTION AND MONITORING

- The site manager (or environmental representative) is to inspect (and record the condition of, and any action required) the condition of all erosion and sediment controls:
 - At least weekly during normal construction hours
 - Daily during rain events
 - Within 24 hours of the cessation of a rain event causing runoff.
- Additional erosion and sediment controls will be installed as necessary to ensure satisfactory outcomes in keeping with the EPL conditions and best-practice Blue Book guidelines.
- Inspections will include a review of existing ESCPs, with updates or revisions made as required.
- Any waste rock or excessive sediment transported from the site will be removed from public roads as soon as possible.
- Sediment accumulated in any trapping device (eg. basin, sediment fence) will be removed to a secure location, preferably to an active stockpile.
- A rainfall gauge will be installed at the site office, with rainfall recorded on a chart or spreadsheet every 24 hours by a nominated person. This record is to be made available to relevant government or RMS staff whenever requested.
- Safe storage areas for wastes, fuels and other hazardous materials are to be delineated by the site manager.
- Waste receptacles are to be emptied as required and in accordance with ECHR requirements.
- Adequate supplies of erosion control measures (eg. geobarricade, jute matting, hydraulic soil stabilizer) are to be maintained in the site compound at all times for rapid deployment as required.
- Adequate supplies of flocculant (and flocculating equipment) are to be maintained at all times, based on the number of sediment basins present at that time.

SLOPE LENGTHS & BATTER CHUTES

- Slope lengths are to be maintained at the intervals as shown on the drawing 13000214_P01_ESCP02 across all disturbed lands during rainfall.
- Diversion border drains, low flow earth banks (Standard Drawing SD 5-5) or sandbags/equivalent should be installed prior to any rainfall event to achieve this.
- Lined batter chutes are to be provided to direct flows down batters (where necessary) at 4.0m intervals.
- Barrier gradients and batter slope lengths are to be managed and maintained in accordance with Table 3.

EXCAVATIONS

- Water accumulating in any sort of excavation within the site effectively becomes a sediment basin.
- Management of this water should be as per the sediment basin requirements (See 'Sediment Basins' and 'Flocculation of Sediment Basins' notes).
- Water from excavations must not be discharged from the site unless it contains less than 50mg/l of suspended solids and pH 6.5 to 8.5 and no visible oil and grease. Flocculation should be used to achieve this where necessary.
- However, if the water is going to be used within the construction site for dust-suppression purposes and will drain back into the sediment capture system it will not require flocculation.

ENHANCED EROSION CONTROL MEASURES

During the period from 15 November to 30 May ground cover is required to lock down all exposed surfaces within the areas as listed below, to ensure that they are stable (60% ground cover equivalent) whenever rain is falling or imminent.

- All lands draining to and within 40m of a watercourse;
- All potentially acid sulfate soil (PASS) lands;
- All flood prone lands;
- All lands where slope lengths cannot be maintained at the required intervals;
- Any other lands where specified on the plans.

The lands listed above are to be progressively stabilised to as per the requirements in Table 1.

- All lands within the project site will be subject to the following requirements:
- Slope lengths are to be maintained at the intervals across all disturbed lands during rainfall as shown on the drawing 13000214_P01_ESCP02.
 - Soil disturbance is to be minimised as much as possible within the flood prone or PASS lands and excavations here are to be kept to an absolute minimum.
 - Barrier gradient restrictions are to be carried out in accordance with Table 3 on Drawing 13000214_P01_ESCP03.

TABLE 1 MAXIMUM ACCEPTABLE C-FACTORS AT NOMINATED TIMES

LANDS	MAXIMUM C-FACTOR	REMARKS
Soil Class 6 lands (see Table 4, for specific catchment areas) all lands below the 2yr ARI flood level, all lands within potentially acid sulfate soil areas and all lands within 20m of a watercourse.	0.05 (i.e. 70% cover)	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows.
Waterways and other areas subjected to concentrated flows (e.g. table drains, post construction and during operation)	0.05 (i.e. 70% cover)	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Flows will be limited to those shown in Table 5.2 of Lantcom 12004. Foot and vehicular traffic will be prohibited in these areas
Stockpiles and batters, post construction and during operation	0.10 (i.e. 60% cover)	Applies after ten working days from completion of formation. Maximum C-factor of 0.10 equals 60% ground cover
All lands, including waterways and stockpiles during construction and operation	0.15 (i.e. 50% cover)	Applies after 20 working days of inactivity, even though works might continue later. Maximum C-factor of 0.15 equals 50% ground cover
All lands post construction	0.05 (i.e. 70% cover)	Applies after 60 working days of completion of works. Maximum C-factor of 0.05 equals 70% ground cover

TABLE 2 LIMITATIONS TO ACCESS DURING CONSTRUCTION

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

TABLE 3 – BATTER RESTRICTIONS

SLOPE LENGTHS TO BE MAINTAINED AT THE MAXIMUM INTERVALS AS LISTED BELOW FOR THE RESPECTIVE TYPICAL SLOPE GRADIENTS:

GRADIENT (H:V)	MAXIMUM SLOPE LENGTHS
2:1	3m
3:1	5m
4:1	7m
5:1	8m
6:1	10m

(H:V) – HORIZONTAL - VERTICAL



REV	DATE	DES.	DRN.	APP.	REVISION DETAILS	DRAWING STATUS	North	CLIENT	CONTRACTOR	PROJECT TITLE	DRAWING TITLE	PROJECT NO.	SUB-PR. NO.	DRAWING NO.	REV
00	17/07/13	AL	AL	A.J.B.	REVISIONS TO INCORPORATE RMS COMMENTS – FINAL	N/A		Polys 1096, Bavel, 859, 2576 10/12/2013 0102 4822 1633 0102 4822 3088 email: erobinson@seec.com.au		TOOLUOOLA ROAD FILL WORKS STAGE OF FOXGROUND AND BERRY BYPASS	13000214	P01	ESCP01	00	
1	26/09/13	AL	AL	A.J.B.	INITIAL DRAFT	FINAL		element ENVIRONMENTAL		EROSION AND SEDIMENT CONTROL PLAN GENERAL NOTES AND REQUIREMENTS	13000214	P01	ESCP01	00	

LEGEND

- STABILISED SITE ACCESS (REFER TO IECA SD EXIT-01 & 02)
- BARRETT TAP/FENCE
- TEMPORARY PIPE (MIN Ø375)
- DIRTY WATER DIVERSION DRAIN
- CLEAN WATER DIVERSION DRAIN
- EXISTING DRAINAGE PIPE
- SLOPE BREAKS INSTALLED AT MAX INTERVALS AS SHOWN ON PLAN - TO BE INSTALLED IF RAINFALL IS IMMINENT OR PRIOR TO SITE CLOSURE.
- ROCK DISPASATER (REFER TO IECA SD 05-01&02)
- SEDIMENT BASIN
- CATCHMENT AREA 1 (CA1)
- CATCHMENT AREA 2 (CA2)
- CATCHMENT AREA 3 (CA3)
- BATTER CHUTES
- FBB PROJECT BOUNDARY
- ACCESS TRACK
- BAFFLES (SEE DETAIL BELOW)
- CHECK DAMS (SD 5-4)

BACKGROUND AND CALCULATIONS

RUSLE: $A = \text{SOIL LOSS (tonnes/ha/yr)} = R \cdot K \cdot L \cdot S \cdot P \cdot C$

THE AVERAGE ANNUAL SOIL LOSS CALCULATIONS WERE UNDERTAKEN USING THE "BLUE BOOK" - MANAGING URBAN STORMWATER (LANDCOM, 2004)

R-FACTOR	6290	SOILS ARE TYPE D (DISPERSIBLE)
K-FACTOR	0.05	CA1 - 3.05 (BASED ON 18% SLOPE AND 20m SLOPE LENGTH)
LS-FACTOR	CA2 - 0.35 (BASED ON 3.5% SLOPE AND 40m SLOPE LENGTH)	CA3 - 1.61 (BASED ON 19.5% SLOPE AND 20m SLOPE LENGTH)
P-FACTOR	13	- DEFAULT ASSUMED
C-FACTOR	1	- DEFAULT ASSUMED
CATCHMENT AREA (ha)	CA1 = 3.33	
	CA2 = 1.09	
	CA3 = 2.47	
RUSLE (A) (tonnes/ha/yr)	CA1 = 977 (SOIL LOSS CLASS 6)	
	CA2 = 225 (SOIL LOSS CLASS 2)	
	CA3 = 660 (SOIL LOSS CLASS 5)	

THE "BLUE BOOK" REQUIRES THE INSTALLATION OF A SEDIMENT BASIN ON THE SITE IF THE SOIL LOSS > 200 tonnes/yr. THEREFORE A SEDIMENT BASIN IS REQUIRED FOR ALL CATCHMENT AREAS.

NOTE: CA = CATCHMENT AREA

TABLE 4 - DIVERSION DRAIN DETAILS

(H:V) - (HORIZONTAL : VERTICAL)

DRAIN	CD1	CD2	CD3	DD1	DD2	DD3	DD4
BASE WIDTH	0.5m	0.5m	LOW FLOW	0.5m	0.5m	0.5m	0.5m
DRAIN/BUND DEPTH	0.5m	0.5m	EARTH BANK (SD 5-5)	0.6m	0.6m	0.6m	0.6m
BANK SLOPE	2:1	2:1		2:1	2:1	2:1	2:1
LINING TYPE	1	1	2	2	2	2	2

LINING TYPES: - 1 TERRAMAT ECP-2 & SEEDING)
- 2 JUITE MESH, P47 AND SEEDING UNLESS SPECIFIED OTHERWISE)

TABLE 5 - SEDIMENT BASIN DETAILS

(H:V) - (HORIZONTAL : VERTICAL)
ALL VOLUMES ARE IN M3

SEDIMENT BASIN	SB1	SB2	SB3
SEDIMENT STORAGE VOLUME (m ³)	396	31	209
SETTLING ZONE VOLUME (m ³)	967	317	718
TOTAL BASIN VOLUME (m ³)	1363	348	927
SPILLWAY			
BASE WIDTH (m)	4	3	4
(H:V) SIDE SLOPES	2:1	2:1	2:1
SPILLWAY DEPTH (m)	0.9	0.5	0.8

SPILLWAY LINING AND BASIN INLET LINING
ROCK LINED WITH GEOTEXTILE UNDERLAY - MINIMUM 200MM Ø ROCK UNDERLAY WITH BIDIM A34 - NON-WOVEN GEOTEXTILE (OR EQUIVALENT). SPILLWAY TO EXTEND TO WATERCOURSE OR 100% VEGETATED LANDS.

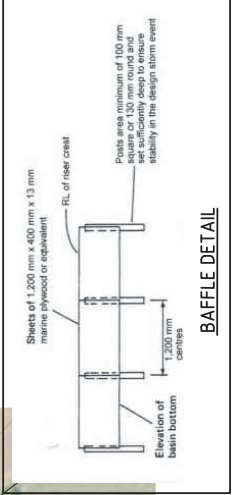
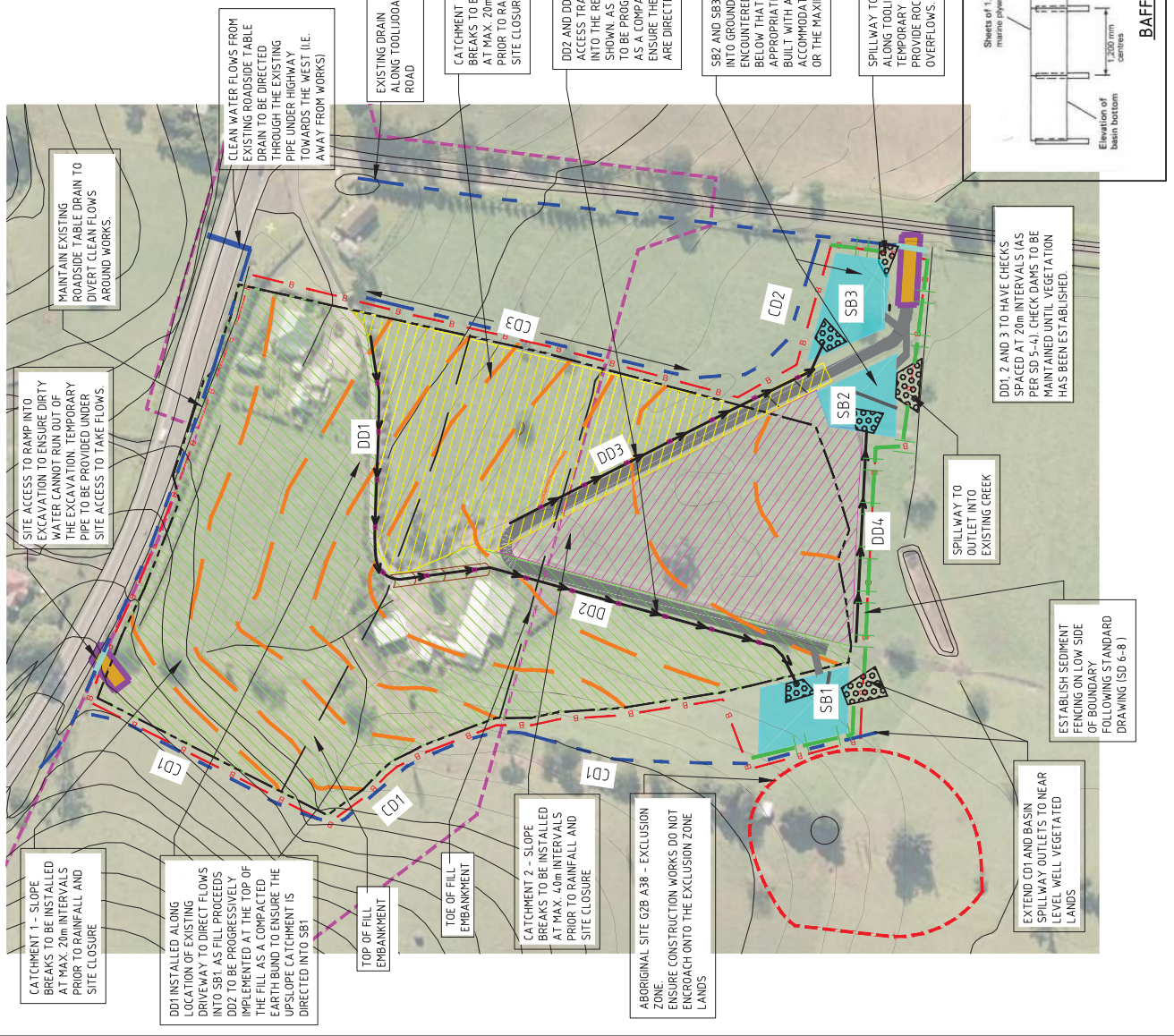
DESIGN Baffle DEPTH
= 4x (H:V) (SD47, 057H, 0461)

SEDIMENT BASIN NOTES

THE CONSTRUCTION AND MAINTENANCE OF SEDIMENT BASINS IS TO BE IN ACCORDANCE WITH RMS SPECIFICATION D&C G38.

DURING SEDIMENT BASIN CONSTRUCTION, INTERNAL WALLS AND INLETS TO BE STABILISED WITH GYPSUM TREATMENT APPLIED AT RATE OF 0.2KG/M² SHALLOW RIP OR BLEND GYPSUM 100mm DEEP USING EXCAVATOR BUCKET TEETH INTO SUBGRADE THEN LIGHTLY TAP SURFACES TO COMPACT.

SEDIMENT BASINS TO INCLUDE A MARKER SHOWING THE SEDIMENT STORAGE ZONE LEVEL WITHIN THE BASIN. BASINS MUST BE CLEANED OUT WHEN SEDIMENT EXCEEDS 60% OF THIS SEDIMENT STORAGE ZONE (MARKER TO INDICATE THIS LEVEL).



REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
00	17/11/13	AL	A.J.B.		REVISIONS TO INCORPORATE RMS COMMENTS - FINAL
1	26/09/13	AL	A.J.B.		FOR REVIEW
2	26/09/13	AL	A.J.B.		INITIAL DRAFT

DRIVING STATUS: A.I.
FINAL APPROVAL: A.J.B.
SCALE: 1:2000
(on A3 Original)

FINAL

CLIENT: **element ENVIRONMENTAL**

CONTRACTOR: **Fuison Hogan**

PROJECT TITLE: **TOOLLOOJA ROAD FILL WORKS STAGE OF FOXGROUND AND BERRY BYPASS**

DRAWING TITLE: **EROSION AND SEDIMENT CONTROL PLAN**

PROJECT NO: 13000214
SUB-PR NO: P01
DRAWING NO: ESCP02
REV: 00

Plot Date: Friday, 1 November 2013 3:39:18 PM
CAD File Name: K:\13000214 Gerringong Berry REF Fill Placement Works\Drawings\13000214_P01_ESCP_REV_00.dwg



REV: 00
 DRAWING NO.: ESCP03
 SUB-PR. NO.: P01
 PROJECT NO.: 13000214

TABLE A3 AND D1
 FROM LANDCOM (2004)
 "THE BLUE BOOK"

TOOLOONA ROAD
 FILL WORKS STAGE OF
 FOXGROUND AND
 BERRY BYPASS

POBox 1096, Berrig, NSW 2576
 67 Rye Street, Berrig, NSW 2576
 012 462 1633
 012 462 3088
 email: info@secc.com.au
 WWW.SECC.COM.AU



REVISION STATUS			
DESIGN BY	AJ		
DRAWN BY	AJ		
FINAL APPROVAL	A.J.B.		
SCALE:	N/A		
(on A3 Original)			

SECC
 element
 FULTON HOGAN

REV: 00
 DATE: 17/11/13
 DES: 26/09/13

Notes	Product	Type	Enhances vegetation growth	Reduces erosion	Stabilizes soil	Reduces sediment	Reduces surface runoff	Reduces water usage	Reduces maintenance
1. Whether vegetation is planted and type of type 'a', will affect the resistance level. Biodegradable mulches and products that are made of plant matter are used. Biodegradable mulches are used to reduce erosion, stabilize soil and reduce maintenance. However, they are used in isolation rather than being used with other products. Multi-layered mulches are used to reduce erosion, stabilize soil and reduce maintenance. However, they are used in isolation rather than being used with other products. Non-biodegradable mulches are used to reduce erosion, stabilize soil and reduce maintenance. However, they are used in isolation rather than being used with other products. Permanent mulches are used to reduce erosion, stabilize soil and reduce maintenance. However, they are used in isolation rather than being used with other products.		Grass	High	Medium	Low	< 10	< 10	< 10	< 10
2. Whether or not a product is readily available is critical to the selection process. Many RECP's and products are not readily available in the region. Temporary seeding might also be used in some areas. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install.		Grass	High	Medium	Low	< 10	< 10	< 10	< 10
3. Whether or not a product is readily available is critical to the selection process. Many RECP's and products are not readily available in the region. Temporary seeding might also be used in some areas. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install.		Grass	High	Medium	Low	< 10	< 10	< 10	< 10

Table D1 Erosion Control Products for Stabilising Disturbed Lands

Notes	Product	Type	Enhances vegetation growth	Reduces erosion	Stabilizes soil	Reduces sediment	Reduces surface runoff	Reduces water usage	Reduces maintenance
1. Whether or not a product is readily available is critical to the selection process. Many RECP's and products are not readily available in the region. Temporary seeding might also be used in some areas. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install.		Grass	High	Medium	Low	< 10	< 10	< 10	< 10
2. Whether or not a product is readily available is critical to the selection process. Many RECP's and products are not readily available in the region. Temporary seeding might also be used in some areas. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install.		Grass	High	Medium	Low	< 10	< 10	< 10	< 10
3. Whether or not a product is readily available is critical to the selection process. Many RECP's and products are not readily available in the region. Temporary seeding might also be used in some areas. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install. However, a product is relatively inexpensive to purchase and install.		Grass	High	Medium	Low	< 10	< 10	< 10	< 10

SD 4-1 STOCKPILES

Construction Notes

- Place stockpiles away from 2 (approximately 5) metres from existing vegetation, unconsolidated water flow, roads and hazard areas.
- Construct on the shoulder as low, flat, ungrouted mounds.
- Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
- Where they are to be in place for more than 10 days, stockpiles following the approved EDCP or SWMP shall be constructed to a maximum height of 1.5 metres above the ground surface.
- Stockpiles shall be constructed with a 1:1 slope on the sides and a 1:1.5 slope on the top.

Construction Notes

- Place stockpiles away from 2 (approximately 5) metres from existing vegetation, unconsolidated water flow, roads and hazard areas.
- Construct on the shoulder as low, flat, ungrouted mounds.
- Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
- Where they are to be in place for more than 10 days, stockpiles following the approved EDCP or SWMP shall be constructed to a maximum height of 1.5 metres above the ground surface.
- Stockpiles shall be constructed with a 1:1 slope on the sides and a 1:1.5 slope on the top.

SD 4-2 REPLACING TOPSOIL

Construction Notes

- Locate the ground surface along the line of cutback to a depth of 50 mm to 100 mm to be used as the topsoil replacement surface and to provide a good bond between the reported and existing topsoil.
- Add topsoil as required by the EDCP or SWMP.
- Fill to a depth of 100 mm of compacted topsoil.
- Where possible, replace topsoil to a depth of 400 to 450 mm on banks where the slope exceeds 40% (1V:1.25H) and to at least 75 mm on lower gradients.

SD 5-1 TEMPORARY WATERWAY CROSSING

Construction Notes

- Provide all traffic until the access way is constructed.
- Strip any topsoil and place a needle-punch geotextile over the base of the crossing.
- 100 mm to 150 mm clean stone cover for flow or minimum slope of 200 mm above the geotextile.
- Provide a 3-metre wide canopy with sufficient length of outlet pipe to allow flow in a 3:1V:1.75H slope on both sides.
- Install storm water pipe to the waterway.
- Ensure that outlet culverts extend beyond the toe of the embankments.

SD 5-4 ROCK CHECK DAM

Construction Notes

- Check dam shall be built with rock material, including rock, logs, and other debris. The dam shall be constructed with a minimum height of 1.5 metres above the ground surface.
- When rock is used, the dam shall be constructed with a minimum height of 1.5 metres above the ground surface.
- Normally, the maximum height shall be 1.5 metres above the ground surface.
- The dam shall be constructed with a minimum height of 1.5 metres above the ground surface.
- The dam shall be constructed with a minimum height of 1.5 metres above the ground surface.

SD 5-5 EARTH BANK (LOW FLOW)

Construction Notes

- Build with granules between 1.5 and 5 percent.
- After removing trees and stumps, work around them.
- Ensure the structure has a base of granules of other materials that could be used.
- Build the structure with concrete, available or recycled cross sections, not V-shaped.
- Ensure the banks are properly compacted to prevent failure.
- Complete permanent or temporary stabilization within 10 days of construction.

SD 5-6 EARTH BANK (HIGH FLOWS)

Construction Notes

- Remove all vegetation and topsoil under the dam wall and from within the storage area.
- Construct a cut-off trench 500 mm deep and 1,200 mm wide along the outside of the embankment extending to a point on the gully wall level with the rear crest.
- Fill the cut-off trench with 100 mm to 150 mm clean stone cover for flow or minimum slope of 200 mm above the geotextile.
- Provide a 3-metre wide canopy with sufficient length of outlet pipe to allow flow in a 3:1V:1.75H slope on both sides.
- Install storm water pipe to the waterway.
- Ensure that outlet culverts extend beyond the toe of the embankments.

SD 5-8 ENERGY DISSIPATER

Construction Notes

- Compact the subgrade to the density of the surrounding undisturbed material.
- Construct a concrete deck with a minimum thickness of 100 mm.
- Place a layer of 100 mm to 150 mm clean stone cover for flow or minimum slope of 200 mm above the geotextile.
- Provide a 3-metre wide canopy with sufficient length of outlet pipe to allow flow in a 3:1V:1.75H slope on both sides.
- Install storm water pipe to the waterway.
- Ensure that outlet culverts extend beyond the toe of the embankments.

SD 6-4 EARTH BASIN - WET

Construction Notes

- Remove all vegetation and topsoil under the dam wall and from within the storage area.
- Construct a cut-off trench 500 mm deep and 1,200 mm wide along the outside of the embankment extending to a point on the gully wall level with the rear crest.
- Fill the cut-off trench with 100 mm to 150 mm clean stone cover for flow or minimum slope of 200 mm above the geotextile.
- Provide a 3-metre wide canopy with sufficient length of outlet pipe to allow flow in a 3:1V:1.75H slope on both sides.
- Install storm water pipe to the waterway.
- Ensure that outlet culverts extend beyond the toe of the embankments.

SD 6-3 SEDIMENT FENCE

Construction Notes

- Construct sediment fence as close as possible to being parallel to the crest of the bank.
- The structure shall be constructed with a minimum height of 1.5 metres above the ground surface.
- Normally, the maximum height shall be 1.5 metres above the ground surface.
- The structure shall be constructed with a minimum height of 1.5 metres above the ground surface.
- The structure shall be constructed with a minimum height of 1.5 metres above the ground surface.

SD 6-14 STABILISED SITE ACCESS

Construction Notes

- Strip the topsoil, level the site and compact the subgrade.
- Construct a 200-mm thick joint over the granules using road base or 20mm aggregate.
- Construct a 200-mm thick joint over the granules using road base or 20mm aggregate.
- Construct a 200-mm thick joint over the granules using road base or 20mm aggregate.
- When a sediment fence is used, construct a 1.5 metre high and at least 1 metre wide access to the structure.
- When a sediment fence is used, construct a 1.5 metre high and at least 1 metre wide access to the structure.

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
00	17/07/13	AL	A.J.B.		REVISIONS TO INCORPORATE RWS COMMENTS - FINAL
1	26/09/13	AL	A.J.B.		FOR REVIEW
2	26/09/13	AL	A.J.B.		INITIAL DRAFT

Scale: N/A
(on A3 Original)

FINAL

CLIENT
element ENVIRONMENT

CONTRACTOR
Fuiton Hogan

PROJECT TITLE
TOOLOOBA ROAD
FILL WORKS STAGE OF
FOXGROUND AND
BERRY BYPASS

DRAWING TITLE
STANDARD DRAWINGS

Project No. 13000214
SUB-PR. NO. P01
DRAWING NO. ESCP04
REV. 00

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SEEC

SD 6-4 EARTH BASIN - WET
approved by the relevant authority

1. Erosion Hazard and Sediment Basins

Site Name: Toolijooa Road Fill Works

Site Location: Toolijooa Road / Princes Highway Intersection

Stage: Stage 1 of Foxground and Berry Bypass

Other Details: Based on site inspection dated 20/9/13

Site area	Sub-catchment or Name of Structure						Notes
	CA1	CA2	CA3				
Total catchment area (ha)	3.33	1.09	2.47				
Disturbed catchment area (ha)	3.33	1.09	2.47				

Soil analysis (enter sediment type if known, or laboratory particle size data)

Sediment Type (C, F or D) if known:	D	D	D				From Appendix C (if known)
% sand (fraction 0.02 to 2.00 mm)							Enter the percentage of each soil fraction. E.g. enter 10 for 10%
% silt (fraction 0.002 to 0.02 mm)							
% clay (fraction finer than 0.002 mm)							
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D	D	D				Automatic calculation from above

Rainfall data

Design rainfall depth (no of days)	5	5	5				See Section 6.3.4 and, particularly, Table 6.3 on pages 6-24 and 6-25.
Design rainfall depth (percentile)	85	85	85				
x-day, y-percentile rainfall event (mm)	42.1	42.1	42.1				
Rainfall R-factor (if known)							Only need to enter one or the other here
IFD: 2-year, 6-hour storm (if known)	16.5	16.5	16.5				

RUSLE Factors

Rainfall erosivity (R -factor)	6290	6290	6290				Auto-filled from above
Soil erodibility (K -factor)	0.05	0.05	0.05				RUSLE LS factor calculated for a high rill/interrill ratio.
Slope length (m)	20	40	20				
Slope gradient (%)	18	3.5	13.5				
Length/gradient (LS -factor)	2.27	0.55	1.61				
Erosion control practice (P -factor)	1.3	1.3	1.3	1.3	1.3	1.3	
Ground cover (C -factor)	1	1	1	1	1	1	

Sediment Basin Design Criteria (for Type D/F basins only. Leave blank for Type C basins)

Storage (soil) zone design (no of months)	2	2	2				Minimum is generally 2 months
Cv (Volumetric runoff coefficient)	0.69	0.69	0.69				See Table F2, page F-4 in Appendix F

Calculations and Type D/F Sediment Basin Volumes

Soil loss (t/ha/yr)	927	225	660				
Soil Loss Class	6	2	5				See Table 4.2, page 4-13
Soil loss (m ³ /ha/yr)	713	173	508				Conversion to cubic metres
Sediment basin storage (soil) volume (m ³)	396	31	209				See Sections 6.3.4(i) for calculations
Sediment basin settling (water) volume (m ³)	967	317	718				See Sections 6.3.4(i) for calculations
Sediment basin total volume (m ³)	1363	348	927				

NB for sizing of Type C (coarse) sediment basins, see Worksheet 3 (if required).

Appendix C

Not used

Appendix D

Not used

Appendix E

Not used

Appendix F

Stockpile Management Protocol

Stockpile Management Protocol

Purpose

This protocol describes the requirements for monitoring and managing spoil and fill including details of how excavated material would be handled, stockpiled, reused and disposed is detailed. This protocol outlines the locational criteria used to guide the placement of stockpiles and provides both standard and site-specific mitigation measures to be implemented to minimise impacts on the environment.

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

- Excavated material 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.
- Topsoil, mulch, excess timber for landscaping and revegetation works.

Scope

This protocol is relevant to the siting and placement of all stockpiles on/related to the Project.

Protocol

Prior to the establishment of any stockpile on site as part of the Project, ensure that:

1. The location of the stockpile is considered against the site selection criteria contained in Table 1 and that detail of how the stockpile site meets each of the criteria is provided.
2. Site-specific mitigation measures, where they are necessary to further reduce impacts, are identified and detailed in Table 1.
3. Mitigation measures for each stockpile site include as a minimum:
 - The perimeter of the stockpile will be delineated with a bund (made out of earth/RAP or similar) or other type of fencing or barrier.
 - Materials will be stockpiled at least 5 m away from trees or native vegetation, and never pushed up around the base of trees.
 - Erosion and sedimentation controls will be erected between the site and any drainage lines or down-slope areas.
 - A diversion bund will be installed on the uphill side of the stockpile to divert water around the site.
 - Short-term stockpiles will be covered with plastic or kept damp to control dust where required. Long-term stockpiles (i.e. greater than 10 days) will be stabilised with cover- crop or similar.
 - Potentially affected residents within 200 m of stockpiles will be notified regarding the location of the stockpile areas, the potential impact from constructing the stockpile (including visual and odour impacts) and proposed mitigation measures. Should a resident express concern or are not satisfied with the proposed mitigation measures, the stockpile location or associated mitigation measures would be revised accordingly.
 - Where stockpiles are located within 200 m of residences, these stockpile areas will be monitored for odour. If nuisance odours are generated and are impacting sensitive receivers, odour control measures will be implemented, if feasible and reasonable. If this is not possible, material found to be emitting odours will be relocated to an alternative stockpile location away from residences.
 - ASS management, including leachate containment, will be in accordance with Appendix G of the SWMP.

Table 1 Stockpile requirements

Ref no.	Location (chainage)	Purpose	a) Be located at least 5 metres clear of all areas of possible concentrated water flow.	b) Be located at least 10 metres from a waterway	c) Be located on land with a slope less than 10%	d) Have ready access to the road network or direct access to the construction corridor.	e) On land that does not require the removal of threatened species, EECs or roosting habitat for listed threatened fauna species.	f) Be located in areas of low heritage conservation significance (including identified Aboriginal cultural value) and not impact on heritage sites beyond those already impacted by the project.	Site specific mitigation measures

Locate stockpiles above the 100 year ARI flood level where possible. If sites cannot be located above the 100 year ARI flood level, locate them above the 20 year ARI flood level subject to the implementation of appropriate mitigation measures to reduce flood risk and impacts on the surrounding environment (such as provision of a sufficient freeboard for storage areas).

Appendix G

Acid Sulfate Materials Management Sub-Plan



Acid Sulfate Material Management Sub Plan

CEMP – Appendix Q

PROJECT: GERRINGONG UPGRADE – MT PLEASANT TO TOOLIJOOA ROAD
CONTRACT No.: 10.2574.1450

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Originated by:
Rebekah Byrne – Environmental Manager (NSW Construction)

Reviewed and authorised by:
John Ilott – Project Director

(Signature/Date)

(Signature/Date)

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- Appendix D** Contingency Procedure
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- Appendix F** Field pH and the 30% Peroxide Test Procedure
- Appendix G** Dewatering Record Forms

1. Introduction

1.1. Purpose and Scope

This Acid Sulfate Material Management Sub Plan (ASMMSP) has been prepared to detail how Fulton Hogan proposes to manage and control environmental issues relating to Acid Sulfate Materials (ASM), handling and disposal associated with the construction of the Gerringong Upgrade Project.

The ASMMSP is a Sub Plan to the Construction Environmental Management Plan (CEMP) and is applicable to all staff, employees and subcontractors throughout the duration of the contract until project completion.

References to the CEMP and its appendices are in *italics*. References to appendices to this plan are in **bold**.

The ASMMSP has been prepared to address the requirements of the REF and Submissions Report, RMS Environmental Contract Specification, the Scope of Works and Technical Criteria (SWTC) and applicable best practice management guidelines (herein referred to as the 'Project Environmental Documents') and applicable NSW legislation

1.2. Background

The Review of Environmental Factors (REF) for the Gerringong Upgrade Project (the Project) identified the need for the management of Acid Sulfate Material (ASM) sites, features and items which are to be or have the potential to be impacted through the construction of the Project.

An ASM assessment was undertaken as part of the REF which identified significant deposits of AASS and PASS at the northern end of the route at Omega Flats between Gerringong and Mount Pleasant Ridge. Based on the results of the earlier testing programs, the REF recommended that the estuarine soils of Omega Flat are ASM and an Acid Sulfate Material Management Plan is required. The nature of the ASM Management Plan will depend on whether greater or less than 1000 tonnes of ASS will be disturbed.

As part of project works, Fulton Hogan will implement this ASMMSP to manage and mitigate construction impacts to the surrounding soil and water environments from the considerable environmental risk associated with ASS/PASS when disturbed, as they will become severely acid when exposed to air and oxidised and sulphuric acid is ultimately produced.

Where possible the Project requirements will be designed or redesigned to minimise the disturbance of acid sulfate soils. If an evaluation of the soil attributes indicates areas of high sulfide concentration (hot spots) where the impacts may be difficult to manage, consideration should be given to reconfiguring the activity to avoid these areas as much as possible.

1.3. Objectives

The objective of this ASMMSP is to provide management strategies to contain, mitigate and avoid impacts from ASM and to provide management plans for those activities where disturbance of ASM is unavoidable. The main objectives of the Sub Plan are to:

- present principles and guidelines to aid in minimising impacts on the local environment;
- describe the practical measures and best management practices to be included in design and construction to prevent or mitigate potential impacts relating to Acid Sulfate Materials (ASM);
- outline the roles and responsibilities of those involved in the implementation of ASM management controls;
- outline an effective implementation, monitoring, auditing and reporting framework; and
- provide an efficient, simplified and diligent approach to addressing the issue of ASM.

This will be achieved by:

- identifying local and project specific ASM issues;
- outlining the construction philosophy of minimising the disturbance of ASM as the primary management strategy;
- providing management procedures appropriate for various activities in ASS areas where disturbance is unavoidable;
- providing a contingency plan for AASS and/or PASS identified in areas not previously identified as having acid sulfate potential;
- consulting with stakeholders;
- describing project and activity specific environmental monitoring procedures with specific relevance to ASS; and
- by establishing implementation and review procedures.

This Sub Plan has been developed in general accordance with the ASSMAC *Acid Sulphate Soil Manual* (1998), RMS's *Guideline for the Management of Acid Sulfate Materials* (RTA 2005) and other regulatory requirements outlined in **Section 2**. As part of developing this Sub Plan, a copy of the plan will be provided to Primary Industries (NSW) regarding the testing regime undertaken to date (refer to Table 2.1) and the components of this plan which addresses planned testing of the soils to ensure predictions all potential risk areas are assessed (in accordance with a commitment in the Submissions Report page 67).

2. Legal and Other Requirements

2.1. Legislation

Legislation applicable to ASM management for the Project includes:

Commonwealth

- Environment Protection and Biodiversity Conservation Act 2000

NSW

- Protection of the Environment Operations Act 1997 (POEO Act)
- Environment Planning and Assessment Act 1979 (EP&A Act)
- Waste Avoidance and Resource Recovery Act 2001
- Water Management Act 2000
- Water Act NSW 1912
- Native Vegetation Act 2003
- Fisheries Management Act 1994
- Contaminated Land Management Act 1997
- Coastal Protection Act 1979
- Environmentally Hazardous Chemicals Act 1985
- Threatened Species Conservation Act 1995
- National Parks and Wildlife Act 1974 (NPW Act)
- State Environmental Planning Policy No.71 – Coastal Protection (SEPP 71)
- State Environmental Planning Policy No.14 – Coastal Wetlands (SEPP 14)

The applicability of all legislation to the project is detailed further in *Appendix A* of the CEMP.

2.2. Review of Environmental Factors and Submissions Report

The ASMMSP has been prepared in accordance with the requirements of the REF and the Submissions Report. **Table 2.1** details the document requirements and where they have been addressed in this plan. Specific ASM management measures to be implemented from the documents are detailed in **Appendix A**.

Table 2.1 Commitments from REF and Submissions Report

Document Reference	Measure	ASMMSP Reference
<p>REF Table 7.1</p> <p>SUB REP Section 4</p>	<ul style="list-style-type: none"> • An acid sulfate soils management plan (ASSMP) would be developed and implemented to mitigate for potential impacts associated with acid sulfate soils, with particular reference to the proposed excavations below the water table for drainage structures on the Omega Flat floodplain. The ASSMP would be prepared in accordance with the RTA's Guideline for the Management of Acid Sulfate Materials (RTA 2005). • Driven piles would be used for bridge foundations where possible to reduce oxidation of potentially acid sulfate soils to reduce the risk of contamination to Werri Lagoon (SEPP 14 Wetland). • The ESCP would identify ongoing monitoring requirements to manage potential water quality impacts during construction in accordance with the water quality criteria outlined in the Environment Protection License (EPL). The monitoring program would also document the requirements for water quality monitoring of pre-loading water discharge and dewatering activities. • A dewatering management plan detailing processes for dewatering and proposed treatment of potentially acidic groundwater prior to discharge would be prepared in the event that dewatering is required for the proposal. <p>Ancillary infrastructure</p> <ul style="list-style-type: none"> • Sites would be located on residual land purchased for the road works where such land is available and suitable. • Wherever practicable sites would be separated from creeks or watercourses by at least 50 metres conditional upon the provision of adequate erosion and sedimentation controls. Where 50 metres separation is not possible they would be sited subject to investigation of appropriate controls. • Sites would have low conservation significance for flora and fauna. • Sites would not be of Aboriginal or non-Aboriginal heritage significance. • Sites would be already cleared of native vegetation. • Sites would not be located within 200 metres of, or drain directly to, SEPP 14 Wetlands. 	<p>This ASMMSP</p> <p>Section 1.3</p> <p>Section 4.2.7</p> <p>Appendix E Appendix L – Soil and Water Management Sub Plan</p> <p>Appendix B</p> <p>Appendix B</p> <p>Appendix B</p> <p>Appendix B</p>

2.3. Client Specification

In accordance with RMS contract specification 'Environmental Management', the following measures in **Table 2.2** applies to ASM management.

Table 2.2 Commitments from RMS Contract Specification

Document Reference	Measure	ASMMSP Reference
G36 3.6	Comply with ISO 14001 Clause 4.4.6 including as applicable: (h) Incident management.	<i>Section 7.3 of CEMP</i>
G36 5	The Sensitive Area Plans must include all sensitive receivers, watercourses and catchments , threatened species communities, vegetation to be retained, mangroves, seagrasses, important fauna areas or issues (including threatened fauna and their habitat sites, State Forests, National Park, Nature Reserves, Marine Parks, potential or actual acid sulfate soil areas, contaminated sites, and heritage areas (including non-Aboriginal heritage sites (refer clause 6.14), taking into account privacy implications.	<i>Environmental Constraints Maps Append E to CEMP</i>
G36 6 Table 1	<p>Details on: (Construction Soil and Water Management Plan)</p> <ul style="list-style-type: none"> • measures, systems and responsibilities for the management of acid sulfate soils to prevent impacts to water quality and aquatic flora and fauna including, but not limited to: <ul style="list-style-type: none"> - proposed areas where ASS will be treated/ stored; - liming rates and mixing; - bunding design; - testing of soils in bunded areas; - proposed final use of the neutralised material; and - monitoring and reporting requirements. 	<p>Section 4</p> <p>Appendix E</p> <p>Appendix B</p> <p>Appendix E</p> <p>Appendix C</p> <p>Appendix E</p> <p>Appendix E</p> <p>Section 6.3</p>
G38 2	The Contractor must prepare the following procedures / Works Method Statements: e). acid sulfate soil management and treatment procedure.	Appendix E
ANNEXURE G38/A	Provide sound treatment systems for the management of acid sulfate soils. Design of storage areas must address stability of bunds and permeability of soil under the bunded areas and bund walls. Develop procedures for sampling of water quality in storage areas and dewatering of basins.	Appendix A - E
ANNEXURE G38/D	The Construction Soil and Water Management Plan (CSWMP) must cover the following items, where relevant: 3. Site investigations and assessments including: <ul style="list-style-type: none"> • a soil properties (including dispersion properties and the presence of Acid Sulfate Soils), 	<i>Appendix L to CEMP – Soil and Water Management Sub Plan</i>

2.4. Associated Documents

The RMS Scope of Works and Technical Criteria (SWTC) do not contain specific requirements in relation to ASM.

2.5. Guidelines and Standards

Best management practice guidelines, technical resources and standards relevant to the ASM management include the following:

- Guidelines for the Management of Acid Sulphate Materials (RTA 2005).
- NSW Acid Sulfate Soil Manual (Acid Sulfate Soils Management Advisory Committee (ASSMAC) 1998).
- NSW Acid Sulfate Soil Risk Maps and Acid Sulfate Soil Planning Maps (Department of Infrastructure, Planning and Natural Resources).
- Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland (QASSIT), Department of Natural Resources, Resources Sciences Centre, Indooroopilly –. (Ahern C R, Ahern M R and Powell B 1998a).
- Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines Version 3.8 QASSIT (S E Dear, N G Moore, S K Dobbs, K M Watling and C R Ahern 2002).
- Waste Classification Guidelines Part 4: Acid Sulfate Soils (DECC 2008).

A description of the relevant guidelines and standards has been detailed further in *Appendix A* of the CEMP

2.6. Investigations and Studies Undertaken

The following investigations for ASM have been completed along the road alignment to date:

- Gerringong to Bomaderry Princes Highway Upgrade – Route Options Development - Preliminary Geotechnical Report (DEV06/04-GE-CO-Prelim Geotechnical Report Rev-1 (Coffey 2007).
- Geotechnical Factual Report for Concept Design - Gerringong to Bomaderry NSW (GEOTWOLL02580AE-BD) (Coffey 2010).
- HW1 Princes Highway - Gerringong Upgrade Mt Pleasant to Toolijooa Road - Geotechnical Overview Report (RMS 2011).

3. Identified Acid Sulfate Materials

Areas of known and potential acid sulfate materials are identified on the Environmental Constraints Maps in *Appendix E* of the CEMP. These maps will be continually updated throughout the construction period as new information becomes available and as incidental finds of ASM are encountered during construction must be inspected by a soil specialist to facilitate an ASM Management Plan as required by works in the area.

3.1. Acid Sulfate Soils

Acid Sulfate Soils (ASS) have formed naturally, commonly in estuarine areas along the east coast of Australia as well as other parts of the continent and throughout the world. If permanently deprived of oxygen, the sulphide minerals in ASS cause no environmental harm and the materials are referred to as Potential Acid Sulfate Soils (PASS). PASS occur predominantly in soils which sit below 5 metres Australian Height Datum (AHD). If exposed to oxygen, the sulphide minerals in the soil oxidise and can produce excess sulphuric acid. Such soils are referred to as Actual Acid Sulfate Soils (AASS).

Usually, where Holocene-age (<10,000 years old) floodplain materials exist, AASS overlie PASS and may be up to 1.5 m thick. These AASS materials may contain stores of existing acidity, equivalent of up to 200 tonnes of sulphuric acid per hectare and an average of 50 t of sulphuric acid per ha. The chemical nature of these acid stores is complex but the acidity is released into the upper layer of the shallow groundwater. The groundwater may be displaced by rainfall causing water tables to rise and discharge into surface waters. These acidic discharges may cause widespread and serious environmental and structural damage (e.g. respectively fish kills and damage to arable land, and also corrosion to structural materials).

Works associated with the Project will involve disturbance of ASM within Omega Flats between Gerringong and Mount Pleasant Ridge and therefore has the potential for environmental impact. The greatest potential to cause such impacts is associated with:

1. Creation of new acidity by causing oxidation of PASS (e.g. by excavation, or in situ
2. drainage of PASS).
3. Alterations to the surface/groundwater regime that increase the discharge of the
4. existing acidity (e.g. by altering run-off/infiltration ratios through drainage changes).
5. Piling activities wherein the groundwater table is intersected.

Impacts may occur in the short term (e.g. through construction works) or they can manifest in the long term (e.g. through prolonged retention times of floodwaters). For the purposes of this document, all references to ASM are inclusive of AASS and PASS.

3.2. Acid Sulfate Rock

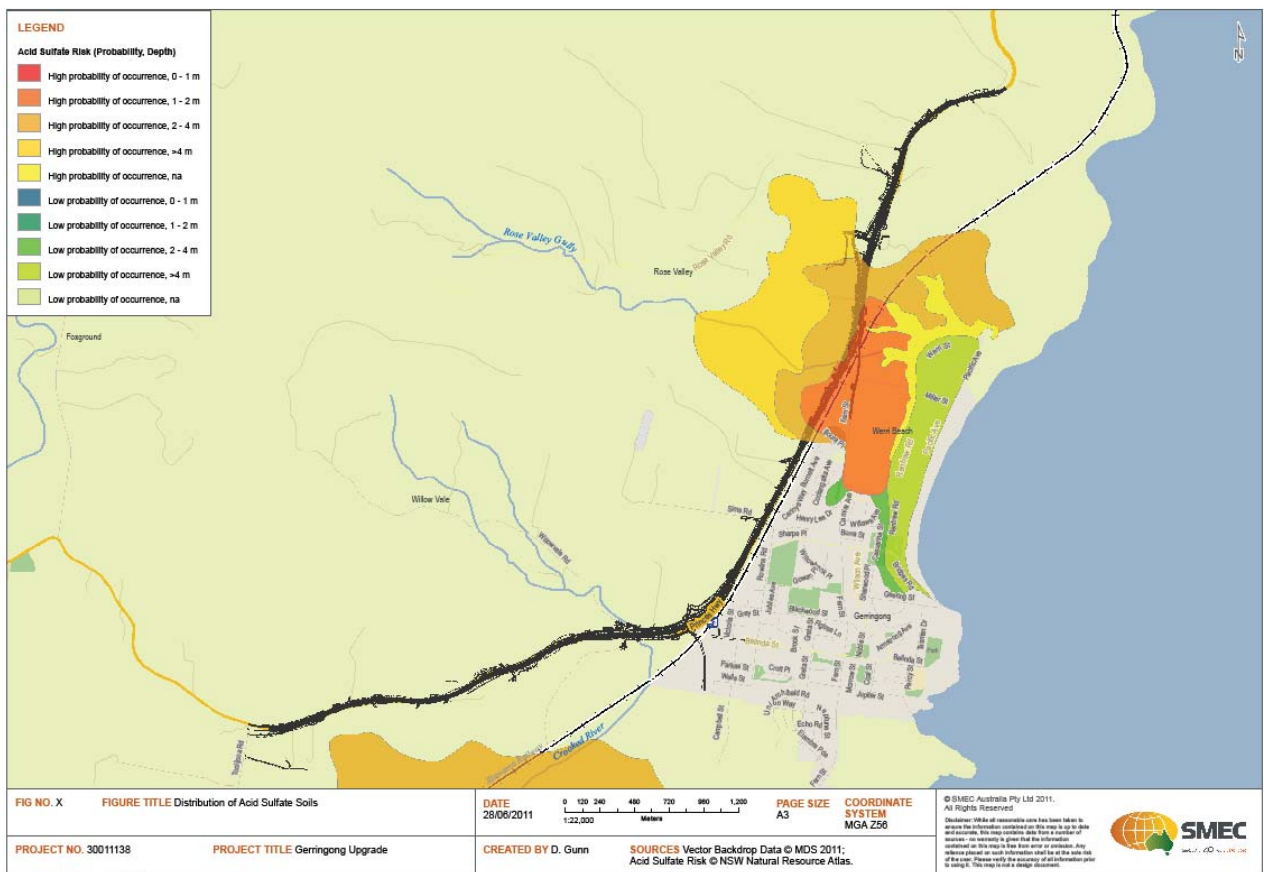
Acid Sulfate Rock (ASR) includes geological rock units that contain sulphide and sulfate minerals (pyrite). All rock (sedimentary, igneous and metamorphosed) has the potential to contain varying quantities of sulphide / sulphate minerals. Elevated concentrations are generally associated with metalliferous ore deposits and coal units but can also occur in other forms such as uplifted marine sedimentary rocks and wind driven sediments containing pyrite minerals. It can either be present as a fine (microscopic) or primary mineral (macroscopic). The particle size range will determine the rate and severity of reaction, with finer particles offering a higher proportional surface area to mass ratio and hence quicker oxidation rate (Bannerman, 2005). ASR much like ASS, is generally not a hazard when left in anaerobic conditions (below water table or deep within fine grained units with low oxygen diffusion rates). When fresh pyrite containing rock is disturbed during road construction such as in deep cuttings, oxidation can occur through exposure to air and water. The oxidation and weathering process can lead to the

generation of acidity, which in turn increases the solubility of sulfates. The leaching of sulfates and increase in acidity can degrade construction materials such as steel and concrete and potentially pollute water resources (surface and groundwater). Where rock units contain naturally elevated heavy metals concentrations, additional acidity may leach the currently bound metals into solution.

3.3. Monosulphides and Monosulphidic Black Ooze

Monosulphides and Monosulphidic Black Ooze (MBO) are characterised by their black and often oily appearance, and when disturbed the release of hydrogen sulphide (rotten egg gas). They generally accumulate in low energy ASS environments such as waterways and lagoons and form thick 'blankets' of organic rich, gel like materials. When disturbed in significant quantities they can cause acidification of waterways and deoxygenation of waters. Where drains and wetlands are constructed MBO can continue to accumulate where favourable conditions exist, and present an ongoing management issue.

Figure 1 Project layout and acid sulfate soil mapping (DLWC)



3.4. Identification of ASS

Where ASS risk has been mapped as “high probability”, the presence of ASS will be confirmed by the following general field characteristics:

- soil pH of <4;
- a sulphurous smell following soils 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 are also indicators of ASS impacts;
- excessive corrosion of concrete and or steel structures exposed to ground or drainage waters; and
- blue-grey, blue-green or grey waterlogged soils which smell of rotten egg gas.

If the above soil characteristics confirm the presence of ASS then the material will be transferred to the ASS treatment facility for treatment. If the soils are in a high risk or previously identified ASS area and show no signs of the above characteristics then testing will occur for PASS.

In the event that field indicators are ambiguous, then laboratory tests shall be conducted with test results being assessed against the Action Criteria in ASSMAC guidelines. Nominated Table 4.4 immediately triggers the need to prepare a management plan and is based on the percentage of oxidisable sulfur (or equivalent TPA, TAA) for broad categories of soil types. Works in soils that exceed these action criteria must prepare a management plan. For projects that disturb >1000 tonnes of ASS soils with $\geq 0.03\%$ oxidisable sulfur or equivalent existing acidity, a detailed management plan and development consent will be required.

4. Environmental Activities, Impacts and Risks

4.1. Construction Environmental Activities

The Project’s construction environmental activities can have a direct and decisive impact on the environment and can contribute to a larger environmental change.

The most significant construction activities which could impact upon ASM sites, features and items include:

- demolition and site clearing;
- excavation and other associated earthworks;
- establishing stockpiling locations and transport routes;
- establishment of ancillary structures and site compounds; and
- vibration generated from construction works.

4.1.1. Summary of Previous ASM Investigations

The REF identified that AASS and PASS have the potential to be affected by the Project works. The following section presents summary information relating to studies undertaken along the road corridor and ASM occurrences. The field monitoring and mapping correlated well with the information presented in the ASS maps indicate that Acid Sulfate Soils are present throughout Omega Flat. The majority of the samples from Omega Flat exceed both Action Criteria (<1000 tonnes and >1000 tonnes disturbed).

The exceedences are mainly in the acid trail rather than the sulfur trail. This may suggest that the soil has already become actual acid sulfate soils.

Field data collected to date has identified AASS at Omega Flat is located near the surface and PASS is generally located below about 1.5m. Based on the results of the testing it could be assumed that the estuarine soils of Omega Flat are ASS and an ASS Management Plan will be required. The nature of the ASS Management Plan will depend on whether greater or less than 1000 tonnes of ASS will be disturbed.

4.2. Construction Environmental Impacts

ASM occur along the road corridor at specific locations associated with low lying areas containing sulfate and sulphide minerals as demonstrated in Figure 1 of this ASMMSP. The aspects, potential impacts and risk associated with these locations are related to the design of the road foremost, and secondly the construction techniques used to construct the road. The main adverse impacts that could occur during road construction through ASS/ASR landscapes if not managed appropriately are:

- generation of additional acidity from in situ PASS disturbance;
- export of existing acidity upon disturbance and wetting;
- generation of low pH waters (surface and groundwater) and potentially elevated dissolved metals;
- impacts on sensitive environments (flora and fauna);
- potential for soil structural decline;
- potential for infrastructure decline due to aggressivity to structures (corrosion etc);
- effects being of both short and long term consequence; and
- community perceptions of the project.

The usual management tool for excavated ASS is neutralisation with fine agricultural lime in accordance with the ASSMAC guidelines. The calculated liming rate based on the samples tested varies from between 4kg lime/ tonne and 76.4kg lime/ tonne, with an average liming rate of about 14kg lime/ tonne (including a 1.5 factor of safety).

Excavations or drilling in Omega Flat areas may disturb ASM and will therefore require management of all disturbed soils.

Table 4.1 Summary of ground engaging assets and ASM treatment requirements

Approximate Chainage (m)	Design Asset	Disturbance Type	Approx. Disturbance mbgl	Liming Rate 0.0-3.0 mbgl	Liming Rate >3.0 mbgl
1550-1650	Basin C	TBC	TBC	TBC	TBC
1650-1750	INFRA 2,3,4	Excavation 4.0m Piles 12.0m		8.4	TBC
1750-1840	Basin J	TBC	TBC	33.5	TBC
1840-1950	INFRA 5,6	Excavation 4.0m Piles 18.0m		15.1	TBC
	Basin J1	TBC	TBC	TBC	TBC
	Basin J2	TBC	TBC	TBC	TBC

2080-2220	INFRA 7,8,9	Excavation 4.0m Piles 17.0m		28.9	26
2150	Basin E	TBC	TBC	TBC	TBC
2290-2400	INFRA 10,11	TBC		76.4	7.3
Fern St (CH100)	INFRA 19 Basin Z	Excavation 4.0m Piles 17.0m	TBC	16.7	TBC
2450-2700	INFRA 12 Basin K	Excavation 4.0m Piles 17.0m TBC	TBC	30.7	TBC
2750-2850	Basin L	TBC	TBC	TBC	TBC

Key: TBC = To be confirmed following additional field survey.

The following sections provide a summary of the primary construction activities which are likely to have an interaction with ASM and the potential impacts that could be expected.

4.2.1. Filling Low Lying Soft Ground

Filling of low lying soft ground areas (back swamps, floodplain and marshlands) generally occurs during road construction to raise the road grade. Embankments are used to provide solid foundation for construction of the road and to be within the desired road design requirements. Filling is often undertaken using materials from cuttings, borrow areas and external sources. The quality and chemistry of the imported material can vary depending on its origin. Potential impacts of filling low lying soft ground areas include:

- upward heaving of surface and sub – surface soils at the edge of the embankment when the filling rate does not allow for even settlement (ground failure). This may lead to generation of acid from PASS layers previously in an anoxic soil horizon;
- settlement of AASS beneath the embankment when preloading and surcharging occurs;
- generation of acid spikes from AASS layers pushed into the shallow groundwater;
- where wick drains are used to accelerate consolidation, the water quality may be poor;
- where extremely soft soils are encountered, load induced groundwater flow may occur as water is squeezed out of the pore space of the consolidated sediments (typically clays); and
- as settlement of materials under the embankment occurs, a reduction in permeability and storage of water in materials (less space due to compaction) occurs also. This may lead to slight mounding of groundwater on one side of the embankment and slight lowering on the other side (dependant on geology, hydrology and settlement).

4.2.2. Shallow Excavations

Shallow excavation is required for road infrastructure such as longitudinal drainage, pipes, culverts, geotechnically unsuitable material, pile caps, signposting, services and

open channels. The majority of these types of excavations are generally less than 3.0m below ground level and usually not more than 1.5m. Often in low lying areas containing ASS, groundwater may be intercepted during excavations. ASR is generally not an issue during shallow excavations and is therefore discussed in more detail in the following sections. Potential impacts of shallow excavations due to ASS materials include:

- excavation of AASS with the immediate ability to export acid and potentially dissolved metals upon wetting;
- excavation of PASS with the potential to generate acid upon exposure to oxygen and acidify;
- exposure of the cut faces of excavations to oxygen and water that may generate additional acidity or mobilise existing acidity;
- water quality reduction over short timeframes due to acid spikes and elevated dissolved metal concentrations;
- long term water quality issues (low pH, elevated total acidity, soluble sulfate, insoluble iron hydroxides and metals, principally Al, Fe, Mn and Zn). This especially applies to shallow drainage cut into ASS. Aesthetically drains and water appear unclean and stagnant;
- seepage of affected water into the shallow groundwater which may affect a larger initial area of disturbance;
- shallow dewatering for box culverts and discharge of potentially acidic water into adjacent surface water bodies;
- associated water quality impacts on sensitive receptors (flora and fauna); and
- Increased aggressivity towards concrete and steel structures that water flows against and soil sits against. Steel will corrode quicker and the bonding of cement will break down faster to show underlying aggregate and possibly weaken structures over time.

4.2.3. Deep Excavations

Deep excavation is required for road cuttings, piled foundations and road infrastructure such as large culverts. The majority of these types of excavations are generally greater than 3.0m below ground level. Often in low lying areas containing ASS, groundwater may be intercepted during early excavations. Generally where deep excavations are required some dewatering is also used to draw - down the surrounding groundwater level to allow for construction. Much of the 'shallow excavations' potential impacts occur for deep excavations (on a larger scale). In addition to the potential 'shallow impacts' detailed above, potential issues within ASS may include:

- larger areas of disturbance which may provide a greater risk to surrounding environments;
- where groundwater draw – down is necessary in an ASS landscape additional acidity may be generated and mobilised;
- the zone of influence or 'cone of depression' from groundwater draw – down may extend away from the initial disturbance site and affect groundwater dependant ecosystems; and
- where large scale soil amelioration takes place, there is a greater potential risk to the environment due to greater volumes of acid forming materials being handled.

4.2.4. Dewatering

Dewatering is generally required where excavations occur below groundwater. Dewatering may occur for large excavations such as tunnels, piling and within large

deep cuts and shallow dewatering or 'water removal' for drainage construction. Potential impacts of dewatering due to presence of ASM include:

- lowering groundwater levels that may allow oxygen to diffuse into soils and rock that were under anoxic conditions and therefore produce acid;
- reducing the storage potential of particularly coarse units when dewatering occurs as settlement and re – packing of the grains reduces permeability and transfer of water;
- dewatering potentially acidic waters or low quality and the potential for spillages/leaks to surrounding areas;
- the zone of influence or 'cone of depression' from groundwater draw – down may affect groundwater dependant ecosystems; and
- short and long term impacts on hydrology.

4.2.5. Ripping and Cutting Rock

Road design requires certain grades to be safe and efficient for travellers and especially trucks. Where highway routes traverse hilly landscapes, deep and extensive cutting into residual and hard rock materials is often required to comply with a design grade requirement. The cut face will usually consist of benches (depending on height) with drainage, angled cut faces and often some engineered anchoring depending on the stability of the geological terrain encountered. Often cuts will only intercept residual soil and weathered rock with limited potential for exposing additional highly potentially or currently acidic materials. This is due to the already weathered profile, infusion of oxygen over time and dissipation.

Very deep cutting that intercepts fresh rock that contains concentrated areas of acid forming compounds (sulphides and sulfates in the form of Pyrite and others) are of a high magnitude of risk due to their relatively undisturbed nature compared to weathered profiles. Exposure of these materials may lead to:

- generation of excess acidity, sulfates and heavy metals in solution that may leach out of rock and pollute and degrade surface and groundwater;
- leachate containing high acidity and sulfate may degrade concrete and metal structures reducing their design life and strength; and
- impacts on sensitive environments (flora and fauna) and potentially human health if there is a potential for direct or in – direct access to water containing elevated heavy metals in solution.

4.2.6. Diverting Small Open Drainage Lines

Road design often requires some form of drainage diversion. Diversion of small open drains for vehicular access or road alignment is generally required. Diverting of drainage lines will usually only disturb ASS and potentially MBO (depending of channel flow energy). Potential impacts of diverting small open drainage lines due to ASM include:

- excavation of AASS with the immediate ability to export acid and potentially dissolved metals upon wetting;
- excavation of PASS with the potential to generate acid upon exposure to oxygen and acidify;
- exposure of the cut faces of excavations to oxygen and water that may generate additional acidity or mobilise existing acidity;

- water quality reduction over short timeframes due to acid spikes and elevated dissolved metal concentrations;
- long term water quality issues (low pH, elevated total acidity, soluble sulfate, insoluble iron hydroxides and metals, principally Al, Fe, Mn and Zn). This especially applies to shallow drainage cut into ASS. Aesthetically drains and water appear unclean and stagnant;
- seepage of affected water into the shallow groundwater which may affect a larger initial area of disturbance;
- associated water quality impacts on sensitive receptors (flora and fauna); and
- increased aggressivity towards concrete and steel structures that water flows against and soil sits against. Steel will corrode quicker and the bonding of cement will break down faster to show underlying aggregate and possibly weaken structures over time.

4.3. Environmental Risk Assessment

A risk assessment has been undertaken to provide a means of categorising the likelihood and consequence of ASM impact from the construction of the Project. By assessing the risk an activity poses to the environment treatment options can be formulated which, when applied correctly, can manage and mitigate the risk. The risk prioritisation process is detailed in *Section 5.1* of the CEMP.

The aspects of the Project and ASM impacts have been assessed and are included in the Aspects and Impacts Register in *Appendix D* of the CEMP. The risk assessment is used as a guide for the formulation of environmental control measures as discussed in **Section 5** of this Plan.

The risk to the environment is relative to the areas containing ASM, severity of ASM and the disturbance undertaken at those areas. Therefore, detailed investigations by a soil specialist are required to delineate the occurrence, severity and distribution of ASM along the project. Where identified, the environmental risk will be based on the disturbance mechanism involved, severity of materials, volume and location of sensitive receptors.

Based on the investigation findings and road design, the environmental risk for disturbance ASM can be assessed, environmental management measures provided and monitoring programs applied.

4.4. ASM Management Procedures

During construction activities, environmental management measures are to be undertaken to reduce the risk of adverse environmental issues or incidents due to disturbance of ASM. The following general construction activities have been identified as potentially disturbing ASM along the road corridor:

- shallow excavations;
- embankment filling;
- piling and drilling;
- shallow dewatering; and
- ripping and cutting in potential ASR areas.

The following sub sections and **Appendix A-G** of this sub plan provide environmental management measures to limit adverse impacts to the environment. In all areas of disturbance, review of sampling locations, sample depths and results should be completed to provide site specific data.

4.4.1. Shallow Excavations

Where shallow excavations occur, the following steps will be undertaken:

- identify the location of disturbance against sampling locations and results;
- determine and document the construction activity and controls;
- determine approximate volume of materials that may be disturbed;
- determine the liming rates required to neutralise all disturbed materials;
- spread a 'dusting' of fine aglime over the area of disturbance to help neutralise any immediate acidity generated prior to commencing works;
- collect all excavated ASM impacted materials and place in a containment area for amelioration (**Appendix A – E**);
- apply aglime to excavated faces at a rate of 5kg/m² to limit acid generation;
- monitor any pooled water within the excavation for acidity issues daily (pH, Electrical Conductivity (EC), Dissolved Oxygen (DO) and turbidity);
- treat any water with acidity issues at rates indicated in SWMSP and Appendix E of this sub plan; and
- monitor disturbed area for any acidity issues (**Appendix D**).

4.4.2. Embankment Filling

Although filling activities do not generally disturb the ground, they can during embankment construction disturb soil profile or groundwater flows where settlement is uneven and upward heaving at the edge (failure) occurs. As embankments are designed and constructed using safety factors and construction rates to negate failure, it is anticipated that upward heaving will be limited (if any). Where embankment filling on soft compressible ground occurs the following monitoring will be conducted as determined by the site specific ASM management plan:

- groundwater level and quality monitoring on a monthly basis at all monitoring wells adjacent to the embankment loading zones. Quality monitoring to measure pH, EC, DO, and turbidity;
- documenting of results and observations;
- collation of all pre-construction groundwater data and comparison to data recorded during embankment loading timeframe;
- identifying any significant differences in level and quality that may have occurred;
- re-assessing groundwater monitoring based regime based on results obtained;
- weekly observation of embankment batters and toe edge areas to determine if there are any acidity or groundwater daylighting issues; and
- where wick drains are used to speed up settlement, water quality of drained water will be assessed and contained if necessary in drains and holding ponds, and treated prior to surface discharge.

4.4.3. Shallow Dewatering

Shallow dewatering refers to small excavations for construction activities that may intercept the shallow groundwater table or rainfall that drains into an excavated pit. Where shallow dewatering for activities such as construction of sediment basins, pile

caps, box culverts, pipes, services and shallow excavations occurs, the following steps will be undertaken:

- determine the approximate length of time required to dewater the area;
- determine the appropriate pumping rates required to remove water;
- make sure pump and feeder hose are long enough to remove water to correct surface drainage;
- locate existing construction drainage that feeds into holding ponds/sedimentation basins near the activity;
- discharge water into holding drains leading to basins;
- observe pit or excavated area for signs of acidity daily and lime cut faces at a rate of 5 kg/m² to limit acid build up and leaching;
- transport, contain and treat and excavated materials with the correct volume of aglime to neutralise the net acidity of the material (**Appendix A-E**);
- test holding basins and pond water quality and ensure water is within the construction guideline criteria prior to discharge (**Appendix E**);
- when activities are completed remove pump and feeder line and treat base and side of pit with aglime at a rate of 5 kg/m² to neutralise any acidity present;
- observe area of works weekly after disturbance for any acidity issues and treat accordingly until equilibrium has been reached; and
- complete dewatering record forms (**Appendix G**).

Note this does not refer to deep dewatering activities that may have a wider cone of depression and impact. No deep dewatering requirements have been identified as part of the Project works. If these works are identified as being required, a specific detailed ASM Management Plan would be prepared prior to works commencing.

4.4.4. Ripping and Cutting (ASR)

As investigations are yet to be completed to ascertain the severity and distribution of potential ASR, the following environmental management steps and options are general only. The management of ASR will involve:

- minimising the break up of the material prior to placement;
- minimising the period between excavation and placement;
- stockpiling excavated materials in a low permeability bunded area of sufficient volume to contain any leachate generated;
- provide a soil capping layer over the embankment soils;
- preventing oxidisation by placing ASR in an aerobic environment usually below water;
- isolate higher risk/higher concentration materials from exposure to oxygen;
- monitoring pH of run-off and ponded water;
- where runoff indicates acidity, lime drainage lines with a mixture of limed clay and/or lime aggregate sand bagging at regular intervals within the channel;
- directing drainage from fill embankment into holding basins, monitor holding basins; and
- directing drainage from cut faces into holding basins, monitor holding basins.

More detailed management guidelines will be developed once the investigations are complete and more is known about the materials present on site.

4.4.5. Stockpiling and Treating Soils

All excavated ASM will be stockpiled in a low permeability bunded area capable of containing all materials and associated leachate that may be produced either by seepage (drying) or rainfall. No ASM should be stockpiled for any longer than one day without adequate bunding and containment. Typical stockpiling sketches are shown in **Appendix C**. The following stockpile construction elements must be used:

- Stockpiles will be placed away from creek lines, flow lines, and any other type of water body. Distances will vary depending on the topography of the land, however it is expected that as a minimum distance of 100m should apply and 200m from SEPP14 Wetland area.
- A low permeability dense clay with minimal sand and coarse materials will be used for bunding and base materials.
- Clay will be compacted to reduce permeability further.
- A base layer of >80 micron plastic sheeting or geo - synthetic may be used to reduce permeability when suitable fill is unavailable.
- Bunds must be high enough to contain all materials stockpiled and leave some room at the base for leachate to collect and drain to a low point, discharge point (sump) or attached holding pond.
- Clay base layers must be a minimum 0.5m thick (compacted).
- A 'guard layer' of mixed clay and aglime will be used above the base layer (0.3m thick) to immediately neutralise acidity from placed materials. The 'guard layer' will be mixed with clay at a minimum rate of 20kg/m³ for all materials and up to 50kg/m³ for highly acidic or potentially acidic materials >125 molH⁺/t or 0.2%S.

ASM stockpiled materials will be placed as follows:

- Layers not to exceed 0.5m depth and preferably 0.15 - 0.3m to allow for efficient mixing and drying of potentially wet sediments.
- When materials are sufficiently dry (not saturated) apply aglime at the calculated rates for the material and spread evenly and mix thoroughly (several times as required).
- Sample for validation testing as required (**Appendix E**).
- Check validation results and either re – lime if required, compact for the next layer or place in a separate placement area for ASS that has passed the validation process.
- Earthworks processes may require adjustment to suit the requirements of processing and treatment of ASS.

Short to medium term stockpiling of ASM will only be undertaken when transport to or treatment in the treatment area is not possible. In this case, stockpiling will be in accordance with the following table:

Table 4.2 Stockpiling of ASS/PASS material

Type of Material	Maximum Stockpiling	Duration of Treatment
Texture Range	Approx. Clay Content (%)	Days
Coarse Texture (Sands to loamy sands)	<5	5
Medium Texture (Sandy loams to light clays)	5-40	14

Fine Texture (Medium to heavy clays and silt clays)	>40	21
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4.4.6. Leachate and Water Liming

Ponded leachate from excavated ASM materials should not be appreciably acidic, since the management protocols have been formulated to prevent build-up of significant acidity. However, heavy or sustained rainfall during excavation, especially over weekends, may produce leachate from excavated stockpiles, which have pH less than the receiving water, since they have not had sufficient time to contact and react with the neutralising agent.

In the above instances, and in cases where ponded leachate needs “finishing” before discharge to natural waterways, a calcium hydroxide solution will be used for rapid neutralisation as per the Soil and Water Management Sub Plan and **Appendix E** of this sub plan.

4.4.7. General Works

Where disturbance in ASM areas occurs, weekly observations of the construction area will be undertaken to detect any potential acidity issues. Truck movements and overall disturbance of surface sediments can lead to some increases in acid production due to the oxidation of pyrite, exchange of existing acidity in previously acidified soils and breakdown of organic matter that will release organic acids. Where there is an acidity issue, lime application at low rates of 2.5kg/m² or a ‘dusting’ will be used to limit or adjust any build up of acid. Due regard for pH sensitive environments such as estuarine areas and particularly the SEPP 14 Wetland with low pH adjusted flora and fauna will be made through site specific observations and expert recommendations.

4.4.8. Grubbing and Stripping Topsoil

Where topsoil and surface vegetation (generally including upper 0.2m of soil) are grubbed and stripped in ASS areas, surface liming will occur within 24hr of disturbance. Liming will generally include ‘dusting’ (2.5 – 5kg/m²) the area stripped with a fine aglime to neutralise any organic or non – organic acidity that may be generated due to disturbance and diffusion of oxygen to surface soils. All topsoil (excluding plant matter) will be stockpiled and dosed with fine aglime at calculated rates. Where calculated rates are unavailable, use 20kg/m³ for clays and silty clays and 10kg/m³ for sands. Natural topsoil will generally have very high organics and low inorganic sulphur.

5. Environmental Control Implementation

5.1. ASM Mitigation and Management Measures

Project mitigation and management measures and responsibilities for ASM are outlined in **Appendix A**. These mitigation and management measures have been developed from the REF and Submissions Report, SWTC, and RMS Contract Specifications to ensure compliance with relevant legislation and best practice. In addition, the following procedures have been prepared to provide further guidance for ASM management and treatment during construction;

- ASM Treatment Sites (**Appendix B**)
- ASM Treatment Pad Design (**Appendix C**)
- Contingency Procedure (**Appendix D**)
- Acid Sulfate Material Management and Treatment Procedure (**Appendix E**)
- Field pH and the 30% Peroxide Test Procedure (**Appendix F**)

5.2. Roles and Responsibilities

The Project team’s organisational structure and roles and responsibilities are detailed in *Section 4* of the CEMP. The main responsibilities in relation to ASM management on site are detailed in **Table 5.1**. Specific responsibilities in relation to mitigation measures are also included in **Appendix A**.

Table 5.1 ASM Management Roles and Responsibilities

Role	Responsibility
Project Director	<ul style="list-style-type: none"> • Ensure resources are made available to enable Project works to comply with the Environmental Documents and relevant legislation. • Liaise with the Environmental Manager and approval authorities as required.
Environmental Manager	<ul style="list-style-type: none"> • Ensuring that the ASMSP is implemented in accordance with project requirements through the construction program. • Coordinate all ASM reporting requirements. • Manage unexpected finds procedure. • Manage consultation requirements.
Environment Officer	<ul style="list-style-type: none"> • Monitoring of disturbed soil for ASS. • Monitoring of treated ASS. • Monitoring of leachate ponds from ASS treatment areas. • Monitoring of Imported Fill.
Project Manager	<ul style="list-style-type: none"> • Implement the ASMMSP for the Project. • Allow for sufficient resources to be made available to implement the ASMMSP. • Participate (as requested) during the Environmental Review Group (ERG). • Report to RMS in relation to compliance with the ASMMSP as required by the Environmental Documents.
Superintendent	<ul style="list-style-type: none"> • Oversee the implementation of the ASMMSP on site. • Supervise and instruct all Project personnel in regards to ASM areas. • Regulate the placement of ancillary facilities, stockpiles and haul roads so as to prevent impact to ASM areas. • Advise on potential conflicts between ASM management objectives and construction requirements.

Role	Responsibility
Foreman	<ul style="list-style-type: none"> Undertake project works in accordance with the ASMMSP. Maintain awareness of ASM during daily prestart meetings with field personnel when working in proximity to ASM areas. Supervise field personal and subcontractor's works with regard to keeping clear of exclusion zones and performing maintenance to fencing and signage when required. Report all incidents or unexpected finds to the Environmental Manager.
Project Employees	<ul style="list-style-type: none"> Maintain exclusion zone fencing and signage as required. Restrict all access into exclusion zones and attend ASM training sessions.
Admin	<ul style="list-style-type: none"> Maintain environmental posters around the office compound and project induction training register.
Sub Contractors	<ul style="list-style-type: none"> Attend project induction and ASM training / toolbox sessions; and Follow directions given by Foremen / Superintendent.
Soil Specialist	<ul style="list-style-type: none"> For individual disturbances greater than 100 m³ and for disturbances affecting groundwater, a suitably qualified person experienced with ASM must conduct the investigation and develop the management plan. Such a suitably qualified person would be a professionally accredited soil scientist or environmental scientist.

5.3. EWMS and ECMs

As described in *Section 2.5* of the CEMP, ASM management measures will be incorporated into Environmental Work Method Statements (EWMS) accompanied by Environmental Control Maps (ECM) for activities which are assessed as having significant risk of impacts to ASM sites, features and items.

6. Managing Compliance with ASMMSP

6.1. Training and Awareness

As stated in the CEMP all project personnel, subcontractors and consultants will receive training in environmental obligations during the inductions and toolbox talks. From time-to-time staff may also attend specific training sessions, where deemed necessary by FH. All Project personnel will undergo a general Project induction prior to commencing work on site. This will include an ASM component to reinforce the importance of management and the measures that will be implemented to address ASM issues. Toolbox talks will highlight the specific environmental requirements and activities being undertaken at each worksite. These will be based on the measures outlined in the specific EWMS and relevant CEMP Sub Plans.

In accordance with *Section 6* of the CEMP, all Project personnel will undertake ASM awareness training aligned with their specific role in relation to ASM management. ASM management training will generally include:

- unexpected discovery of ASS/PASS;
- location of known ASM within the alignment and the ASS treatment areas; and
- the requirements of the ASMMSP;

Environmental Posters to be placed in areas of high visitation and meeting areas will include ASM management information reflected in this Plan. Training records for all Project personnel will be kept and maintained in a register detailing names, dates, content and type of training undertaken.

6.2. Inspection and Surveillance and Monitoring

Daily visual inspections targeting the ASM management areas to identify actual or potential ASS concerns will be undertaken during construction by the Foremen. These inspections will form part of the management and mitigation schedule in **Appendix A** of the ASMMSP and be used to identify and rectify any ASM management issues.

ASM management issues identified through site inspections and monitoring of construction works will be managed in accordance with *Section 7* of the CEMP.

Environmental inspections and monitoring events will be recorded and actioned to facilitate compliance with the ASMMSP.

Discharge of water from ASM treatment basins will be in accordance with SWMSP. Prior to controlled discharge of water from ASM treatment areas (including basins) to the environment, sampling and testing shall be undertaken by the Environmental Officer or trained site delegates and laboratory confirmation will occur to ensure that the water quality criteria listed in SWMSP are met. Reporting and documentation regarding water discharge will be in accordance with the SWMSP.

6.3. Reporting Requirements

Project reporting will be undertaken in accordance with *Section 8.3* of the CEMP.

The following reports will be prepared:

- A daily record will be maintained at all ASM sites and will include inspections, dates, times, sampling dates, locations and corrective actions if required.
- Weekly and monthly inspection report on the effectiveness of the programs to treat and neutralise ASM in accordance with **Appendix E**.
- Dewatering records (**Appendix G**) for all dewatering activities.

A copy of this ASMMSP plan will be provided to Primary Industries (NSW) prior to construction commencing regarding the testing regime undertaken to date and the components of this plan which address planned testing of the soils to ensure predictions all potential risk areas are assessed (in accordance with *Section 2.1* of the Submissions Report).

Additional reporting required in relation to ASM management may be required in the event that unexpected finds are encountered during works.

7. Review and Improvement of the ASMMSP

7.1. Improvement Process

During construction of the Project, it is anticipated that the management of ASM will be improved through a variety of mechanisms including:

- reviewing past performance and identifying opportunities for improvement;
- monitoring current performance and evaluating against relevant project goals and objectives;
- identifying causes for non conformances with goals and objectives;
- implementing actions to address deficiencies including corrective and preventative actions; and
- ongoing monitoring to evaluate current effectiveness of changes.

Project performance will be addressed by the process as described in *Section 7.10* of the CEMP.

7.2. Revision of the ASMMSP

In accordance with *Section 7.10* of the CEMP, the ASMMSP will typically be revised if the documents are:

- not adequately addressing the Project requirements/ are causing nonconformity;
- no longer representing current practice or as a result of adverse audit findings;
- no longer representing Fulton Hogan’s current or appropriate practice; or
- to address changes in legislative requirements.

Between revisions, environmental issues raised e.g. from audit findings, regulatory stakeholders, the ERG etc, will be incorporated into the plan using ‘tracked changes’ and electronically stored on the Project server in a “Work in Review” folder. This will allow the progressive capture of all environmental items and timely issue of the next document revision.

Areas of known and potential acid sulfate materials are identified on the Environmental Constraints Maps in *Appendix E* of the CEMP. These maps will be continually updated throughout the construction period as new information becomes available and reissued immediately to relevant Project stakeholders.

Any proposed revision to the ASMMSP will be forwarded to RMS and other relevant stakeholders (if required) for comment prior to reissue. Document revision numbers will be updated and details included in the document control section of this plan. Once revised, this plan will be distributed to all relevant Project stakeholders.

Revision History

Rev	Revised By	Reviewed & Approved By	Date	Description/Summary of Changes
0	R. Byrne	J. Ilott	09/03/12	Initial issue for use.

ASMMSP Appendix A: Management, Mitigation Measures & Responsibilities

Appendix A: ASM Management Measures

No.	Management and Mitigation Measures	Responsibility
	GENERAL	
ASM3	The design and location of ASS treatment areas will be marked on EWMs and other relevant plans.	Environmental Manager
ASM4	Aglime or other ASS treatment material suppliers and storage locations will be finalised prior to construction and stores of these materials will be established for on-site ASS treatment.	Superintendent
ASM5	All relevant construction personnel and contractors will be trained in the requirements of this Plan and will be aware of the location of the ASS treatment areas and their personal obligations to report excavated ASS or PASS material to their supervisor.	Environmental Manager / Foreman
	ACID SULFATE SOILS IDENTIFICATION	
ASM6	The ASM Contingency Procedure (Appendix D) will be followed when ASS or PASS are unexpectedly encountered during excavation / construction activities. Detailed assessment by qualified soil specialist required.	Superintendent/ Foreman / Environmental Manager / Environment Officer/Soil Specialist
	ACID SULFATE SOILS DISTURBANCE	
ASM7	The time of exposure of ASS and PASS will be minimised to reduce acid production and resulting impacts by: <ul style="list-style-type: none"> - Programming excavations to ensure that excavations in ASS/PASS areas are left open for the minimum time possible with the objective of wherever possible having temporary excavations refilled within 24 hours. - All ASS/PASS stockpiles that require more than 24 hrs (temporary storage) will be stabilised with lime to prevent acid generation. 	Foreman / Project Engineers / Environment Officer

No.	Management and Mitigation Measures	Responsibility
ASM8	Clearing and grubbing in areas of expected ASS and PASS will be managed so that exposure of soils to oxidation is minimised.	Foreman / Project Engineers / Environment Officer
ASM9	Where excavations have the potential to discharge water to the surrounding environment, barriers of limestone will be put in place to neutralise acidic runoff. These barriers will consist of sand bags or similar being placed in drainage lines to direct runoff into the sand bag barrier. The barrier will contain limestone, and potentially acidic water will contact the limestone leading to (partial) neutralisation prior to the water flowing out of the sandbag barrier and to surrounding waters (refer Appendix E).	Foreman / Project Engineers / Environment Officer
ASM10	Disturbed ASS / PASS areas will be capped with clean fill (VENM/ENM or suitably approved fill from Project site) or covered with aglime (5kg/m ²) to reduce exposure of soils and reduce the generation of acid.	Foreman / Project Engineers / Environment Officer
	ACID SULFATE SOILS TREATMENT AREAS	
ASM11	As ancillary facilities, ASS treatment areas will be located in accordance with Appendix B and C .	Environmental Manager
ASM12	Detention basins in ASS treatment areas will, where the alignment geometry permits, be built up and bunded rather than excavated, to further minimise the disturbance of ASS or PASS.	Superintendent/ Environmental Manager
ASM13	Bunded, impervious ASS treatment areas will be constructed to treat ASS or PASS. Treatment areas will be constructed using impervious clay or plastic sheeting covered by geotextile fabric layer and sandstone base, with the outside batters of bund walls topsoiled and stabilised.	Superintendent / Foreman / Project Engineers
ASM14	Prior to operation of an acid sulfate soil treatment area, an Internal Permit will need to be signed off by the Environmental Manager. This permit requires permeability tests to be undertaken by an industry accepted method to verify that the treatment area base, bunds and leachate ponds are impermeable.	Foreman / Environment Manager
ASM15	The ASS treatment areas will be designed to have the capacity to treat the estimated ASS or PASS for the duration of the Project plus a safety factor contingency in the event of excess unexpected material.	Superintendent/ Project Engineers / Environmental Manager

No.	Management and Mitigation Measures	Responsibility
ASM16	Spoil will only be transferred to ASS treatment areas if ASS field testing is either positive or inconclusive. This is to ensure that overly wet soil, which is not ASS or PASS is not utilising resources required for ASS and PASS.	Superintendent/ Foreman
ASM17	A supply of aglime or other suitable treatment material will be stored in the treatment areas in adequate quantities to treat the planned volumes of disturbed ASS soils. These stockpiles will be stored with adequate controls to prevent erosion of material from wind and water in accordance with the SWMP.	Superintendent
ASM18	Diversion banks or bunds around the ASS treatment areas will be established to prevent run-on or lowland waters entering the ASS bunded area.	Superintendent/ Foreman
ASM19	Drains leading from treatment areas to the leachate pond will be lined with intermittent limestone barriers to neutralise any acidic runoff prior to collection. This will assist to limit the need to treat acidic leachate using hydrated lime (refer Appendix E).	Superintendent/ Foreman
	ACID SULFATE SOILS STORAGE AND MANAGEMENT	
ASM20	Short to medium term stockpiling of ASS and PASS will only be undertaken when transport to or treatment in the treatment area is not possible. In this case, stockpiling will be in accordance with the ASMMSP. Stockpiles will be adequately bunded to prevent acid impacts	Superintendent
ASM21	ASS will be treated in accordance with the Treatment of ASS Procedure (Appendix E) .	Superintendent/ Foreman / Environmental Manager / Environment Officer
ASM22	Run-off captured from areas affected by ASS or PASS (including treatment and construction areas) will be managed to ensure that leachate criteria (as listed in SWMSP Discharge Water Quality Criteria) are met.	Superintendent/ Foreman / Environmental Manager / Environment Officer
ASM23	Containment strategies will be identified and implemented prior to working in areas containing ASS / PASS to ensure that any acidic leachate associated with the oxidation of ASS is contained for treatment or removal and is prevented from entering downstream watercourses. These will be detailed in the EWMS.	Superintendent/ Foreman / Environmental Manager / Environment Officer

No.	Management and Mitigation Measures	Responsibility
	MONITORING, AUDITING AND REPORTING	
ASM24	When water is present in the leachate pond, field pH monitoring of leachate ponds will be undertaken at least weekly and after each rain event causing runoff, to determine water pH and appropriate treatment requirements.	Environment Officer
ASM25	Water from wick drains will be monitored for potential ASS related impacts. If water is found to be acidic then it will be either captured, if providing quantities permit, and transported to the ASS leachate pond for treatment; or treated at the source using aglime.	Foreman / Project Engineers / Environmental Manager / Environment Officer
ASM26	Discharge of water from ASS treatment areas will be in accordance with Sediment Basin Management and Discharge Procedure within the SWMSP (Appendix L to EMP). Prior to discharge, the water quality criteria listed in SWMSP Discharge Water Quality Criteria will be met. All documentation relating to this sampling and discharge will be recorded.	Environment Officer
ASM27	Surplus excavated material from low lying areas (<10m AHD) within the Project corridor will be assessed by a qualified soil specialist, and if required, by field screening pH and peroxide analysis and/or laboratory analysis, to determine if appropriate for reuse on site. No ASS or PASS will be imported to site.	Superintendent / Foreman/Soil Specialist

ASMMSP Appendix B - ASM Treatment Areas

Once the presence of acid sulphate material on site has been assessed by a suitably experienced and qualified soil scientist and an understanding of the proposed soil disturbance activities and quantities involved are established, acid sulfate material treatment areas will be identified, established and added to the Environmental Constraints Maps and recorded below.

In selecting possible locations for treatment areas, the following will be considered:

- Areas will be previously disturbed.
- Areas will not require clearing of native vegetation.
- Areas will be assessed to be of low conservation significance for flora, fauna, indigenous or non-indigenous heritage.

The design of the treatment areas will be in accordance with the procedures set out in **Appendix C**.

Table 1 Acid Sulfate Material Treatment Areas

Location	Contact	Capacity and Final Use
TBC		

Note: To be continually updated as more treatment sites are made available.

ASMMSP Appendix C - ASM Treatment Pad Design

Treatment Pad Design & Stockpile Construction Sketches

For treatment of large volumes of material, neutralisation will be carried out on a treatment or liming pad. The following issues will be considered in the treatment pad design: schematic cross-section of a treatment pad, including a compacted clay layer, guard layer, leachate collection system and containment with bunding.

The sketches provided are examples only. Other methods of containing and treating materials may be viable. In all cases, no untreated and monitored leachate should escape the stockpiling area and the placement of the treatment area will be on high ground with minimal potential for run-off into the area. Due regard for sensitive receptors and environmental risk will also be accounted for in design, transport and placement.

Figure 1 Treatment pad design with treatment area and stockpile area

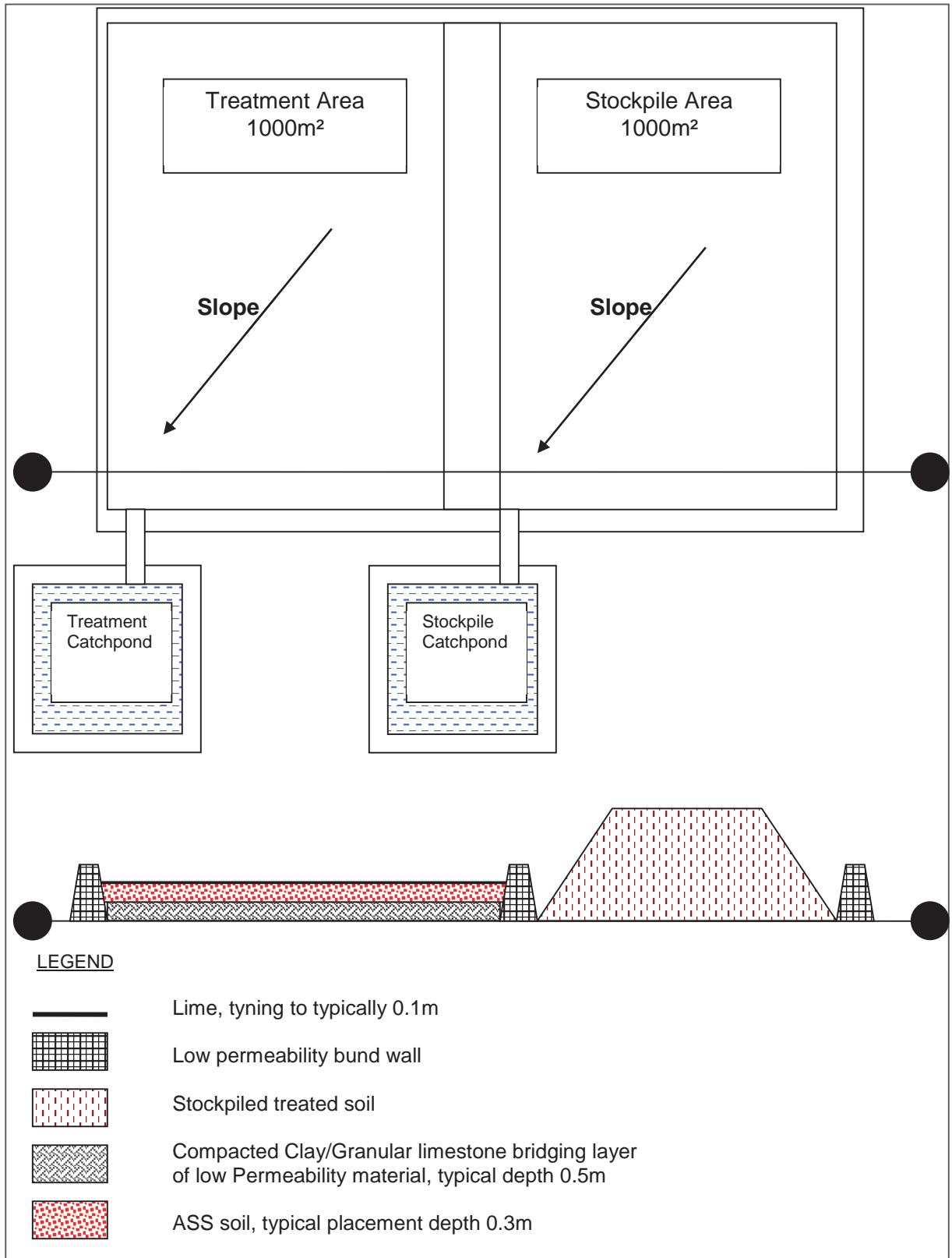
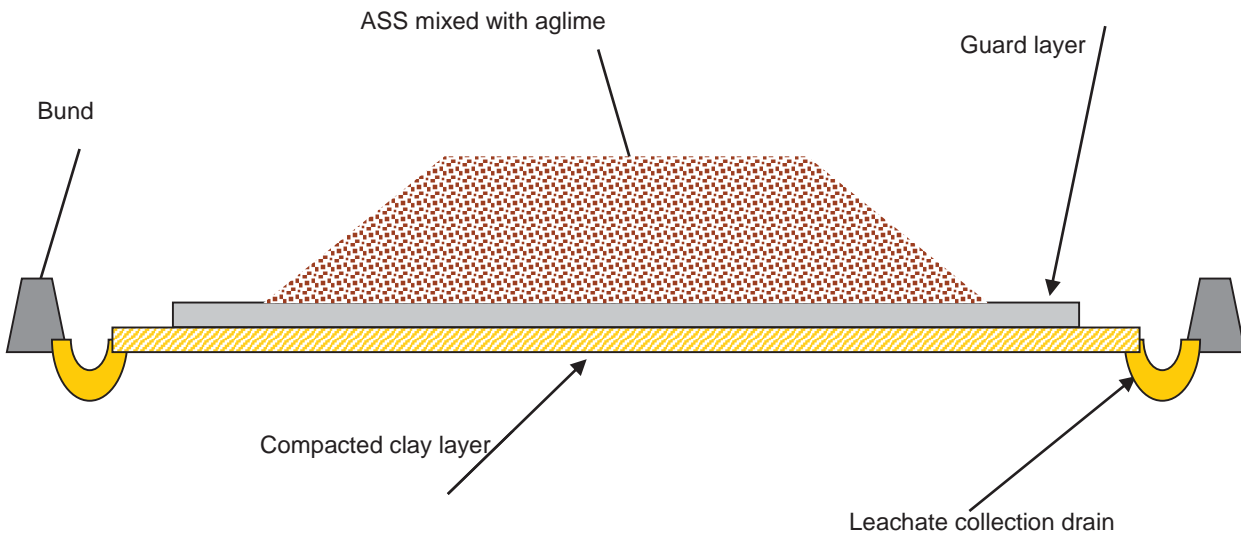


Figure 2 Cross section of land applied lime amended ASM



Photograph 1 Bunded treatment area for ASM and lime application



ASMMSP Appendix D - Contingency Procedure

Potential Failure Modes, Contingencies and Remedial Actions

Table 1 (over page) identifies potential failure modes which may occur along the Project in relation to ASM. Potential consequences, likelihood of occurrence and possible remedial measures are identified for each failure mode.

The remedial measures provided are indicative only and would need to be carried out by a suitably qualified and experienced soil specialist in accordance with RMS's *Guideline for the Management of Acid Sulfate Materials* (RTA 2005).

Table 1 Potential failure modes, contingencies and remedial action

Potential Failure Mode	Potential Consequence	Likelihood of Occurring	Contingency Measures	Possible Remediation Action
Lack of space to place excavated ASM.	Materials placed and untreated. Release of acidity into immediate surrounds.	Unlikely due to small quantities of materials to be excavated.	Monitoring of placement areas by Foreman daily. Controls are in place i.e. initial guard layers, drainage, monitoring and abundance of available plant to manage soil.	Remove materials not placed in correct areas. Grade soil and apply lime at calculated rates within bunded treatment area. Verification testing of placed soil and clearance testing of temporary holding area. Assess possible relocation of ASM to other treatment pads within the project.
Failure of ASS validation testing.	Release of acidity into underlying soils and groundwater.	Unlikely - may occur in some samples due to pockets of slightly higher sulphide.	Rapid re-application of neutralising agent where required. Abundance of plant on site to carry out re-application and mixing.	Re - apply neutralising agent and repeat verification testing on placed soil.
Local flooding of stockpile area and movement of sediments or wash out of neutralising agent.	Movement of sediments containing sulphide off site. Wash out of neutralising agent.	Unlikely but not improbable during construction.	Majority of soil will be treated in 24hr. Neutralising agent will be incorporated into soil. Monitoring of surface and groundwater (ongoing).	Scrape up washed out sediments with machine and place back into original area. Re-apply neutralising agent where washed out. Divert surface water around stockpile areas.
Unacceptable impacts on groundwater such as: lowering/raising pH, increased metal toxicity.	Release into the environment with effects on flora, fauna, and groundwater dependant ecosystems.	Unlikely to occur. This would only occur if insufficient neutralising agent was incorporated into the soil and/or incorporated too late.	Monitoring to detect any impacts (ongoing). Remedial action where required.	Installation of 'lime curtains' or re-injection spear pumps within the shallow aquifer to raise pH to an acceptable level in line with background trends. Continued monitoring throughout the remedial stages until no appreciable impacts are identified.
Unacceptable impacts on surface water such as: lowering/raising pH, increased metal toxicity.	Release into the environment with effects on flora and fauna.	Unlikely to occur. This would only occur if insufficient neutralising agent was incorporated into the soil and/or incorporated too late.	Liming construction drainage lines at regular intervals. Re – direction of flow to holding ponds to monitor and treat water. Monitoring to detect any impacts (ongoing). Remedial action where required.	Re-liming of drainage lines and increasing lime application rates to materials to raise pH ASM impacted areas. Continued monitoring throughout the remedial stages until no appreciable impacts are identified and verification testing on amended soils and water have been satisfied.
Material not neutralised because insufficient neutralisation material is available.	Release of acidity into underlying soils and groundwater and into catch drains.	Very unlikely to occur.	Excavation will cease if neutralisation agent stock is inadequate. Monitoring of neutralising quantities on site daily. Coupling excavation rates to neutralising agent requirements. Ability to order neutralising agents to site within short time frames. Material not to leave treatment pads until verification testing can confirm adequate neutralising agent has been applied.	In the event groundwater or soils have been impacted, a groundwater reinjection of suitable neutralising agent to be applied in solution or developed into a groundwater interception trench to prevent off site migration of impacted groundwater or soils. Continued monitoring throughout the remedial stages until no appreciable impacts are identified.
Neutralisation rate below required rate: during	Release of acidity into underlying soils and	Very unlikely. Investigations have	Material found to be insufficiently neutralised [through laboratory analysis] will be excavated	In the event groundwater or soils have been impacted, a groundwater reinjection of suitable

Potential Failure Mode	Potential Consequence	Likelihood of Occurring	Contingency Measures	Possible Remediation Action
construction.	groundwater and into catch drains a) during construction.	identified liming rate requirements for soils and validation testing will provide final assessment of rate of dosing.	and additional neutralisation agent will be applied to meet requirements.	neutralising agent to be applied in solution or developed into a groundwater interception trench to prevent off site migration of impacted groundwater or soils. Continued monitoring throughout the remedial stages until no appreciable impacts are identified.
Neutralisation rate below required rate: after construction	Release of acidity into underlying soils and groundwater and into catch drains b) after construction	Extremely unlikely to occur because of the stringent validation process during construction.	Material found to be insufficiently neutralised [through laboratory analysis] will be excavated and additional neutralisation agent will be applied to meet requirements.	In the event groundwater or soils have been impacted, a long term impact model to be developed to identify suitable groundwater management methodology to prevent off site migration of impacted groundwater or soils.
Unexpected exposure of ASM	Generation of acidity	Unlikely, detailed investigations have delineated areas containing ASM.	Stop work, fill in disturbed materials if disturbed for <24hr. Containment strategies will be identified and implemented to ensure that any acidic leachate associated with the oxidation of acid sulfate soil is contained for treatment or removal and is prevented from entering downstream watercourses. A detailed Acid Sulphate Soil Management Sub-plan shall be prepared by soil specialist prior to any additional construction activity taking place in the area affected.	Continued monitoring throughout the remedial stages until no appreciable impacts are identified and verification of neutralisation has been achieved.
Unexpected exposure of PASR	Generation of acidity	Unlikely, detailed investigations have delineated areas containing PASR.	Stop work and prepare a detailed Acid Sulphate Rock Management Sub-plan by a soil specialist prior to any additional construction activity taking place in the area affected.	Application of calculated rates of neutralising agent to neutralise rock net acidity or place materials through project treatment procedure.
Poor treatment of excavated potential PASR	Generation of acidity	Unlikely, procedures in place to treat materials at required rates.	Validation and characterisation laboratory testing will be carried out throughout the excavation and processing timeline during construction. Water quality monitoring will be conducted to assess any potential water quality changes.	Assess treatment procedures and laboratory results. Where additional neutralising materials are required, increase volume used. Increase the characterisation testing frequency.

Appendix E- Acid Sulfate Material Management and Treatment Procedure ASMMSP

Action Criteria for Management Intervention - ASS

Table 1 details the texture based action criteria for management of ASS disturbance. Where soils containing concentrations at or above the action criteria are disturbed, management of spoil is required. As this project may disturb spoil greater than 1000 tonnes, the two right hand columns should be used.

Table 1 Action criteria based on the ASS analysis for three broad texture categories

Type of Material		Action Criteria 1- 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. S _{TOS} or S _{POS}	Acid trail mol H+/tonne e.g. TPA or TSA	Sulphur trail % S oxidisable e.g. S _{TOS} or S _{POS}	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 ASM from Earthworks

Neutralising agents must be incorporated within all ASM. All cut batters shall be coated with fine aglime at the rate of 5kg/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 (as per **Appendix C**) 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 S% to determine an indicative level of treatment as specified in Table 2. Interpretation of analytical data must be conducted by an appropriately qualified and experienced in dealing with ASM management.

ASM 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 as defined in **Appendix C** and protected from stormwater ingress.

Mixing of ASM with neutralising agent shall be carried out by spreading the soil in layers of not more than 300-400mm 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.

Table 2 Estimating treatment levels and aglime required to treat total weight of disturbed Acid Sulfate Soils

The tonnes (t) of pure fine aglime, CaCO₃ required to fully treat the total weight/volume of acid sulfate soils (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.

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)

† 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 m³ 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.
‡ Potential acidity can be determined by Chromium Reducible Sulfur (S_{CR}), Peroxide Oxidisable Sulfur (S_{PO5}) and Total Oxidisable Sulfur (S_{TO5}). For samples with pH < 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. Consult the Queensland Acid Sulfate Soils Technical Manual, Laboratory Methods Guidelines.

Note: Lime rates are for pure fine aglime, CaCO₃ assuming an NV of 100% and using a safety factor of 1.5. A factor that accounts for Effective Neutralising Value is needed for commercial grade lime. (See the Information Sheets on Neutralising Agents - Neutralising Considerations).

Source: (based on soil analysis) (Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines 2002)

Neutralising Materials

For management or neutralisation of ASS and 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% or better, (that is, Neutralising Value [NV] > 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.

An Aglime store will be established at the compound site. 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 200kg or so. This will enable the regular treatment of soil and cater for any unexpected occurrences of ‘hotter’ AASS/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 ASM

The objective of ameliorating ASM 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 additional application of neutralising agent.

Soils that have been mixed with aglime will be analysed by either the SPOCAS or S_{CR} Suite test methods at a rate of one sample per 250m³. All validation samples are to be recorded by GPS or survey, clearly marked on a map/sketch or otherwise recorded.

Where large quantities (>1,000m³) of ameliorated soils are involved and 'net acidity' rates are generally low (18 – <125 mol H⁺/t or 0.03 – 0.20 %S), a reduced rate of sampling may be appropriate subject to approval. A rate of one sample per 1,000m³ may be suitable for example.

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

1. The neutralising capacity of the treated soil must exceed the existing plus potential acidity of the soil.
2. Post-neutralisation, the soil pH is to be greater than 5.5.
3. 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.

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.

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 FH 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).
- Suitability of soil type for plant growth.

Treatment of Acidic Waters

No single treatment approach can provide a total 'walk-away' solution, as all systems require a degree of monitoring and maintenance. Selection of the appropriate acid water treatment method (or combination of methods) invariably depends on site-specific conditions, including water composition and treatment targets.

Many New South Wales waters are acidic ($\text{pH} < 7.0$) and some are quite so ($\text{pH} < 5.5$). The ionic form of aluminium, which is highly toxic, is likely to occur below about $\text{pH} 5.0$ and more likely to occur at even lower pH levels. With the use of aluminium-based settling agents, accurate measurement and treatment of water pH must be undertaken to ensure that values are above 5.5 always. Regular ongoing testing of the runoff water should be undertaken to ensure that the recent exposure of certain soils in the catchment area has not caused pH levels to drop to less than 5.5. Further, any residual concentrations of alum remaining in the supernatant before discharge should not exceed the ANZECC (2000) freshwater quality "trigger value" of 0.055 milligrams per litre for aluminium at pH levels above 6.5.

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 - 8.5. This can occur quite easily if more soluble or caustic neutralising agents such as hydrated lime ($\text{pH} 12$) or magnesium hydroxide ($\text{pH} 12$) are used. Overdosing natural waterways results in alkaline conditions. 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 ($\text{pH} 8.2$) is the safest and cheapest 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.

Calculating the quantity of lime

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

As a general guide, Table 2 shows minimum quantities of pure lime, hydrated lime or sodium bicarbonate needed to treat dams or drains of 1 ML (1,000 m^3) capacity.

Table 2 Quantity of pure neutralising agent required to raise from existing pH to pH 7 for 1 megalitre of low salinity acid water.

Current Water pH	[H ⁺] {mol/L}	H ⁺ in 1 Megalitre {mol}	Lime to neutralise 1 Megalitre {kg pure CaCO ₃ }	Hydr. lime to neutralise 1 Megalitre {kg pure Ca(OH) ₂ }	Pure NaHCO ₃ / 1 Megalitre {kg }
0.5	.316	316,228	15,824	11,716	26,563
1.0	.1	100,000	5,004	3705	8390
1.5	.032	32,000	1,600	1185	2686
2.0	.01	10,000	500	370	839
2.5	.0032	3,200	160	118	269
3.0	.001	1,000	50	37	84
3.5	.00032	320	16	12	27
4.0	.0001	100	5	4	8.4
4.5	.000032	32	1.6	1.18	2.69
5.0	.00001	10	0.5	0.37	0.84
5.5	.0000032	3.2	0.16	0.12	0.27
6.0	.000001	1	0.05	0.037	0.08
6.5	.00000032	.32	0.016	0.12	0.027

Notes on Table 2: 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:
- $Fe^{3+} + 3H_2O \rightarrow Fe(OH)_3 + 3H^+$
- If neutralising substantial quantities of acid sulfate soil 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 waterbody 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.
- 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.

ASMMSP Appendix E-Field pH (pH_f) and Field Peroxide pH (pH_{Fox})

Field Testing Interpretation

Field tests have been developed for rapid field assessment of the likelihood of ASM. Field pH (pH_f) and field peroxide pH (pH_{Fox}) screening will be conducted on all samples and methodology expanded in Appendix A.

A combination of three factors is considered in arriving at a 'positive field sulfide identification':

- (a) a reaction with hydrogen peroxide;
- (b) a much lower pH_{Fox} than field pH_f (ΔpH) and
- (c) the actual value of pH_{Fox} .

Factor (a) - The strength of the reaction with peroxide is a useful indicator but cannot be used alone. Organic matter and other soil constituents such as manganese oxides can also cause a reaction. Care must be exercised in interpreting a reaction on surface soils and high organic matter soils such as peat and some mangrove/estuarine muds and marine clays. This reaction should be rated as per Appendix A, Table 1.

Factor (b) - A pH_{Fox} value at least one unit below field pH_f may indicate a PASS. The greater the difference between the two measurements (ΔpH), the more indicative the value is of a PASS. The lower the final pH_{Fox} value is, the better the indication of a positive result.

Factor (c) - If the $\text{pH}_{\text{Fox}} < 3$, and the other two conditions apply, then it strongly indicates a PASS. The more the pH_{Fox} drops below 3, the more positive the presence of sulfides.

A pH_{Fox} 3-4 is less positive and laboratory analyses are needed to confirm if sulfides are present. (If only low pH peroxide is available, the field test is less discriminatory,

In the event that sand are sampled it is worth noting the action limit (0.03 % S) for sulphides may give confusing field test results and must be confirmed by laboratory analysis. Field testing can identify which samples require laboratory confirmation.

Interpretation of data is to be carried out by a suitably qualified environmental professional trained in ASS screening procedures.

Method for Field pH (pH_f)

Field pH (pH_f) tests cannot be used as a substitute for laboratory ASS analysis. However, they are a necessary additional tool to establish field representation of laboratory data generated.

The procedure for the field pH_f is outlined below:

1. Calibrate battery powered field pH meter according to manufacturer's instructions.
2. Prepare the test tubes in the test tube rack. Make sure the rack is marked with the depths so there is no confusion about the top and bottom of the profile. Use of separate racks for the pH_f and pH_{Fox} tests is recommended as contamination may occur when the pH_{Fox} reactions are vigorous. As the soil:water paste is inclined to stick to the walls of tubes, it is best to use shallow, broad test tubes as this makes cleaning easier.
3. Conduct tests at intervals on the soil profile of 0.5 m or at least one test per horizon whichever is lesser.

4. Remove approximately 1 teaspoon of soil from the profile. Place approximately ½ teaspoon of that soil into the pH_f test tube and place ½ teaspoon of the soil into the pH_{fox} test tube for the corresponding depth test. It is important that these two sub-samples come from the same depth and that they are similar in characteristics.
5. Place enough deionised water (or demineralised water if deionised water is not available; never use tap water) in the pH_f test tube to make a paste similar to 'grout mix' or 'white sauce', stirring the soil:water paste with a skewer, strong tooth pick or similar to ensure all soil 'lumps' are removed. Do not leave the soil samples in the test tubes without water for more than 10 minutes.
6. Immediately place the spear point electrode (preferred method) into the test tube, ensuring that the spear point is totally submerged in the soil:water paste.
7. Measure the pH_f using a pH meter with spear point electrode.
8. Wait for the reading to stabilise and record the pH measurement.
9. All measurements should be recorded on a data sheet.

Rating Soil Reactions of the pH_{fox} Test Using the XXXX Scale

The rate of the reaction generally indicates the level of sulfides present, but depends also on texture and other soil constituents. A soil containing very little sulfides may only rate an 'X' however a soil containing high levels of sulfides (remember the exact level of sulfides cannot be determined using the pH_{fox} test) is more likely to rate a 'XXXX' although there are exceptions. This rating scale alone should not be used to identify ASS. It is not a very reliable feature in isolation as there are other factors including manganese and organic acids which may trigger reactions. Reactions with organic matter tend to be more 'frothing' and don't tend to generate as much heat as sulfidic reactions. Manganese reactions will be quite extreme, but don't tend to lower the pH_{fox}. Table 1 indicates the reaction scale for pH_{fox} tests.

Table 1 Soil reaction scale for the pH_{fox} test

Reaction Scale	Rate of Reaction
X	Slight Reaction
XX	Moderate Reaction
XXX	High Reaction
XXXX	Very vigorous reaction, gas evolution and heat generation

Appendix H
Not used

Appendix I
Not used

Appendix J
Not used

Appendix K

Unexpected Discovery of Contaminated Land Procedure



Transport
Roads & Maritime
Services

Unexpected discovery of contaminated land procedure

MAY 2012



Document control

File name	N/A
Report name	Unexpected discovery of contaminated land procedure
Revision number	Rev 0

Plan approved by:

[signed]

[signed]

[signed]

Name

Name

Name

Contractor PM

Contractor EM

RMS representative

Revision history

Revision	Date	Description	Approval
0			
1			
2			

1 Distribution

There are no restrictions on the distribution/circulation of this Procedure within the Foxground and Berry bypass Project.

2 Purpose

This Procedure details the actions to be taken when potential contaminated soil / material is encountered during excavation/construction activities.

3 Induction / Training

Where required, personnel will be trained in the identification of potential contaminated soil / material including the requirements of this Procedure during the Project induction and / or regular toolbox talks.

4 Scope

This Procedure is applicable to all activities conducted by personnel on the Foxground and Berry bypass Project that have the potential to uncover/encounter contaminated soil/material.

5 Procedure

1. Potential Contaminated Soil / Material Encountered during Construction Activities

If potential contaminated soil / material is encountered during excavation / construction activities:

- STOP ALL WORK in the immediate / affected area.
- Immediately notify the Environment Manager (EM).
- Recommence works in an alternate area where practicable.

2. Personal Protective Equipment (PPE)

Prior to any contamination investigation/management, appropriate personal protective equipment (PPE) is to be worn as per the relevant Material Safety Data Sheet(s) (MSDS).

This may include, but not be limited to:

- Eye goggles.
- Face mask.
- Rubber boots.
- Rubber gloves.
- Work clothes (i.e. long sleeve shirt/pants and steel capped boots).

3. Undertake a Site / Area Contamination Investigation

The G36 Hold Point for 6.15 Contaminated Land must be implemented.

The EM or Environmental Officer (EO) is to assess the situation and if considered necessary, commission a suitably qualified contamination specialist to undertake a contamination investigation in the area of the find.

The material is to be classified in accordance with the *Waste Classification Guidelines*

(DECCW, 2009).

If necessary, the EM will liaise with the relevant authorities to determine the appropriate management options.

The EM (in consultation with specialists) will determine the appropriate management measures to be implemented. This may include treatment or offsite disposal. If the material is to be disposed of offsite, ensure the waste facility is appropriately licensed.

If the material is determined to be acid sulfate soil or potential acid sulfate soil, the Acid Sulfate Materials Management Sub-Plan (Appendix G of this SWMP) is to be followed.

4. Remedial Action

Remedial actions are to be incorporated into specific Environmental Work Method Statements (EWMS) and training provided to site personnel and subcontractors through inductions and toolbox training sessions.

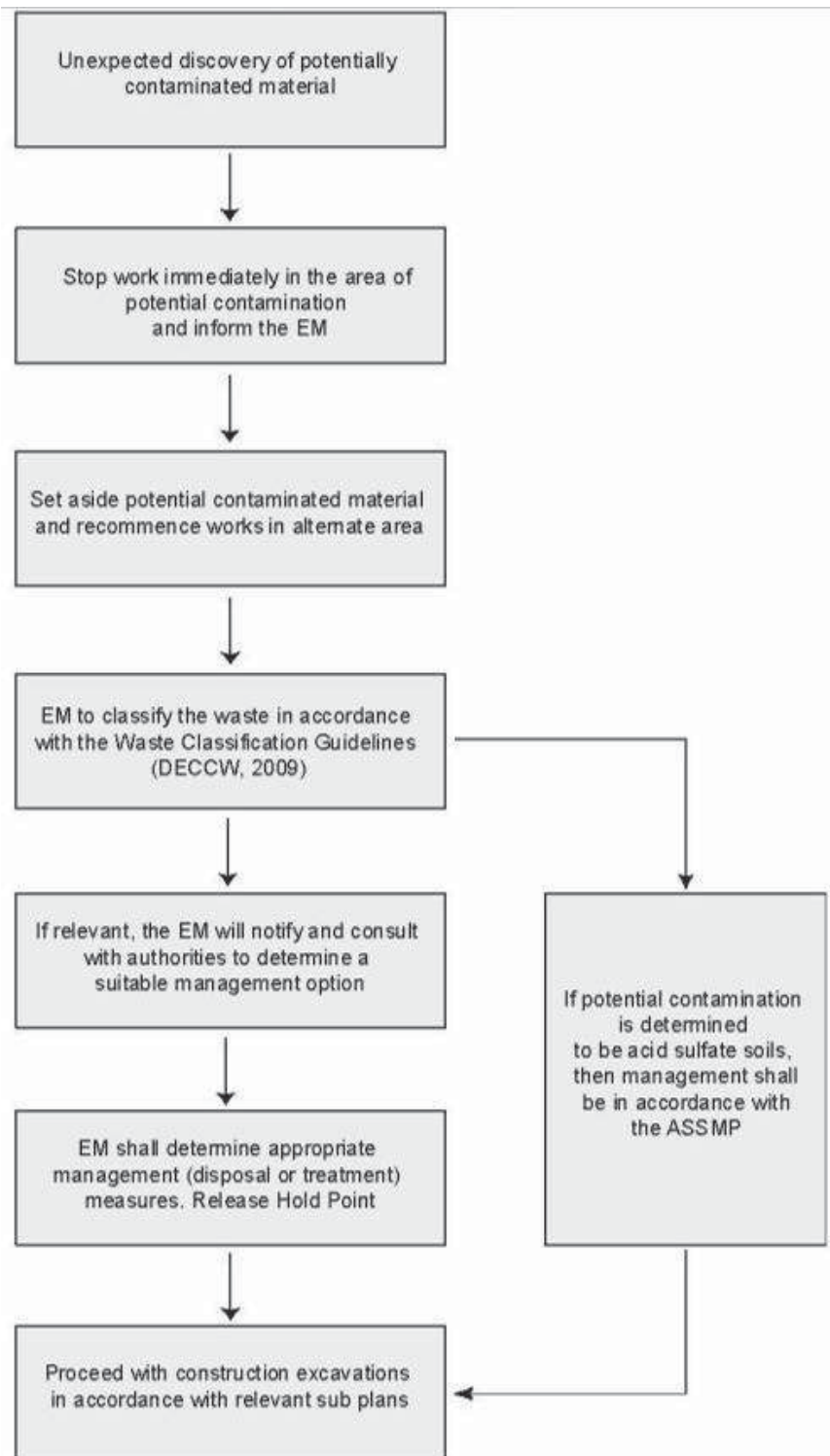
Remedial works are to be undertaken in line with the EWMS.

5. Recommence Works

Recommence works once remedial works have been implemented. The EM grants approval once hold point is released.

Figure K-1 is a summary of the procedure as a flow chart. It details the steps to be taken in the event of the unexpected discovery of contaminated land.

Figure K-1 Unexpected discovery of contaminated land procedure flow chart



Appendix L
Dewatering Practice Notes



Technical Guideline

Environmental Management of Construction Site Dewatering

EMS-TG-01 I

Issue 2 April 2011

Environmental Management System (EMS)

About this release

Guideline number:	EMS-TG-011
Guideline title:	Environmental Management of Construction Site Dewatering
Author:	Environment Branch (Environmental Policy)

Issue	Date	Revision description
1	March 2011	Draft
2	April 2011	Final

1.0 Purpose

The purpose of this Guideline is to assist RTA and Contractor project management teams to develop work method statements (WMS) for dewatering activities for main road construction and maintenance projects.

2.0 Scope

This Guideline applies to all projects undertaken by the RTA or engaged contractors that will involve the dewatering of ponded stormwater or infiltrated groundwater. It provides guidance on the preparation of WMS for dewatering activities where required under either RTA specification G35 (Environmental Protection - Management Plan) or G36 (Environmental Protection - Management System).

3.0 Introduction

Dewatering, for the purposes of this guideline, is any activity that involves the removal of ponded stormwater or infiltrated groundwater from any location on site and the subsequent reuse or discharge of that water.

Captured stormwater and infiltrating groundwater will fill sedimentation controls and pool in low lying areas of construction formations and excavations. These areas must be dewatered to maintain the effectiveness of sedimentation controls and to ensure formations and excavations are not adversely affected by long periods of inundation.

During construction activities there may be a requirement to dewater numerous locations including:

- Sedimentation controls (eg sedimentation basins and sumps)
- Excavations
- Culvert and drainage constructions
- Low lying areas of road formations.

It is the objective of this guideline to ensure that all site dewatering activities are completed in a manner that does not cause harm to the environment. To achieve this, a site-specific WMS must be developed for all construction and maintenance projects to ensure that dewatering actions are planned, approved and supervised to minimise impacts on the receiving environment.

No construction site dewatering activity should be carried out unless it is in accordance with a WMS.

4.0 Planning Construction Site Dewatering Activities

Every dewatering activity must be planned to achieve satisfactory environmental outcomes. Sections 4.1 to 4.8 describe critical decisions that must be made in preparing dewatering WMS.

4.1 Identify areas of the site that will require dewatering.

Dewatering locations will be identified through detailed design, in development of the CEMP and during construction as earthworks and construction phases result in changing site drainage conditions. These may include:

- Sedimentation controls (eg sedimentation basins and sumps)
- Excavations
- Culvert and drainage constructions
- Low lying areas of road formations.

Under no circumstances should first flush concrete batching water be pumped to sediment basins for treatment. These waters should be reused within the batching process or must be treated in-situ to ensure accidental discharges do not occur.

4.2 Consider dewatering methods to minimise potential environmental impacts

There are various methods available for dewatering sedimentation controls and inundated areas of construction excavations and formations. The Contractor should assess different technologies with a view to providing the highest level of protection against environmental impacts.

Dewatering methods for sedimentation controls such as basins include pumping, low flow pipes and siphon discharges. Consideration should be given to alternatives to pumped discharges in all cases where practical.

Pumped dewatering presents specific risks relating to the pump inlet falling to the level of deposited sediment, resulting in direct discharge of polluted water to the environment. Any pumped discharge should be designed to prevent this scenario. Likewise, deposited sediment in controls such as basins must be maintained (removed) to ensure that inlets to dewatering systems are always above the level of deposited sediment.

There are two general methods for achieving water quality objectives for any site discharge, being:

- a) Water quality treatment prior to discharge.

This is required for sedimentation basins and is the preferred method for any construction excavation or inundated area that has a sufficient volume and depth of water to provide flocculation of sediments prior to discharge. All area other than defined sedimentation basins that can be treated prior to discharge should have a designed dewatering method (eg a defined pumping point, low flow or siphon discharge).

- b) Treatment with best practice controls prior to discharge.

Treatment with best practice erosion sedimentation controls during discharge is applicable for minor stormwater ponding and for activities such as individual culvert extensions where the volume of stormwater captured is minor and the dewatering activity is infrequent.

In these cases a suite of sedimentation controls, and appropriate erosion controls must be designed and implemented to provide on-site treatment of water prior to discharge to the environment. Controls may include sedimentation fences, mulch bunds, sedimentation sumps, geofabric wrapped gravel or mulch bunds, use of onsite grassed areas or a combination of techniques. The discharge from these activities must be managed to prevent erosion of the receiving environment.

4.3 Assess opportunities for reuse

Onsite reuse of stormwater or detained groundwater should be considered as a priority for all dewatering activities. Onsite reuse may include applications such as dust suppression, earthworks compaction, vegetation establishment/rehabilitation, and plant/vehicle wash-down.

Reuse of water on the construction site may reduce the need for imported or extracted water and provide a lower risk to the environment than direct discharge to the environment. Common minimum requirements for any reuse activity are that the reuse should not cause the ponding or runoff of water, which may then cause concentrated runoff and unauthorised discharge.

4.4 Assess limitations for any proposed reuse methods

Any reuse activity may be limited by climatic or site conditions. During heavy rainfall periods when the need is greatest to remove treated stormwater from sedimentation basins, construction sites may be closed and un-trafficable due to the wet condition of the site. In these cases, onsite reuse for dust suppression or compaction is not feasible or possible. In these cases the water must be discharged to meet the sedimentation basin

maintenance timeframes specified in either the environmental protection licence or the CEMP (for non-licensed sites).

Planning for any reuse activity and the WMS for dewatering must take these limitations into consideration, and a WMS developed for the management of discharge which may be required in high rainfall events.

Discharge water quality objectives (see 4.6) will not apply only in the cases where the reuse activity is designed to be operational under all climatic and construction conditions and discharge to the environment will not be required.

4.5 Select discharge locations and provide adequate energy dissipation

It is important to ensure that dewatering activities do not cause subsequent erosion at the discharge location or in receiving environments. Consideration must be given to the potential for erosion at discharge locations when designing dewatering outlets. Preference should be given to locations with established stable drainage.

Energy dissipation must be provided at all dewatering discharge points. This may include the use of surface protection such as concrete aprons, geofabric, shade cloth, gabions or form ply depending on the condition of the receiving environment.

4.6 Determine and document water quality criteria for discharge and/or reuse

Sites with Environmental Protection Licenses will have defined water quality objectives for discharges from sedimentation basins. Best management practice still applies when discharging water from all other sites. This includes defining representative water quality criteria for the receiving environment and ensuring all discharges comply with these requirements. Standard project water quality objectives criteria are as follows:

- Total suspended solids 50mg/L
- pH 6.5 – 8.5
- oil an grease no visible trace

Specific water quality criteria may be required for activities that have the potential to impact water quality through a range of pollutants including:

- general earthworks in soils with contamination issues
- earthworks in soils with naturally occurring issues such as acid sulphate soils, saline soils or high levels of other sulphide minerals (which may result in high concentrations of heavy metals in runoff).
- hydrocarbon spills
- concrete works (including batching operations)
- stabilised pavements
- precoat aggregates and spray sealing

Generally a review of environmental assessment and approval conditions and onsite conditions will provide further information on potential pollutants that may be present onsite or in site waters. Other methods to determine water pollutants may include the use of a testing probe, indicator strips, laboratory analysis, local knowledge and consultation with environmental officers and regulatory agencies.

If reuse activities are properly designed and managed then ponded stormwater or groundwater may be able to be reused onsite without specific treatment.

4.7 Assess the treatment techniques required to meet the water quality criteria.

Treatments should be designed to achieve the water quality outcome specified for the project, as well as to cater for the time constraints that may be applicable to the activity (ie 5 day management period for sedimentation basins). Treatments should be applied to waters as soon as the requirement is determined, and should be applied only by experienced and competent personnel. Care needs to be taken to ensure treatment methods do not adversely affect water quality.

Examples of common treatment applicable to RTA projects may include;

- Flocculation of turbid waters is used to minimise the settling duration of suspended particles, as well as facilitate the clearing of waters exposed to dispersive soils that are prevalent throughout NSW. Flocculation enables water quality standards to be achieved within an accepted time period. A suitable flocculent should be chosen for sites based on an impact assessment of the receiving environment. In most cases RTA projects would utilise gypsum which is considered to be inert. There are other flocculants available however the use of these must be subject to consultation with relevant stakeholders, including DECCW and NSW Industry & Investment (Fisheries) prior to use.
- pH adjustment using a base such as hydrated lime (for acidic waters) and inversely an acid such as hydrochloric acid (for alkaline waters). Low volume trials for each location will need to be carried out to determine dosage rates. Special care must be taken when adjusting pH to understand the buffer capacity of the waters, ensuring the neutral point is not over-shot. Any personnel involved in the adjustment of pH must be suitably trained and competent in the use of any additives.
- Absorption of oils and grease is used to remove traces of hydrocarbons that may have been mobilised by rainfall. Sources of oil and grease on a project may include spill and leaks from machinery, runoff from precoat aggregate stockpiles, and runoff from adjacent travel lanes. Generally oils and grease will be removed from the surface of water detention structure by the use of floating booms, pads and socks.

4.8 Assess water sampling and testing requirements

Water quality sampling and testing may be required to ensure that the water quality objectives are met prior to either reuse or discharge of the water. Techniques may include sample collection and laboratory testing or in-situ field assessment.

A list of approved testing methods for various analytes can be referenced from "Approved Methods for the Sampling and Analysis of Water Pollutant in New South Wales" (DEC 2004). Licensed premises require approved testing methods as per the conditions of the environmental protection licence (EPL) unless formal agreement has been reached with the relevant agencies. Any such agreement must be documented, and records kept onsite at all times

Non-licensed sites still require an approach to demonstrate due diligence for the testing of waters prior to discharge. This may include the use laboratory analysis and the approved testing methods, but alternatively can include calibrated comparison samples, turbidity tubes, portable probe analysis, or indicator strips. With the use of any of these alternative methods, their use should be discussed with environmental officers and personnel testing must be trained and competent. Regardless of the type testing utilised, comprehensive records must be kept onsite of all discharges.

5.0 Minimum Requirements for Dewatering Work Method Statements

5.1 WMS format

The format of site-specific WMS is flexible according to the procedures used by each Contractor. This guideline and RTA specifications G35 or G36 do not require an individual WMS for each dewatering location on each site.

Maps should be used to show all identified dewatering locations that the WMS applies to. Coded systems for similar type activities (eg pumping from sedimentation basin) can be used. The WMS should provide clear guidance for each dewatering activity on the following:

- a) a map showing areas of the Site that will require dewatering
- b) detailed description and justification of all selected dewatering methods

- c) description of onsite water reuse requirements
- d) a map showing proposed discharge locations for any offsite discharge
- e) design requirements for each offsite discharge location to prevent erosion at the discharge location or in the receiving environment
- f) water quality objectives relevant to the type of dewatering activity
- g) description of the water quality treatment techniques to be used
- h) water sampling and testing regime to validate water quality prior to and (if required) during dewatering
- i) Proposed monitoring and supervision regime.

If changes are proposed to the dewatering method used at any location or new dewatering requirements are identified during construction you must submit either of the following to the Principal before commencing the activity:

- a) revised and updated the Site WMS, or
- b) a site-specific WMS for the activity.

5.2 Document the site activity approvals process

All sites discharging water must have in force a robust delegation for the approval of all controlled discharges. This process is to be clearly documented in work method statements and must nominate specific personnel who can approve dewatering activities. Delegates responsible for dewatering approval must be suitably trained and experienced in their duties. The approval process for dewatering activities is to be included in the worksite induction and training of onsite personnel to ensure unauthorised discharges are eliminated.

The minimum requirements of this approval are:

- water quality is demonstrated to meet the objectives in the WMS
- inspection of intake and discharge locations, equipment and receiving environment completed
- trained personnel are available to supervise and monitor the activity as specified on the WMS.

5.3 Document training and induction requirements

All staff responsible for approval and/or carrying out dewatering activities must be trained and inducted into use of the WMS. The WMS should include an induction register as a record of staff that are approved to conduct or approve dewatering activities.

5.4 Document the requirements for supervision of dewatering activities

The WMS must provide a clear description of all supervision and monitoring required for each dewatering activity. All dewatering activities must be inspected and monitored by inducted, experienced and competent personnel. Prior to commencing any dewatering activity the entire system, including intake and outlet, pump, and discharge location must be inspected.

All dewatering activities must be directly supervised for the entire duration. To remove the need for direct supervision, sites may carry out risk assessments and implement mitigation measures to ELIMINATE risks of causing environmental harm. Mitigation measures must be demonstrated to eliminate the possibilities of the following incidents:

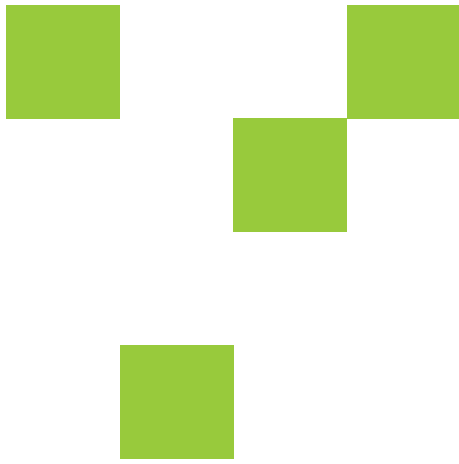
- Intakes dropping into deposited sediments and discharging sediment laden waters,
- Erosion of the discharge locations and downstream environment,
- Inadvertent or intentional controlled discharge of untreated waters.

5.5 Record keeping for dewatering activities

You must keep the following records:

- a) A copy of the dewatering WMS
- b) date, time and estimated volume of water released for each discharge location

- c) water quality test results for each discharge
 - d) records indicating who provides approval for each dewatering activity, and
 - e) evidence of discharge monitoring or risk assessment.
- .



DEWATERING PRACTICE NOTE

Pacific Highway Projects

May 2012



Document control

Document Title	Dewatering Practice Note (Pacific Highway Projects)
Author	RMS Pacific Highway Office

Issue	Date	Revision Description
1	January 2012	Draft
2	February 2012	Draft
3	May 2012	Final

Disclaimer

The information contained within this practice note is for general information only and is not intended to constitute legal advice. RMS accepts no responsibility for any loss arising out of reliance on any information contained in this document.

Acknowledgements

This practice note was prepared by RMS Pacific Highway Office.

RMS Pacific Highway Office would like to acknowledge RMS Environment Branch (Environmental Policy) and their publication *Environmental Management of Construction Site Dewatering EMS-TG-011*; this publication has served as the basis for this practice note.

RMS Pacific Highway Office would also like to acknowledge the assistance of EPA who provided comment on and assisted in the development of this practice note.

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I. How to use the Practice Note

The Dewatering Practice Note is intended for use by RMS project managers, staff and contractors on Pacific Highway construction projects. It has been designed as a means to ensure key mitigation and management principles for dewatering are identified and included in project specific Environmental Work Method Statements (EWMS) to be implemented prior to the need to conduct dewatering activities. It should be employed by RMS project teams as a means to proactively plan, assess and improve on-site procedures involving dewatering. When used correctly the practice note will aid in the enhancement of RMS environmental procedures, ensuring detrimental environmental impacts from RMS construction projects are kept to a minimum.

Refer to this practice note when preparing or assessing EWMS for work activities associated with the removal of ponded stormwater or infiltrated groundwater from any location on site, as well as the subsequent reuse or discharge of that water.

2. Introduction

2.1. Background

Dewatering is considered as any activity involving the removal of ponded stormwater or infiltrated groundwater from any location on site. For the purposes of this practice note and other RMS documentation, dewatering also encompasses any activity involving the subsequent reuse or discharge of such water.

Dewatering is a necessary part of any construction or maintenance project as captured stormwater and infiltrating groundwater will fill and pool in low-lying areas of construction sites over time. Without dewatering, pooling water may otherwise adversely affect project objectives. Reduced sediment control effectiveness, damage to formations and excavations, decreased site-access and increased downtime may all result without dewatering activity.

2.2. Objective

It is a requirement of all RMS Pacific Highway construction projects that ALL dewatering activities are undertaken in a manner that does not pollute the environment. As such project teams working on Pacific Highway projects must develop and comply with appropriately planned, approved and supervised procedures to govern such activities. Documentation of such procedures shall be in the form of an environmental work method statement (EWMS). An EWMS shall be both activity related and project specific and ALL dewatering activities must be addressed for each project. Minimum requirements for each EWMS have been outlined within this practice note, although the use of innovation is encouraged to continually enhance RMS environmental best practice.

Specific aims of this practice note are to deliver best practise and due diligence requirements on Pacific Highway construction projects that enable:

- dewatering activities to be managed to avoid pollution and/or environmental harm as defined under the Protection of the Environment Operations Act (NSW, 1997), (POEO Act) and Regulation;
- that promote sustainability in reusing valuable resources; and
- compliance with conditions of approval, permits, and licence conditions.

3. Considerations in planning dewatering activities

Every dewatering activity must be planned to achieve satisfactory environmental outcomes. In the preparation of an effective and acceptable dewatering EWMS, the following actions must be undertaken:

- Identify areas of the site that will require dewatering
- Identify receiving environment where water will be discharged with consideration and assessment of the sensitivity of the receiving environment (E.g. threatened frog/fish species habitat, Marine Park Areas, etc) - wherever possible dewatering to environmentally sensitive areas should be avoided.
- Consider dewatering methods that will minimise potential environmental impacts
- Assess opportunities for reuse

- Assess limitations for any proposed reuse methods
- Select discharge locations and provide adequate energy dissipation
- Determine and document water quality criteria for discharge and/or reuse
- Assess the treatment techniques required to meet the water quality criteria
- Assess water sampling and testing requirements
- Where discharge to sensitive areas is unavoidable, discharge methods, monitoring, sampling and testing should all reflect the specific nature of that receiving environment, its sensitivity and potential threats. This includes specifically targeting relevant parameters based on consideration of the nature of these sensitive environments.
- Identification of any potential contaminants. It is possible that previous land use activity and or the natural geology may produce contaminants. Where there is evidence to suggest there may be contamination within the catchment of an area requiring dewatering the testing regime should identify any risk and be targeted to ensure that risk is managed.
- Indication of likely volumes and duration of dewatering
- Monitoring requirements / regime
- Ensuring that dewatering does not result in discharged water re-entering the site / disturbed surfaces.
- Considering and addressing potential impacts on natural flows / water levels down stream.
- Considering and addressing mixing rates and dilution to the receiving environment.
- Training requirements / assessment of competency
- Incident management response
- Arrangement and management of the pump inlet
- Bunding of the pump

The subsequent sections (*sections 3.1 to 3.8*) will outline considerations associated with each of the actions listed above. These actions are highly recommended in the early stages of preparing an EWMS although do not constitute necessary deliverable inclusions in an EWMS document. (for minimum deliverable requirements in an EWMS document refer *Section 4: Minimum requirements for dewatering environmental work method statements*)

In addition the *Appendix* of this document provides photographs taken of dewatering activities on RMS construction projects. The photographs may be used to illustrate example designs, aiding in the design consideration process.

3.1. Identify areas of the site that will require dewatering

Dewatering locations will be identified through detailed design, in the development of the CEMP and during construction phase as earthworks and construction processes result in changing site drainage conditions. Typically locations that will require dewatering on RMS projects include:

- Sedimentation controls (e.g. sedimentation basins and sumps)
- Excavations
- Culvert and drainage constructions
- Low lying areas of road formations

3.2. Consider dewatering methods to minimise potential environmental impacts

There are various methods for dewatering sedimentation controls and inundated areas of construction excavation and formations. Common dewatering methods for sedimentation controls such as basins include pumping, low flow pipes and siphon discharges.

When selecting dewatering methods, consideration should be given to alternatives to pumped discharges where practical. Pumped dewatering presents specific risks relating to the pump inlet falling to the level of deposited sediment. This would result in direct discharge of polluted water to the receiving environment. In situations where pumping is necessary, additional protection measures should be designed into the dewatering methodology to prevent this scenario from occurring. Likewise, deposited sediment in controls such as basins must be routinely maintained (removed) to ensure that inlets to dewatering pumps and pipes are always above the level of deposited sediment.

There are two general methods for achieving water quality objectives for any site discharge, these being:

1) Water quality treatment prior to discharge.

This is required for sedimentation basins and is the preferred method for any construction excavation of inundated area that has sufficient volume and depth of water to provide flocculation of sediments prior to discharge. Any area other than defined sedimentation basins that can be treated prior to discharge should have a designed dewatering method (e.g. a defined pumping point, low flow or siphon discharge). This method would be designed to address appropriate water quality parameters and limits, and the type and volume of treatments required.

2) Treatment with best practise controls prior to discharge.

Best practise controls are those referred to within Blue Book Volume 1 and Volume 2D. Controls may include sedimentation fences, mulch bunds, sedimentation sumps, geofabric wrapped gravel or mulch bunds, use of onsite grassed areas or a combination of techniques. Treatment with best practise controls is undertaken prior to discharge. These controls must be designed, implemented, monitored and maintained to prevent erosion of the receiving environment and pollution of waters.

Treatment with best practise erosion and sedimentation controls during discharge is only applicable for minor stormwater ponding and for activities such as individual culvert extensions where the volume of stormwater captured is minor and the dewatering activity is infrequent. Addressing due diligence, risk pollution and environmental harm, site conditions and receiving environment would still need to be considered when determining whether to treat or not to treat water prior to discharge, When considering discharge location and treatment method. The following factors should also be considered:

- application rates,
- soil types,
- hydraulic loading,
- evapo-transpiration rates (as per s6.2 Blue Book Volume 2D, page 28).

The effectiveness of treatments are to be monitored and assessed and need to rectify controls and management strategy as required.

3.3. Assess opportunities for reuse

Onsite reuse of stormwater or detained groundwater should be considered as a priority for all dewatering activities. Onsite reuse may include applications such as dust suppression, earthworks compaction, vegetation establishment/rehabilitation, and plant/vehicle wash-down.

Reuse of water on construction site may reduce the need for imported or extracted water and provide a lower risk to the environment than direct discharge to the environment. A common minimum requirement for any reuse activity is that any reuse should not cause the ponding or runoff of water, which may then cause concentrated runoff and unauthorised discharge.

3.4. Assess limitations for any proposed reuse methods

Any reuse activity may be limited by climatic or site conditions. During heavy rainfall periods, when there is the greatest need to remove treated stormwater from sedimentation basins, construction sites may be closed or access limited due to the wet conditions. In such cases, onsite reuse for dust suppression or compaction is neither feasible nor possible. In these cases the water must be discharged to meet the sedimentation basin maintenance timeframes specified in either the environmental protection licence or the CEMP (for non-licensed site).

Planning for any reuse activity and the EWMS for dewatering must take these limitations into consideration, and an EWMS developed for the management of discharge which may be required as a result of high rainfall events. Planning may include controls such as lining basins, sumps, and excavations with gypsum and/or ensuring the capacity of sumps, excavations are re-instated prior to forecast rain events.

3.5. Select discharge locations and provide adequate energy dissipation

It is important to ensure that dewatering activities do not cause erosion at the discharge location or in receiving environments. Consideration must be given to the potential for erosion at discharge locations when designing dewatering outlets. Preference for treated discharge should be given to locations with established drainage and outlet structures. Locations of designated discharge points should be included on all relevant erosion and sediment control plans for the specific construction activity.

Energy dissipation must be provided at all dewatering discharge points. This may include the use of surface protection such as concrete aprons, rock bunds, geofabric, shade cloth, gabions or form ply and will be dependent on the condition of the receiving environment.

Discharge locations should be chosen with consideration to the receiving environment that may contain environmentally sensitive receivers such as threatened frog/fish species, Marine Park, etc.

Where it is not possible to avoid discharges to sensitive areas, discharge methods, monitoring, sampling and testing should all reflect the specific nature of the receiving environment and relevant parameters should be targeted to monitor, control and minimise any potential impacts.

It is possible that previous land use activity and or the natural geology of the receiving environment may produce contaminants requiring identification and assessment. Where there is evidence to suggest there may be contamination within the catchment of an area requiring dewatering then the testing regime should also identify any risk and be targeted so that the risk is managed.

3.6. Determine and document water quality criteria for discharge and/or reuse

Sites with environmental protection licences will have defined water quality objectives for licensed discharge points. The water quality parameters are also only applicable to basin discharges registered under the license. A discharge that does not achieve the environmental outcomes permitted by an EPL is likely to be considered pollution under s120 of the POEO Act. Any discharges containing contaminants other than those specifically identified in the EPL must not result in pollution to waterways. Best management practice applies when discharging water from all other sites or non-licensed discharge points. This includes defining representative water quality criteria for the receiving environment and ensuring all discharges comply with these requirements as required under the license. For the majority of EPLs for Pacific Highway projects only the outlets of basins is a licensed discharge point registered under the EPL. Standard project water quality objectives criteria for Pacific Highway projects are as follows:

- Total suspended solids 50mg/L
- pH 6.5 – 8.5
- Oil and grease no visible trace

Additional specified receiving water quality criteria may be required for activities that have the potential to impact water quality through a range of pollutants including:

- general earthworks in soils with contamination issues
- earthworks in naturally occurring problematic soils such as acid sulphate soils, saline soil or high levels of other sulphide minerals
- lime storage areas
- tannin leachate
- hydrocarbon spills
- concrete works (including batching operations)
- stabilised pavements
- precoat aggregates and spray sealing
- polymers
- curing compounds

Generally a review of environmental assessment and approval conditions and onsite conditions will provide further information on potential pollutants that may be present onsite or in site waters. Other methods to determine water pollutants may include the use of a testing probe, indicator strips, laboratory analysis, local knowledge and consultation with environmental officers and regulatory agencies.

If reuse activities are properly designed and managed then ponded stormwater or groundwater may be able to be reused onsite without specific treatment.

3.7. Assess the treatment techniques required to meet the water quality criteria

Treatments should be designed to achieve the water quality outcome specified, as well as to cater for the time constraints that may be applicable to the activity (i.e. 5 day management period for sedimentation basins). Treatments should be applied to waters, and should be applied only by

experienced and competent personnel. Care needs to be taken to ensure treatment methods do not adversely affect water quality or the receiving environment.

Examples of common treatment applicable to RMS projects may include:

- Flocculation of turbid waters to minimise the settling duration of suspended particles, as well as facilitate the clearing of waters exposed to dispersive soils. Flocculation enables water quality standards to be achieved within an acceptable time period. A suitable flocculent should be chosen for sites based on an impact assessment of the receiving environment. In most cases RMS projects would utilise gypsum, which is considered to be inert. There are other flocculants available; however the use of these must be subject to consultation with relevant stakeholders, including EPA and NSW DPI (Fisheries) prior to use.
- pH adjustment using a base such as hydrated lime (for acidic waters) and inversely an acid such as hydrochloric acid (for alkaline waters). Low volume trials for each location will need to be carried out to determine dosage rates. Special care must be taken when adjusting pH to understand the buffer capacity of the waters, ensuring the neutral point is not over-shot. Any personnel involved in the adjustment of pH must be suitably trained and competent in the use of any additives.
- Absorption of oils and grease is used to remove traces of hydrocarbons that may have been mobilised by rainfall. Sources of oil and grease on a project may include spills and leaks from machinery, runoff from precoat aggregate stockpiles and runoff from adjacent travel lanes. Generally oils and grease will be removed from the surface of water detention by the use of floating booms, pads and absorption socks.

Additional information is provided in Blue Book references:

- Appendix B, page 41 of Blue Book Volume 2D for basin management immediately after rain
- Appendix E of the Blue Book Volume I with regards to the best practice methodology of flocculation of basins.
- Attachment 5, page 51 of Blue Book V2D for managing pH.

3.8. Assess water sampling and testing requirements

Water quality sampling and testing may be required to ensure that the water quality objectives are met both prior to and during either reuse or discharge of the water. Techniques may include sample collection and laboratory testing or in-situ field assessment.

A list of approved testing methods for various analytes can be referenced from “Approved Methods for the Sampling and Analysis of Water Pollutant in New South Wales” (EPA 2004). All sampling should be representative of the water to be discharged and testing methods in accordance with this document. Licensed premises require approved testing methods as per the conditions of the environmental protection licence (EPL) unless formal agreement has been reached with the relevant agencies. Any such agreement must be documented, and records kept onsite at all times.

Using turbidity as a tool for Total Suspended Solids (TSS) requires an established NTU/TSS correlation and ongoing laboratory verification to ensure the NTU/TSS correlation being applied for the project is correct.

4. Minimum requirements for dewatering environmental work method statements (EWMS)

4.1. EWMS format

The format of site-specific EWMS is flexible according to the procedures used by each project team. This practice note and RMS specification G36 do not require an individual EWMS for each dewatering location on each site although it is necessary for ALL dewatering activities to be accounted for within a documented EWMS.

The EWMS should provide clear guidance for each dewatering activity utilising each of the following:

- a) a map showing areas of the site/project that will require dewatering. This map should identify environmentally sensitive areas and features to be considered when planning discharge locations
- b) detailed description and staged methodology of selected dewatering methods. This should include a clear and concise step by step procedure
- c) description of onsite water reuse requirements
- d) a map showing proposed discharge locations for any offsite discharge
- e) design requirements for each offsite discharge location to prevent erosion at the discharge location or in the receiving environment
- f) water quality objectives relevant to the type of dewatering activity
- g) description of the water quality treatment techniques to be used
- h) water sampling and testing regime to validate water quality prior to and (if required) during dewatering. Water quality sampling records should include, times, persons, method, parameters, treatment, consistent location, results etc.
- i) Treatment volumes, time of application, who, how etc.
- j) details of delegated approval of dewatering activities eg. Internal permit signed off by Environment Construction Manager.
- k) proposed monitoring and supervision regimes.

If changes are proposed to the dewatering method used at any location or new dewatering requirements are identified during construction the project team must submit either of the following to the Principal before commencing the activity:

- a) a revised and updated the site/project EWMS, or
- b) a new stand-alone EWMS for the activity.

5. Document the site activity approvals process

All sites discharging water must have a robust procedure in place for the approval of all controlled discharges from dewatering activities and include a mechanism for quality assurance and verification. This process is to be clearly documented in the EWMS and must nominate specific personnel who can approve dewatering activities and specifically the controlled discharge of water. Delegates responsible for dewatering approval must be suitably trained and experienced in their duties. The approval process for dewatering activities is to be included in the worksite induction and training of onsite personnel. The inclusion and enforcement of these procedures will ensure that the risk of unauthorised discharges is significantly reduced.

The minimum requirements of this approval are:

- water quality is demonstrated to meet the objectives in the EWMS and this practice note
- inspections of intake and discharge locations, equipment and receiving environments are completed
- trained personnel are available to supervise and monitor the activity as specified on the EWMS.

5.1. Document training and induction requirements

All staff responsible for approval and/or execution of dewatering activities must be trained and inducted into use of the EWMS. The EWMS should include an induction register as a record of staff that are approved to conduct or approve dewatering activities.

5.2. Document the requirements for supervision of dewatering activities

The EWMS must provide a clear description of all supervision and monitoring required for each dewatering activity. All dewatering activities must be inspected by inducted, experienced and competent personnel. Prior to commencing any dewatering activity of the entire system including intake and outlet, pump, and discharge locations must be inspected.

All dewatering activities must be directly supervised for the entire duration of the dewatering. To remove the need for direct supervision, sites may carry out risk assessments and implement mitigation measures to ELIMINATE risks of causing environmental harm. Due diligence must be demonstrated to eliminate the possibilities of the following incidents:

- intakes dropping into deposited sediments and discharging sediment-laden waters
- erosion of the discharge locations and downstream environment
- inadvertent or intentional controlled discharge of untreated waters.

5.3. Record keeping for dewatering activities

You must keep the following records:

- a) a copy of the dewatering EWMS
- b) date, time and estimated volume of water released for each discharge location
- c) water quality test results for each discharge
- d) records to verify persons monitoring, and monitoring data including water quality parameters and criteria, timing and location of monitoring
- e) records indicating who provides approval for each dewatering activity, and
- f) evidence of discharge monitoring or risk assessment

Appendix: Photographs of Dewatering Activity on RMS Projects



Figure 1. Application to a sediment basin allows faster settling of sediments and improvements to water quality prior to discharge.



Figure 2. Consideration should always be given to measures to prevent pumped inlets from falling into sediment zones at the bottom of basins. In this example an anchored bucket was seen to be effective.



Figure 3. Informal use of bunding and geotextile was assessed as a suitable outlet treatment for scour protection in this example. The use of a tyre provided both energy dissipation for the discharge flow and anchorage for the discharge pipe.



Figure 3. Use of formal signage indicating discharge procedures was an effective management tool to prevent unauthorised discharges.



Figure 4. A sump adjacent to a working area may require higher levels of maintenance in order to remain effective. Dewatering to a larger sediment basin will be a more viable treatment measure when compared to flocculating the sump itself. Consideration to minimising exposed fines around the immediate catchment (e.g. bottom left corner of the figure) will also reduce sediment entering the sump if deemed practical for construction purposes.



Figure 5. A siphon and float system used for discharging a basin without use of pumps. Floats may be useful for preventing inlets from falling into sediment zones.



Figure 6. An inlet designed with up-turned pipe to ensure settled sediment is not sucked up during discharge. Note that sediment storage zone needs regular maintenance to ensure levels do not reach the inlet level.



TEMPORARY CLEAN WATER DIVERSION PRACTICE NOTE

Pacific Highway Projects

MAY 2012



Document control

Document Title	Temporary Clean Water Diversion Practice note (Pacific Highway Projects)
Author	RMS Pacific Highway Office

Issue	Date	Revision Description
1	January 2012	Draft
2	February 2012	Draft
3	May 2012	Final

Disclaimer

The information contained within this practice note is for general information only and is not intended to constitute legal advice. RMS accepts no responsibility for any loss arising out of reliance on any information contained in this document.

Acknowledgements

This practice note was prepared by RMS Pacific Highway Office.

RMS Pacific Highway Office would like to acknowledge the following sources that have been referenced and/or have contributed ideas and concepts to this practice note:

- Department of Environment & Climate Change NSW, 2008, Managing Urban Stormwater: Soils and Construction, Volume 2D Main Road Construction
- Landcom, 2004, *Managing Urban Stormwater: Soils and Construction*
- RMS Environment Branch (Environmental Policy), 2011, *Temporary stormwater drainage for road construction* and suite of standard drawings contained within Appendix A

RMS Pacific Highway Office would also like to acknowledge the assistance of EPA who provided comment and assisted in the development of this practice note.

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I. How to use this Practice Note

The Temporary Clean Water Diversion practice note is intended for use by RMS project managers, staff and contractors on RMS Pacific Highway construction projects. They have been designed as a means to ensure key mitigation and management principles for temporary clean water diversions are identified and included in project specific Environmental Work Method Statements (EWMS). They should be employed by RMS project teams as a means to assess and improve onsite procedures involving temporary clean water diversions. The practice note has included design advice and example drawings that may be used as the basis for site-specific solutions to temporary clean water diversions, including their design, construction and maintenance. For the purposes of this practice note, temporary creek diversions are classified as temporary clean water diversions.

When used correctly the practice note will aid in the enhancement of RMS environmental procedures, ensuring detrimental environmental impacts from RMS construction projects are kept to a minimum.

Refer to this practice note when preparing or assessing EWMS for work activities associated with the installation and management of clean water diversions.

2. Introduction

2.1. Background

Soil and water management is a critical compliance risk for all RMS construction projects. It is an ongoing risk that requires continual management effort throughout all phases of construction as construction sites and site conditions evolve over time. Effective soil and water management includes a range of principles, these include:

- 1) The intercepting, diverting and safe disposing of ‘clean’ run-on water from undisturbed areas so that it does not flow onto the works
- 2) Passing ‘clean’ water through the site without mixing it with ‘dirty’ sediment-contaminated run-off from the works
- 3) Ensuring that sediment-laden runoff from works areas is effectively transferred to and treated by control measures (e.g. sedimentation basins).
(DECC, 2008)

It is a requirement of RMS projects that temporary clean water diversions are constructed and continually maintained in order to achieve these principles over the entire life of a project.

For the purposes of this practice note temporary clean water diversions are considered as any drainage or flow alteration measure used to prevent ‘clean’ water mixing with ‘dirty’ water that does not constitute part of the final design. For the purposes of this practice note temporary creek diversions are classified as a temporary clean water diversion. ‘Clean’ and ‘dirty’ water are defined as follows:

Offsite (‘clean’) Water	Any water that enters the site from external lands; OR any water that lands within the site but does not make contact with exposed soil or other ‘dirty’ water. Also referred to as ‘clean water’.
Onsite (‘dirty’) Water	Any water that makes contact with exposed soil within the site. Also referred to as ‘dirty water’.

Without the proper implementation of temporary clean water diversions, offsite ‘clean’ water flows may contribute to additional water being captured onsite, adversely affecting project objectives. Additional water captured will likely result in both greater flow quantities and velocities onsite, increasing potential for erosion and the quantity of sediment mobilised. Project works may also be detrimentally impacted. Among other effects, higher risks of inadvertent dirty water discharge lead to a heightened risk of breach of the NSW *Protection of the Environment Operations Act 1997*, potentially resulting regulatory action.

2.2. Scope

This Practice Note has been prepared to assist project delivery. The design advice and example drawings may be used to prepare site-specific solutions to complex temporary drainage issues and provide minimum standards. These minimum standards are required to be consistent with Blue Book and Environmental Protection License (EPL) requirements. The use of innovation is encouraged to provide effective temporary drainage that minimises impacts to the environment.

3. Considerations in temporary clean water diversion design

Selected temporary clean water diversion designs to be implemented on a project shall be included in an EWMS. An EWMS shall be both activity-related and project specific and all clean water diversion construction activities must be addressed for each project. In addition an EWMS must provide evidence that all works towards the construction and maintenance of clean water diversions are undertaken in an appropriately planned, approved and supervised manner. This provides assurance that risk of ‘harm’ to the environment during the construction phase are minimised. Harm to the environment, as described in the POEO Act, includes any direct or indirect alteration of the environment that has the effect of degrading the environment and, without limiting the generality of the above, includes any act or omission that results in pollution.

The key principles that apply to the design of temporary clean water diversions on construction sites are:

- Transfer clean water across the site/project without it becoming contaminated with sediment from onsite
- Avoid mixing ‘clean’ water with ‘dirty’ water
- Ensure onsite water is conveyed to an appropriate sediment retention structure (e.g. sediment basin, sediment trap) prior to release
- All temporary channelized flow paths constructed should be lined. Lining material should be appropriate for use in channel-flow conditions and should provide protection from erosion in both the short and long term

There are a number of considerations to be taken into account when designing a clean water diversion. These have been outlined in sections 3.1-3.8 as follows. Photographed examples of temporary clean water diversions that have successfully applied such considerations on RMS projects have also been included in *Appendix C* of this Practice Note.

3.1. Required functional design life

Required functional design life is important in determining the most suitable temporary clean water diversion designs in terms of both effectiveness and required resources. Depending on the specific circumstances a temporary clean water diversion may be required to function for a time period anywhere between 1 week and 12 months or occasionally even longer periods. Such a large variance will likely affect the performance requirements for any given situation as:

- 1) the likelihood of high rainfall events increase, and
- 2) adjacent site conditions change with time.

Any change in performance requirements will likely mandate other design considerations, such as those discussed the following sections. Design life may also govern the relative appropriateness of associated costs and construction efforts given project and work activity budget, time and resource constraints. Considerations made with regard to the design life of a temporary clean water diversion should not disregard the requirement to comply with the POEO and EPL which make it an offense to pollute waters.

It should be noted that although a control may be constructed on the basis of a short design life, if weather or operational changes extend the period the control will be used for the design should be reviewed and assessed for its suitability so that the licensee achieves compliance with the POEO and EPL.

3.2. Existing flow paths

Where existing flow paths exist, consideration should be given to:

- The existing type of flow (e.g. perennial or intermittent)
- Existing channel characteristics (e.g. width, depth, channel form)
- Surrounding topography and catchment areas
- Surrounding soil types that may present higher risks of erosion with flow alteration
- Surrounding vegetation that may aid in attenuating flows and/or erosion potential

Impacts of flow alterations, particularly scenarios involving the temporary reduction or restriction of an effective flow path must be considered carefully in the development of a suitable design.

3.3. Flow characteristics

Flow characteristics are essential in determining the capacity requirements of any clean water diversion. Surrounding topography will both define catchment areas, and indicate flow quantities and velocities. Consideration should also be given to vegetation (existing and remnant vegetation) present in the area, as this will also affect flow characteristics.

Designed clean water diversions should control flows and maximum velocities should not exceed those recommended in Table 5.2 (*Appendix B*).

3.4. Boundary, constructability and maintenance constraints

Ideally both boundary and constructability constraints should be assessed at the conceptual stage of project design with adequate land (within project clearing limits) provided for any clean water diversion measures to be implemented. Consideration of constructability of such measures is imperative to ensure adequate space is available onsite. Adequate space for temporary clean water diversion construction and maintenance ensures that:

- 1) the most suitable designs are not discounted on the basis of constructability constraints,
- 2) designs are able to be constructed efficiently, and
- 3) designs are able to be maintained to a functional standard over their required life.

Consideration should also be given to any existing services in the area.

Assessment of design space requirements should consider:

- Accessibility for clean water diversion construction
- Potential conflicts with services, project boundaries or other exclusion zones
- Space requirements for construction plant (also consider working platforms)
- Space requirements for temporary erosion and sediment controls during construction of diversions
- Space requirements for permanent erosion and sediment controls (e.g. energy dissipating structures)
- Space requirements for safe access and operational/maintenance activity

3.5. Fish passage

It is important that fish passage is maintained, particularly in waterways that are classified as a Class 1 or Class 2 waterway under NSW DPI Fisheries Practice note (*Policy and Practice note for Bridges, Roads, Causeways, Culverts and Similar Structures, 1999*).

3.6. Construction materials

Clean water diversions can be constructed from a wide range of materials including, but not limited to, a combination of compacted earth, rock gabions, geomembranes, geofabrics, jute mesh, shotcrete, asphalt, pipe or vegetated channels. Various materials should be assessed on the basis of their suitability in:

- 1) Controlling flows
- 2) Constructability in accordance with site constraints

A number of clean water diversion design aspects in regard to construction materials have been discussed below:

Earth-based diversions:

- Should be constructed following Standard Drawings 5-5 and 5-6 (*Appendix B*)
- Require assessment of any additional lands that may be disturbed as a result
- Require assessment into any applicable stabilisation measures and stabilisation timeframes

Vegetated channels:

- Consider species selection and planting method and sequencing
- Consider early scour protection methods
- Consider topsoil requirements

Fabric and biodegradable linings (e.g. jute mesh):

- Should be constructed following Standard Drawing 5-7 (*Appendix B*)
- Useful for temporary protection of diversions

Gravel/Rock linings:

- Size selection **MUST** be based on expected flow velocities in accordance with Table 5.2 (*Appendix B*)
- Gravel/rock must be clean and free of fines.
- Rock should be placed above a filter layer of suitable geotextile and where necessary, properly graded layers of sand and gravel
 - Useful for bends and outlet sections of diversions

Concrete, shotcrete and asphalt linings:

- Should **ONLY** be considered in situations where ecological functions are non-existent or have no potential.
- Require additional assessment of downstream erosion protection
- Chutes and flumes require anchor lugs and inlet/outlet sections a minimum of 1.5m in length
- Useful for high velocity situations or steep slopes

Pipes

- Require additional assessment of downstream erosion protection
- Useful for high velocity situations or steep slopes

- Particularly useful in directing clean water through site without constraining vehicle access (*this is often overlooked and results in having to deal with more dirty water than necessary*)
- Use of pipes may reduce the potential for clean water to be contaminated as it is directed through the project site.

3.7. Consider construction sequencing

It is important that temporary clean water diversions are constructed as early as possible. Diverting clean water prior to major works commencing will result in less run-on water to a site, in turn leading to benefits such as increased construction efficiency, savings in ERSED control installation and maintenance and higher site accessibility.

3.8. Onsite alterations

Although it is important that the design of temporary clean water diversions takes all of the above aspects into careful consideration, there may be instances that designs require modification as construction progresses. In such an event the construction crew should be proactive in making necessary adjustments to the temporary clean water diversion. In addition, any changes (onsite alterations) should be recorded/reported in accordance with commitments made in project documents such as the EWMS/PESCP and/or relevant sub-plans.

4. Standard drawings for temporary clean water design

RMS has compiled a suite of standard drawings for various clean water diversion designs. The drawings are available for reference in *Appendix A* of this document. They include:

- a) New online culvert (preferably as early works)
- b) New offline culvert (preferably as early works)
- c) Continuous culvert extension (online) option 1
- d) Continuous culvert extension (online) option 2
- e) Continuous culvert extension (online) option 3
- f) Temporary clean water controls for construction works in road cuttings
- g) Temporary water management on a roadside cutting
- h) Temporary water management of road works positioned in depression
- i) Cut/fill batter water management
- j) Online pipe replacement/installation – small intermittent depressions only (pump option)
- k) Online pipe replacement installation – small intermittent drainage lines (temporary pipe option)

5. Minimum requirements for temporary clean water diversion environmental work method statements (EWMS)

5.1. Summary of minimum EWMS requirements

The format of site-specific EWMS is flexible according to the procedures used by each project team.

As a minimum requirement, an EWMS for clean water diversions shall:

- Incorporate design drawings of any clean water diversion/s (*Section 5.2*)
- Incorporate maps identifying the clean water diversion/s (*Section 5.3*)
- Incorporate a complete work method risk assessment (*Section 5.4*) that:
 - Lists the sequence of work activities to be undertaken in construction and maintenance of the temporary clean water diversion/s
 - Lists the sequence of work activities to be undertaken when removal clean water diversion. This should also include any stabilisation/revegetation required
 - Identifies potential environmental hazards for each work activity specified
 - Assigns specific risk ratings to individual hazards specified
 - Identifies control measures to eliminate or reduce risks, or where this is not possible, describe mitigation measures to be utilised in the event of a risk event occurring
 - Assigns responsibility of each control measure to a member of the project team
- Incorporate an induction register as a record of staff who have been approved to partake in activities detailed within the EWMS (*Section 5.5*)
- Incorporate evidence of document control such as revision number, release date, a signed authorisation for document release etc.

If changes are proposed to the clean water diversion EWMS used at any location or new temporary clean water diversion requirements are identified during construction, the project team must submit either of the following to the Principal before commencing the activity:

- a) a revised and updated the site/project EWMS, or
- b) a new stand-alone EWMS for the activity.

5.2. Incorporation of design drawings

Each EWMS shall incorporate design drawings of any clean water diversion structure they pertain to. Design drawings shall:

- a) Clearly identify all construction materials incorporated in the clean water diversion
- b) Clearly specify design dimensions
- c) Clearly specify construction tolerances
- d) Clearly identify flow directions (including inlet and outlet flows)

Drawings shall be location specific.

Method of drawing production is for the determination of the project team.

5.3. Incorporation of maps

Maps should be used to show all identified clean water diversion locations that the EWMS applies to. Maps shall:

- a) Clearly identify clean water diversion/s in relation to the project or locality
- b) Clearly identify project boundaries in relation to the clean water diversion
- c) Clearly identify endangered ecological communities in relation to the clean water diversion
- d) Clearly identify other exclusion or problematic areas in relation to the clean water diversion (e.g. ASS/PASS, PADs, contaminated soils)
- e) Clearly identify natural watercourses in relation to the clean water diversion
- f) Identify estimated flow directions (including inlet and outlet flows)

- g) Identify approximate dirty water flows in relation to the clean water diversion
- h) Identify approximate catchment area/s for the clean water diversion

5.4. Incorporate a work method risk assessment

The sequence of works is likely to vary between each clean water diversion on a project. It is often useful to use the sequence of works as a methodical framework for identifying potential environmental hazards associated with each work activity; ensuring risks can be assessed throughout the complete process of clean water diversion construction. Potential hazards then serve as basis for risk management and treatment options.

Risk treatment options shall be described in terms of measures to eliminate, reduce or mitigate risks.

In efforts to ensure risk treatment measures are undertaken as intended, allocation of responsibility shall be given to each risk treatment measure. Persons listed as responsible for risk treatment measures will ultimately be held accountable for proper implementation.

The work method risk assessment in Table 5.4, although not exhaustive, shall be used as a guide for preparation of this section of a clean water diversion EWMS. Table 5.4 has incorporated minimum requirements for risk treatment measures. These minimum requirements must be reflected in the chosen risk treatment measures for each EWMS. In addition example work activities and hazards have also been included in Table 5.4. It is important to note that the work activities and hazards listed are for illustrative purposes only and it will be necessary for each project to develop relevant activities and identify hazards in accordance with clean water diversion design, construction techniques and site conditions.

5.5. Incorporate induction register

All staff responsible for approval and/or execution of clean water diversion design and construction activities must be trained and inducted into the use of the EWMS. The EWMS should include an induction register as a record of staff that are approved to undertake or inspect clean water diversion construction, maintenance and removal activity including activities required to stabilise or revegetate.

For longer duration projects it is important that consideration is given to the requirements for a 'refresher induction'. This will aid in ensuring personnel remain familiar with the EWMS over time. In the event that inductions are required, systems should be in place to specify when they should be undertaken. An induction register should also be kept as a record of staff that are approved to continue to undertake or inspect clean water diversion construction and maintenance activity.

Table 5.4 – Example work method risk assessment for incorporation into clean water diversion EWMS

Sequence	Work Activity	Hazards	Risk Level	Risk Treatment Measures	Responsibility
1	Training of personnel	Non-compliance with EWMS	e.g. high	<p>List all relevant treatment measures</p> <p>As a minimum listed measures must:</p> <ul style="list-style-type: none"> • Ensure all relevant construction personnel are familiar with the EWMS • Ensure all personnel with allocated EWMS responsibilities are aware of responsibilities • Ensure records of EWMS training are continually maintained • Ensure personnel remain familiar with the EWMS, particularly over longer project durations. [e.g. mandated use of refresher induction/training, daily toolbox meetings each covering an aspect of the ESWMS] 	e.g. site engineer, foreman
2	Construction approval	Works commencing without relevant approvals; stakeholders detrimentally impacted without sufficient notice		<p>List all relevant construction approval measures</p> <p>As a minimum listed measures must:</p> <ul style="list-style-type: none"> • Ensure all relevant approvals, permits and licenses are acquired prior to works commencing. [e.g. Permits to excavate, out-of-hours works approval, etc.] • Ensure erosion and sediment control plans have been documented and approved by relevant personnel • Ensure ALL relevant stakeholders have been consulted regarding works and receive appropriate levels of consultation. (This may include adjacent landholders, NSW Trade & Investment <i>Fisheries</i>, relevant Land Councils, etc.) 	
3	Works within close proximity if exclusion zones (if applicable)	Inadvertent detrimental impact on sensitive areas		<p>List all relevant treatment measures</p> <p>As a minimum listed measures must:</p> <ul style="list-style-type: none"> • Ensure all relevant exclusion areas are clearly identifiable and locations known by ALL personnel involved in works. (Areas may include EECs, PADs, habitat trees etc.) [e.g. installation of buffer zones for high risk areas, signage, fenced delineation] 	

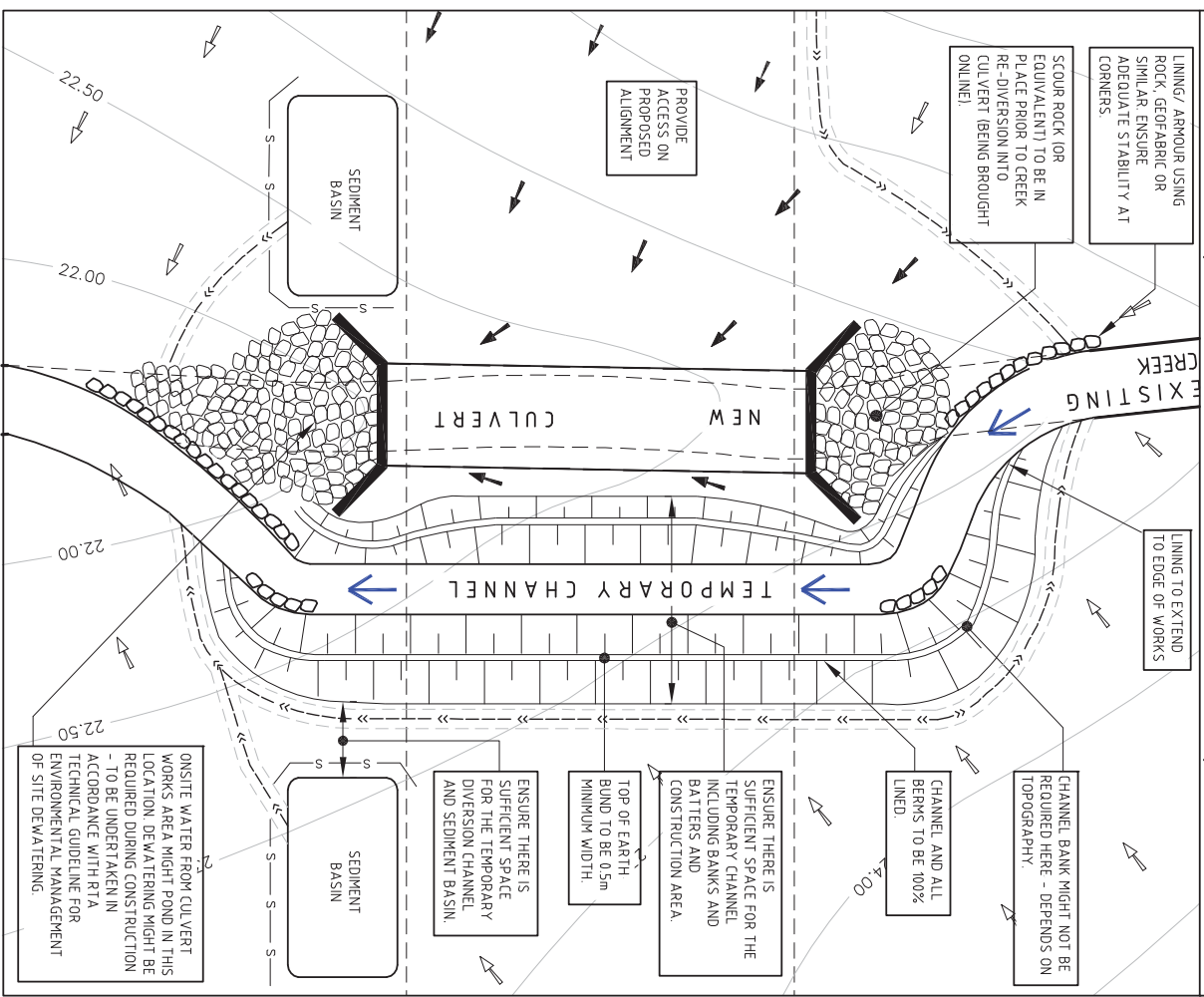
4	ERSED controls	Pollution of waterways	<p>List all relevant treatment measures</p> <p>As a minimum listed measures must:</p> <ul style="list-style-type: none"> • Ensure ERSED plans are developed by appropriately qualified personnel and approved prior to commencement of works • Ensure ERSED controls are in place, inspected and approved by relevant personnel before any ground disturbance • Ensure ERSED controls do not inhibit fish passage (where required) • Ensure ERSED controls are inspected and maintained at all times (particularly after rainfall events) • Ensure ERSED controls are in place until area stabilised or revegetated as required following completion of works to address erosion and sediment control risks and to prevent pollution of waters. • Where pipes are used for crossing ensure the pipes are of adequate strength for the weight of vehicles/plant intended to use the crossing so that the pipes are not damaged and cause clean water to be contaminated and require treatment. • List all relevant treatment measures for each corresponding work activity 	
5	General works variable dependent on design but may include the following: clearing and grubbing; excavation and ground	General works variable dependent on design	<p>List all relevant treatment measures for each corresponding work activity.</p> <p>As a minimum listed measures must:</p> <ul style="list-style-type: none"> • Ensure water quality of diverted water is maintained at all stages throughout clean water diversion construction [e.g. mandatory activity sequencing, maintenance procedures for ERSED controls, water quality testing, etc.] • Ensure diversion inlets and outlets are protected from erosion at all times [e.g. mandatory activity sequencing, 	

	<p>disturbance; access construction; embankment construction; bedding installation; placement of concrete; placement of geofabric; placement of jute mesh; channel connection works</p>		<p>maintenance procedures, etc.]</p> <ul style="list-style-type: none"> • Ensure works are undertaken in a manner that minimises dust generation and particulate emissions [e.g. mandatory activity sequencing, construction speed limits, dust suppression measures, plant maintenance regimes etc.] • Ensure works are undertaken in a manner that reduce the potential for erosion and sediment mobilisation [e.g. mandatory activity sequencing, maintenance of adjacent vegetation, removal of mud/dirt on sealed surfaces, minimising exposed surfaces, etc.] • Ensure works are undertaken in a manner that minimises noise to adjacent community [e.g. assess areas vulnerable to high noise levels; administer procedures to prevent needless noise, etc.] • Ensure protocols are in place in the event of unforeseen or problematic circumstances such as PASS/ASS, heritage item find, potential threatened fauna/flora species find, noxious weeds find, chemical spill. [e.g. Cease work, specialised procedures, etc.] • Ensure works are undertaken in a manner that minimises detrimental impacts on native flora and fauna, in particular movement of aquatic fauna is at no stage impeded [e.g. mandatory activity sequencing, use of exclusion zones, etc.] • Ensure ALL hazardous materials (including environmentally hazardous and wastes are stored, used and disposed of in safe and environmentally sound ways [e.g. designated storage areas, containment inspections, documented refuelling procedures, plant maintenance regimes, documented disposal procedures, etc.] • Ensure that natural resources obtained as a result of works are assessed for reuse, such as topsoil, loggable trees and native seed. • List all relevant treatment measures for each 	
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				<p>corresponding work activity.</p>	
<p>6</p>	<p>Site Rehabilitation</p>			<p>List all relevant treatment measures for each corresponding work activity. As a minimum listed measures must:</p> <ul style="list-style-type: none"> • Ensure ERSED controls are maintained and remain effective • Ensure rehabilitation, stabilisation and restoration work are undertaken as early as possible • Ensure vegetative rehabilitation is protected from erosion and weed infestation until established • Ensure ERSED controls are in place until area stabilised or revegetated as required following completion of works to address erosion and sediment control risks and to prevent pollution of waters. 	
<p>7</p>	<p>Records and documentation</p>	<p>Records insufficient to demonstrate compliance</p>		<p>List all relevant treatment measures for each corresponding documentation compliance activity.</p>	

Appendix A: Standard Drawings

**NEW ONLINE CULVERT
(PREFERABLY AS "EARLY WORKS")**



**SWMP – ONLINE CULVERT CONSTRUCTION
AND CREEK STABILISATION WORKS**

NEW ONLINE CULVERT – CONSTRUCTION NOTES

THESE STEPS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW.

- Stage 1: Temporary Channel Construction
 - Establish diversion drains for off-site water.
 - Construct and line the temporary channel including rock armouring at the existing creek and temporary channel junctions.
 - Construct and line temporary earth bunds.
 - Divert creek flows into this channel. Work downstream to upstream.
- Stage 2: Culvert Construction Works
 - Construct the new culvert including the stabilised culvert inlet and outlets.
 - Stabilise the culvert construction works area once culvert construction works are complete.
- Stage 3: Final diversion and Rehabilitation Works
 - Divert creek flows into new culvert.
 - Temporary channel and bunds to be decommissioned without allowing sediment downstream to creek and the disturbed area stabilised.
 - Diversion drains for off-site water can be redirected to inlet of new culvert on upstream site or can be removed and rehabilitated.

OTHER NOTES

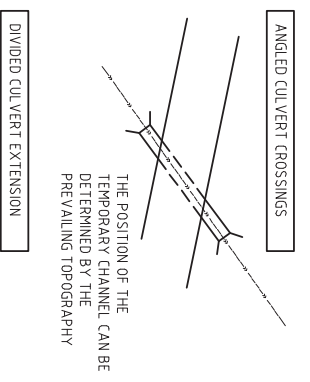
- This design assumes that culvert construction is part of the early works for the site.
- Temporary channel to be sized and lined as per the requirements in Table 6.1 (DEC, 2008) and Table 5.2 (Landcom, 2004).
- Ideally schedule works to periods when rainfall erosivity is low (Refer to Table 4.3 – Landcom, 2004).
- Only undertake in-stream works (e.g. placement of rock) during periods of zero or very low flow and only when the 24 hour weather forecast suggests a significant rain event is not likely.
- Ensure suitable temporary groundcover materials (e.g. geotabric or black plastic) are located on site for rapid stabilisation of exposed soils within in-stream locations if an unexpected rain or flow event occurs.
- No culvert works are to occur until creek flows are successfully diverted into the stabilised temporary channel.
- Culverts are to be completed before being allowed to convey flows. This includes all inlet and outlet protection, wingwalls etc.
- Stabilisation as defined by the Blue Book means achieving:
 - For concentrated flows – At least 70% vegetation cover (or equivalent) within 10 days AND using only materials that are suitable in concentrated flow conditions (refer to Tables A3 and D1 in the Blue Book for suitability).
 - For all other areas – At least 60% vegetation cover (or equivalent) in 20 days AND 70% in 2 months.
- A management regime should be in place to address the risk of these works creating a flooding issue due to construction of the channel during construction.
- If temporary access is required across the existing creek or a diversion channel, use a temporary water crossing - see standard drawing 5-1 in Blue Book Vol 1 (Landcom, 2004).
- Minimise the time that soil is exposed to erosion.

STANDARD DRAWINGS FROM VOL. 1 OF THE BLUE BOOK (LANDCOM, 2004) USED HERE:

- Sediment fence SD 6-8
- High flow earth bank (diversion drain) SD 5-6
- Energy dissipater SD 5-8
- Temporary waterway crossing SD 5-1

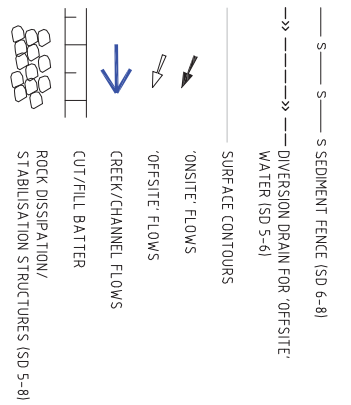
AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

THIS SCENARIO ALSO APPLIES TO:



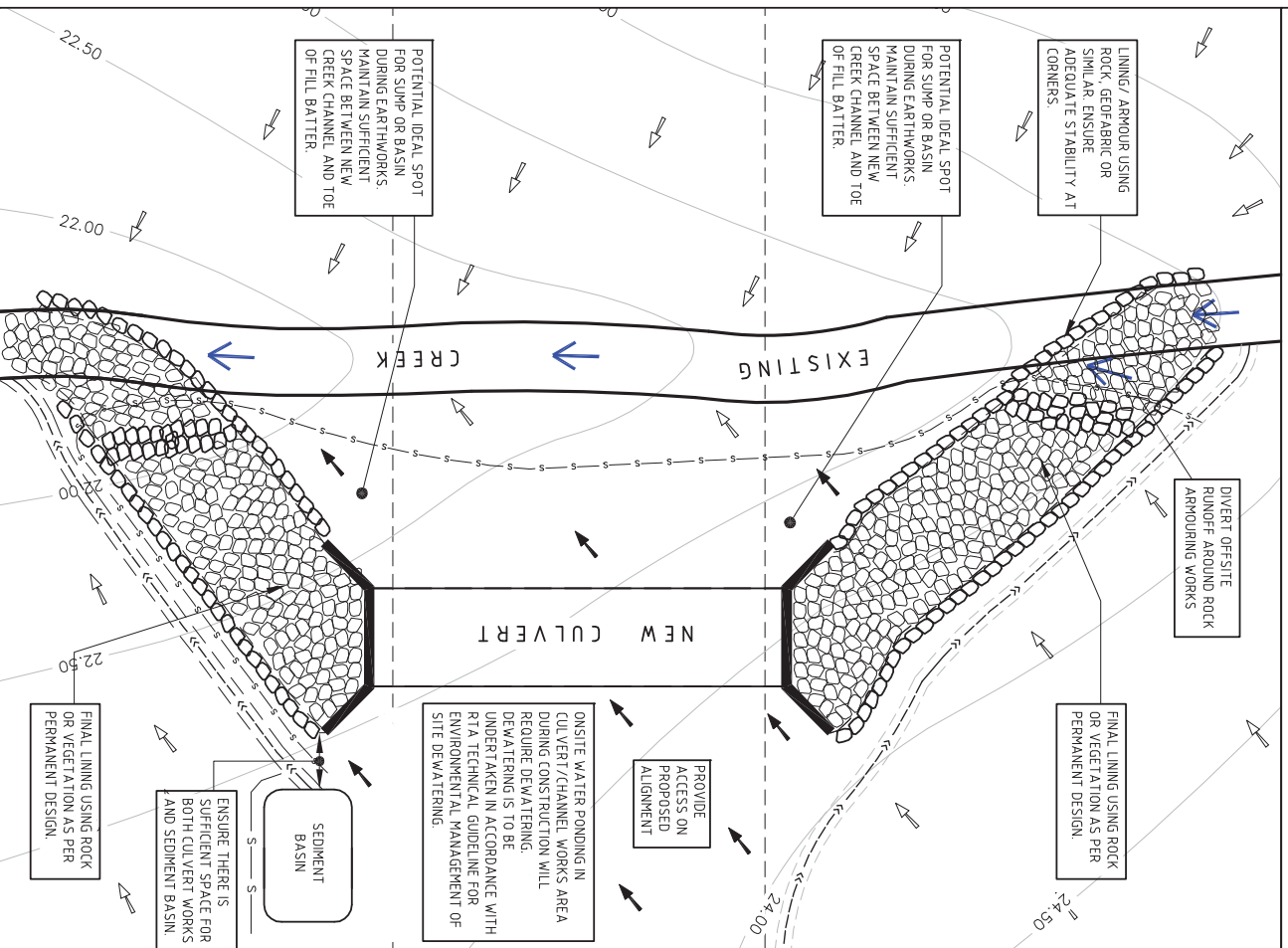
THE APPLICATION OF THIS SCENARIO TO DIVIDED CULVERT EXTENSIONS IS DEPENDENT ON WHETHER THERE IS ENOUGH AVAILABLE SPACE. IF SPACE IS LIMITED PART OF THE TEMPORARY CHANNEL CAN BE CONSTRUCTED OUT OF SHEET PILING OR SIMILAR OR ALTERNATIVELY THE SITE SHOULD BE STABILISED AS FOR A CONTINUOUS ONLINE CULVERT EXTENSION

LEGEND



NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

NEW OFFLINE CULVERT (PREFERABLY AS "EARLY WORKS")



NEW OFFLINE CULVERT - CONSTRUCTION NOTES

THESE STEPS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW.

- Stage 1: Site Preparation Works
 - Establish diversion drains for off-site water.
 - Install berms to block off new channel and ensure all works remain offline from the existing creek.
- Stage 2: Culvert Construction Works
 - Construct the new culvert including the stabilised culvert inlet and outlets.
 - Stabilise the culvert construction works area.
- Stage 3: Final Diversion and Rehabilitation Works
 - Install in-stream (on-line) rock armouring at the locations where flows are turned into and out of the new channel.
 - Remove berms used to block off new channel during construction works starting at downstream end.
 - Divert creek flows into new culvert.
 - Disturbed area to be stabilised.

STANDARD DRAWINGS FROM VOL. 1 OF THE BLUE BOOK (LANDCOM, 2004) USED HERE:

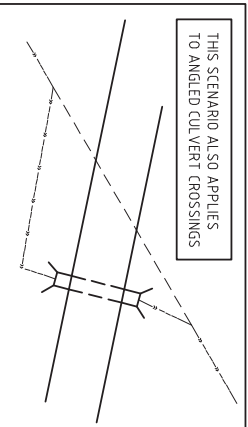
- Sediment fence: SD 6-8
- High flow earth bank (diversion drain): SD 5-6
- Energy dissipater: SD 5-8
- Temporary waterway crossing: SD 5-1

OTHER NOTES

- This design assumes that culvert construction is part of the 'early works' for the site.
- Ideally schedule works to periods when rainfall erosivity is low (Refer to Table 4.3 - Landcom, 2004).
- Only undertake in-stream works (e.g. placement of rock) during periods of zero or very low flow and only when the 24-hour weather forecast suggests a significant rain event is not likely.
- Ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils within in-stream locations if an unexpected rain or flow event occurs.
- Culverts are to be completed before being allowed to convey flows. This includes all inlet and outlet protection, wingwalls etc.
- Stabilisation, as defined by the Blue Book, means achieving:
 - For concentrated flows - At least 70% vegetation cover (or equivalent) within 10 days AND using only materials that are suitable in concentrated flow conditions (refer to Tables A3 and D1 in the Blue Book for suitability).
 - For all other areas - At least 60% vegetation cover (or equivalent) in 20 days AND 70% in 2 months.
- If temporary access is required across the existing creek or a diversion channel, use a temporary water crossing (see standard drawing U14).
- Minimise the time that soil is exposed to erosion.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

THIS SCENARIO ALSO APPLIES TO ANGLED CULVERT CROSSINGS



LEGEND

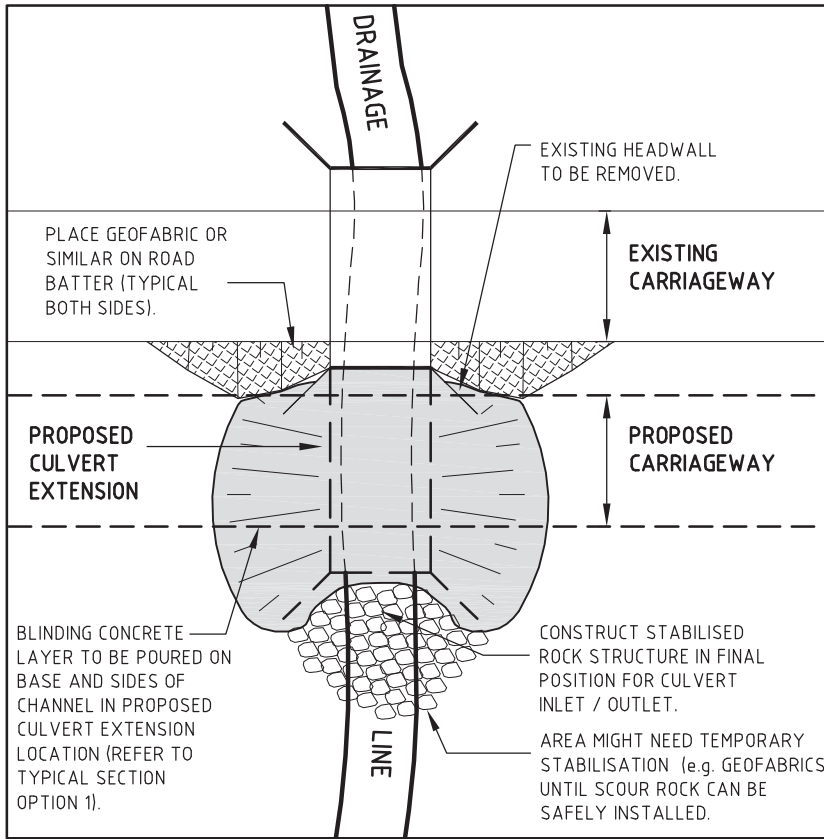
- S — S — SEDIMENT FENCE (SD 6-8)
- >>>—>>>— DIVERSION DRAIN FOR OFFSITE WATER (SD 5-6)
- SURFACE CONTOURS
- ON-SITE FLOWS
- OFFSITE FLOWS
- CREEK/CHANNEL FLOWS
- CUT/FILL BATTER
- ROCK DISPERSION/STABILISATION STRUCTURES (SD 5-8)
- DIVERSION BERMS (e.g. SANDBAG WALLS, LINED EARTH BOUNDS, ROCK)

NOTE THAT NOT ALL ON-SITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

SWMP - OFFLINE CULVERT CONSTRUCTION AND CREEK STABILISATION WORKS

CONTINUOUS CULVERT EXTENSION (ONLINE)

OPTION 1



SITE STABILISATION PROCEDURE

OTHER NOTES

- For divided culvert extensions this stabilisation method could also be applied or alternatively the flows could be diverted as for a new online culvert.
- Note that this method is not suitable for perennial creeks unless additional measures (e.g. pumping or coffer dams) can be reliably included as well.
- This method might not be appropriate where there is a significant depth of unsuitable soil material to be removed.
- For systems with very minor flows in dry periods, temporary damming of flows might be required to hold water back for the nominated work period until the blinding concrete layer and rock is placed.
- Note that not all onsite water management and sediment controls are shown here.

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Prior to undertaking any construction or earthworks ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils if an unexpected rain or flow event occurs.

1. Watch the weather forecast for a dry period (a period longer than the time required to complete earthworks up to the required level).
2. When a dry period is forecast, undertake earthworks quickly (preferably in less than three days).
3. Pour blinding concrete layer and lay rock inlet / outlet.
4. Lay geofabric (or similar) on existing road batter.

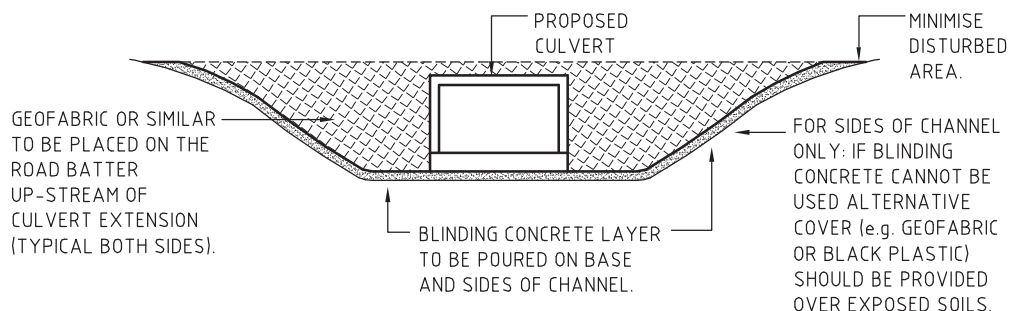
(Ensure steps 2, 3 and 4 occur within the forecast period of dry weather and no flow)

5. Complete culvert construction works over the top of the blinding concrete layer.
6. Maintain the blinding layer until the culvert extension is complete and stabilised. once flows are secure within the new culverts, excess blinding can be removed if desired.

At any time during steps 1 – 4 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

ENSURE THAT 'OFFSITE' CREEK FLOWS DO NOT COME INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

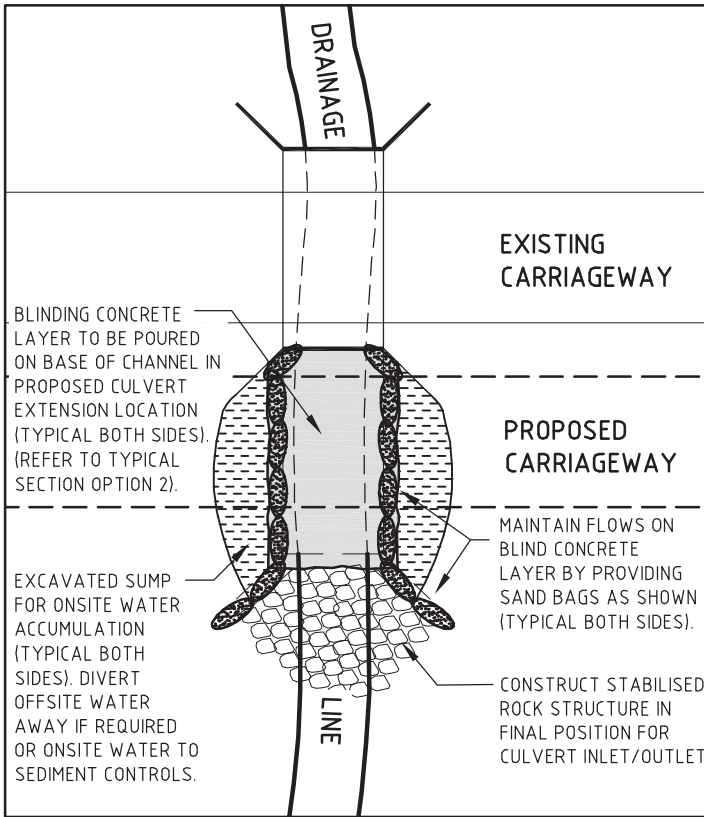
NOTE: MAINTAIN OR INSTALL TEMPORARY GROUND COVER THROUGH FLOW AREA ANYTIME FLOWS ARE IMMINENT.



TYPICAL SECTION – OPTION 1

CONTINUOUS CULVERT EXTENSION (ONLINE)

OPTION 2



SITE STABILISATION PROCEDURE

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Prior to undertaking any construction or earthworks ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils if an unexpected rain or flow event occurs.

1. Watch the weather forecast for a dry period (a period longer than the time required to complete earthworks up to the required level).
2. When a dry period is forecast, undertake earthworks quickly (preferably in less than three days).
3. Pour blinding concrete layer and lay rock inlet / outlet.
4. Position sand bags on the blind concrete layer.

(Ensure steps 2, 3 and 4 occur within the forecast period of dry weather and no flow)

5. Complete culvert construction works over the top of the blinding concrete layer. Take care not to disturb the integrity of the blinding layer.
6. Maintain the sandbag walls on the base slab if a flow event occurs.

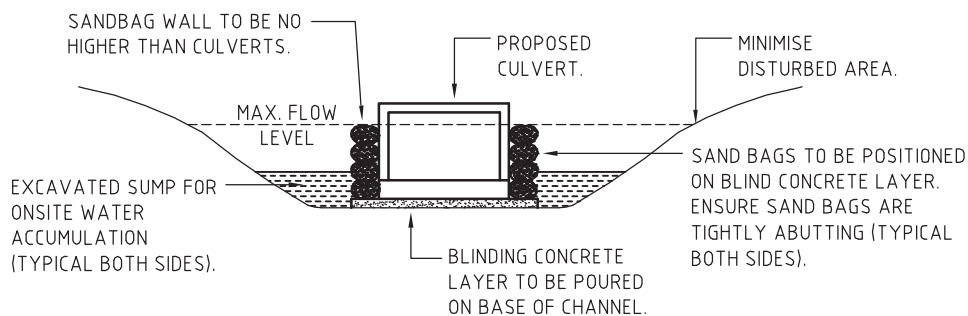
At any time during steps 1 – 4 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

OTHER NOTES

- For divided culvert extensions this stabilisation method could also be applied or alternatively the flows could be diverted as for a new online culvert.
- Note that this method is not suitable for perennial creeks unless additional measures (e.g. pumping or coffer dams) can be reliably included as well.
- This method might not be appropriate where there is a significant depth of unsuitable soil material to be removed.
- For systems with very minor flows in dry periods, temporary damming of flows might be required to hold water back for the nominated work period until the blinding concrete layer and rock is placed.
- Note that not all onsite water management measures and sediment controls are shown here.

ENSURE THAT 'OFFSITE' CREEK FLOWS DO NOT COME INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

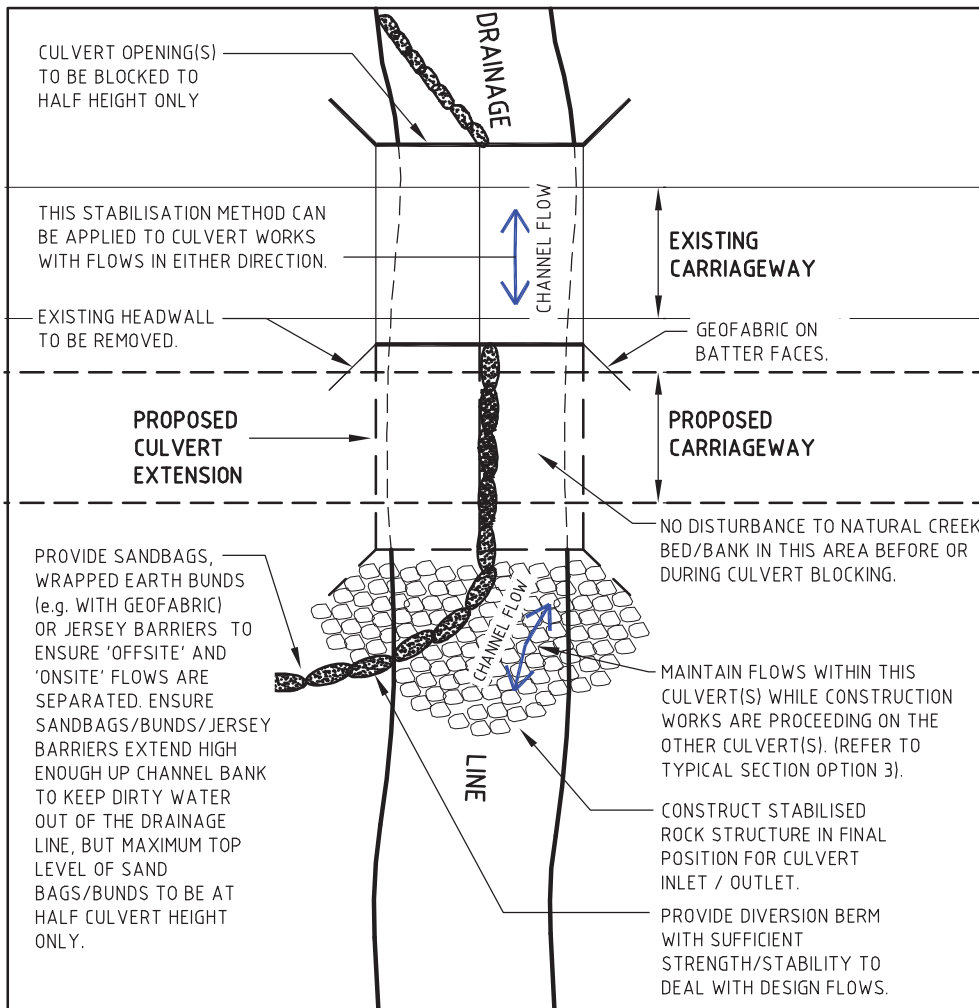
NOTE: MAINTAIN OR INSTALL TEMPORARY GROUND COVER THROUGH FLOW AREA ANYTIME FLOWS ARE IMMINENT.



TYPICAL SECTION – OPTION 2

CONTINUOUS CULVERT EXTENSION (ONLINE)

OPTION 3



OTHER NOTES

- This option will only work when existing ground surface level can be maintained in at least one culvert cell. Therefore this method might not work for deep excavations requiring benching.
- Suitable for use in perennial streams providing in-stream works are conducted when flows are minimal.
- However, regardless of scheduling and timing the adopted controls need to be considerate of the risk of significant flows at any time.
- Note that not all water management and sediment controls are shown here.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

SITE STABILISATION PROCEDURE

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Prior to undertaking any construction or earthworks ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils if an unexpected rain or flow event occurs.

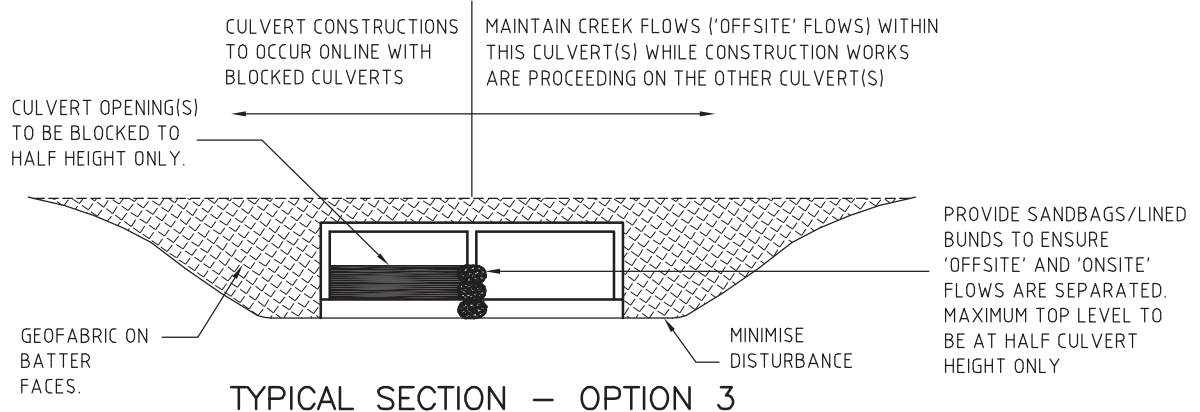
Stage 1.

1. Monitor creek flows ensuring flows levels are not too high.
2. Position sandbags/bunds around culvert works area and block existing culvert end to half culvert height only.
3. Undertake culvert extension construction works only on the blocked side of the culvert(s).
4. Complete inlet/outlet protections.

Stage 2

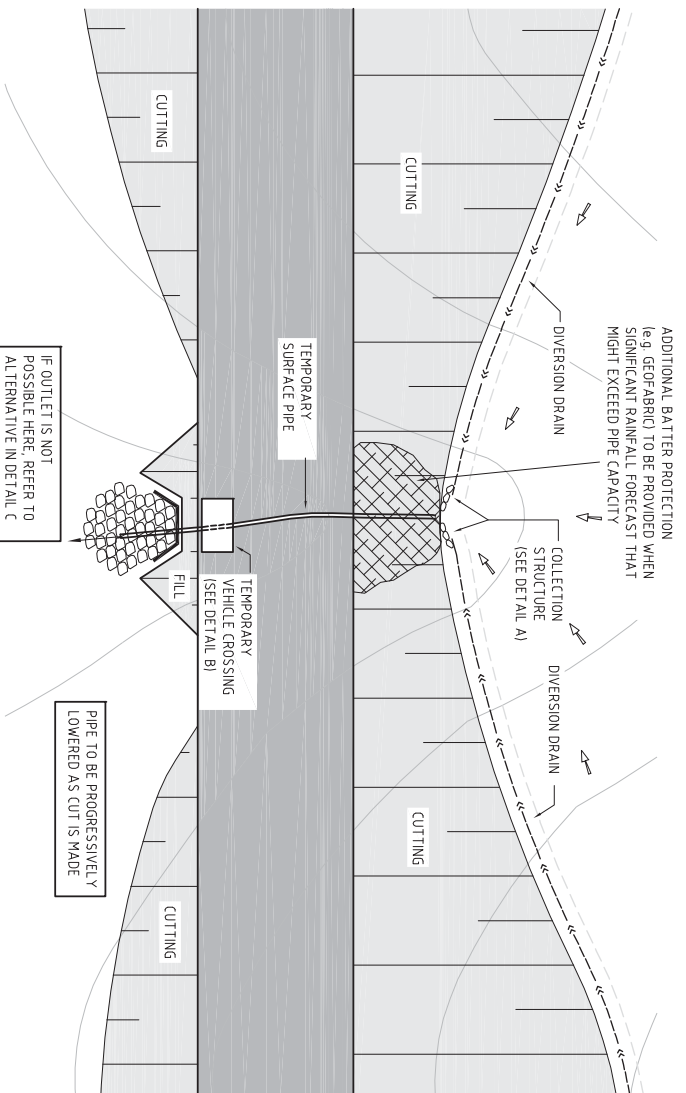
5. Divert the creek flows into the newly constructed culvert extension by blocking off the alternate side using a half-height wall/bund.
6. Complete the culvert extension on the other side including the stabilised inlet/outlet.

At any time where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

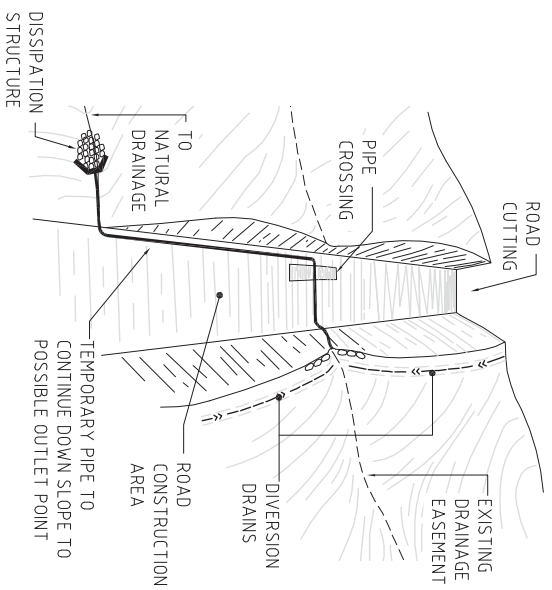


TYPICAL SECTION – OPTION 3

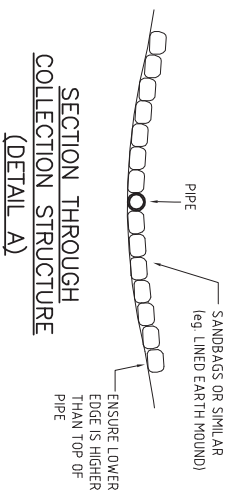
TEMPORARY 'OFFSITE' WATER CONTROLS FOR CONSTRUCTION WORKS IN ROAD CUTTINGS



- CONSTRUCTION NOTES**
1. Permanent diversion drains are to be used as 'offsite' diversion drains during construction works.
 2. Ensure there is continuous fall on the temporary flexible pipe (or temporary sacrificial pipe).
 3. The temporary pipe is to be progressively lowered as the cut is made.
 4. It is not essential that the temporary pipe follows the invert of the depression, however, fall on the pipe must be maintained.
 5. The inlet and outlets of the temporary pipe are to be stabilised. They are to be located beyond the limit of works to ensure no onsite runoff is captured.
 6. The collection structure used to direct 'offsite' flows into the temporary pipe is to be construction out of either rock or lined earth berms.
- OTHER NOTES**
7. This drawing only illustrates 'offsite' water controls. 'Onsite' water management controls will also be required.



AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ON-SITE' WATER



LEGEND

- - - - - DIVERSION DRAIN FOR 'OFFSITE' WATER (SD 5-6)
- SURFACE CONTOURS
- 'OFFSITE' FLOWS
- ROCK STABILISED OUTLET (SD 5-8)
- CUT / FILL BATTER

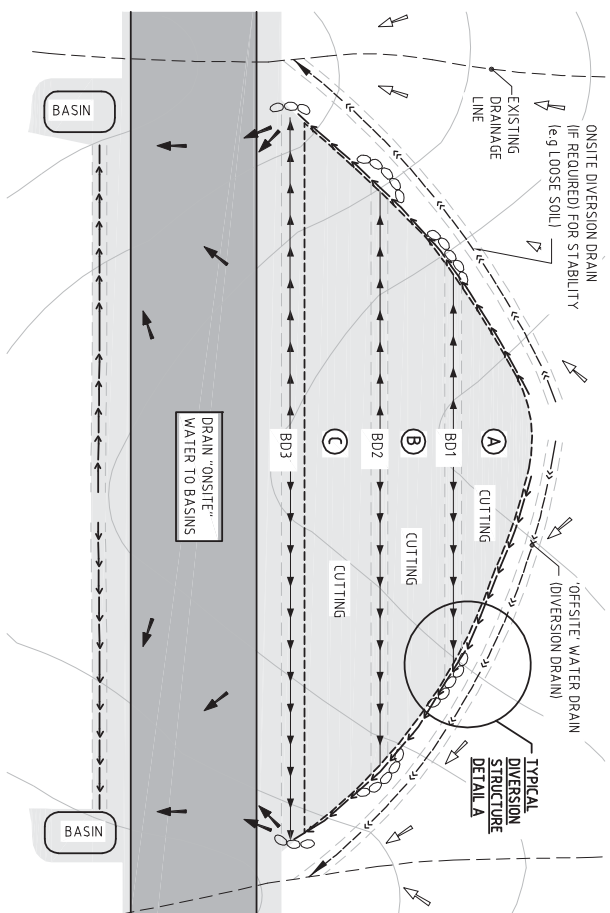
NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

TYPICAL PIPE CROSSING DETAILS (DETAIL B)

OPTIONS INCLUDE:

1. TRENCH PIPE AT CROSSING POINT
2. PRE-FABRICATED RAMP
3. TEMPORARY RUBBLE CROSSING

TEMPORARY WATER MANAGEMENT ON A ROADSIDE CUTTING



- GENERAL NOTES**
1. Progressive stabilisation of batters is essential. Each section of the batter should be shaped, topped, and rehabilitated before proceeding to the next section.
 2. Permanent cut off drains used as 'offsite' drains during construction works.
 3. Take care with mixing flows from 'offsite' (cut off) drains with flows from berm drains ('onsite' water) until upslope batter is vegetated. Diversion structures should be used to ensure this (refer to 'Typical Diversion Structure Detail A').

4. All 'onsite' water is to drain to a sediment trap/basin.
5. Outer 'offsite' water drains to existing drainage line or culvert.
6. A suitable 'offsite' water management system is to be used for conveying 'offsite' flows from the drainage line through the worksite.
7. Note that not all onsite water management and sediment controls are shown here.

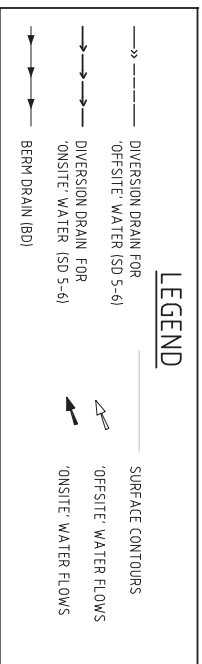
CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

1. Permanent diversion drains ('offsite' water drains) to be established.
2. Earthworks on upper section of cutting (i.e. section A) to be undertaken including construction of BDI.
3. Construction of BDI must include diversion structures as per Phase 1 detail.
4. Section A should be stabilised as per Phase 2 detail.
5. Once section A is successfully stabilised (i.e. at least 60% ground cover has been achieved, BDI can be connected to the cut 'off drain as per Phase 3 detail.
6. Earthworks can now proceed on the next section down (i.e. section B) and the process above (2 to 4) should be again carried out.
7. This process should continue for the entire cutting (i.e. section C and any lower sections if present).

PROGRESSIVE STABILISATION OF BATTERS IS ESSENTIAL. EACH SECTION OF THE BATTER SHOULD BE SHAPED, TOPSOILED, AND REHABILITATED BEFORE PROCEEDING TO THE NEXT SECTION.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER.

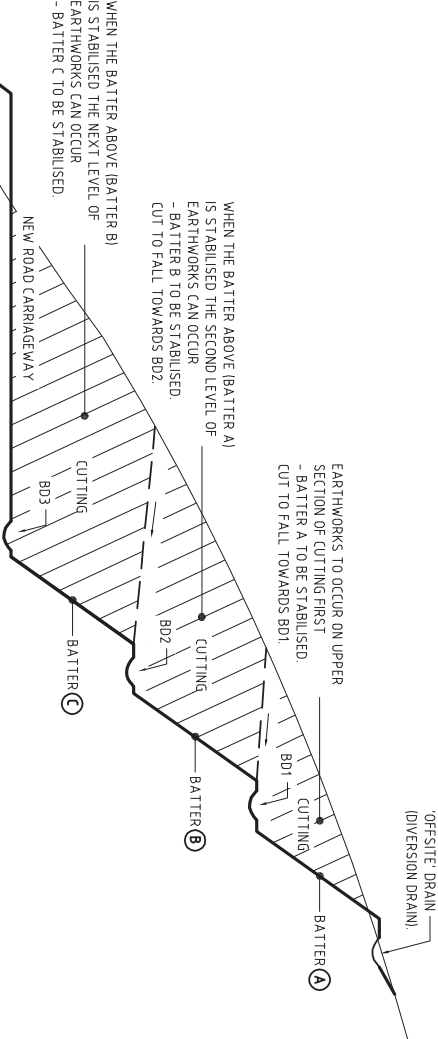


EARTHWORKS TO OCCUR ON UPPER SECTION OF CUTTING FIRST - BATTER A TO BE STABILISED. CUT TO FALL TOWARDS BDI.

WHEN THE BATTER ABOVE (BATTER A) IS STABILISED THE SECOND LEVEL OF EARTHWORKS CAN OCCUR - BATTER B TO BE STABILISED. CUT TO FALL TOWARDS BDI.

WHEN THE BATTER ABOVE (BATTER B) IS STABILISED THE NEXT LEVEL OF EARTHWORKS CAN OCCUR - BATTER C TO BE STABILISED.

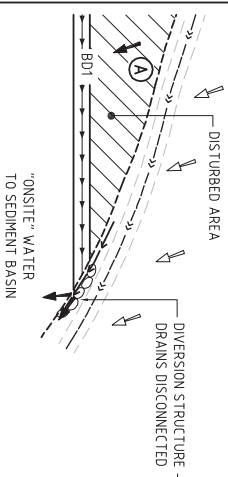
TYPICAL SECTION THROUGH ROADSIDE CUTTING



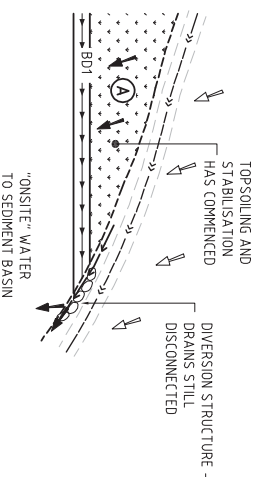
Stabilisation means achieving:

- For concentrated flows - At least 70% vegetation cover (or equivalent) within 10 days AND using only materials that are suitable in concentrated flow conditions (refer to Tables A3 and D1 in the Blue Book for suitability).
- For all other areas - At least 60% vegetation cover (or equivalent) in 20 days AND 70% in 2 months.

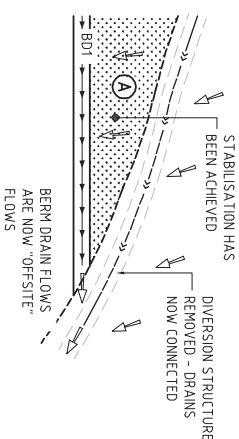
TYPICAL DIVERSION STRUCTURE DETAIL A



PHASE 1: EARTHWORKS

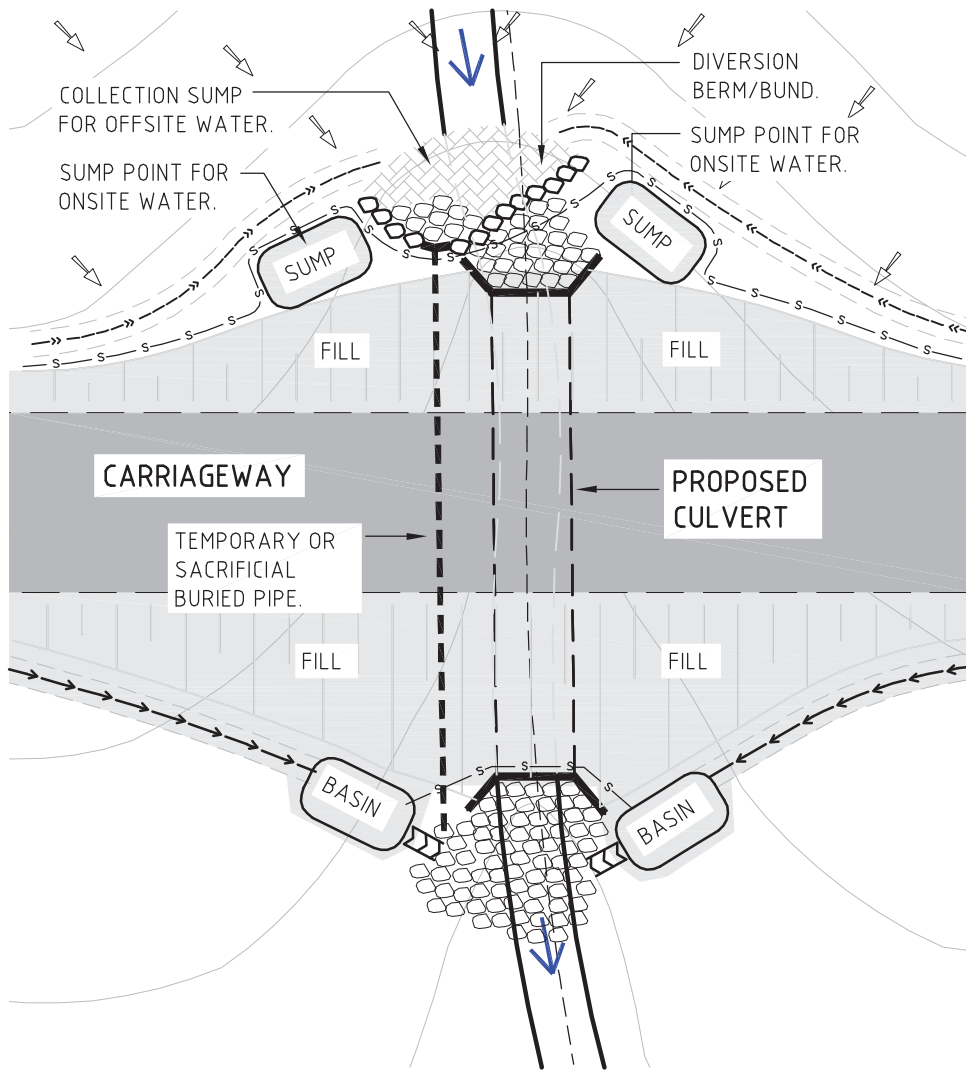


PHASE 2: COMMENCE STABILISING AREA A



PHASE 3: AREA A STABILISED

TEMPORARY WATER MANAGEMENT OF ROAD WORKS POSITIONED IN DEPRESSION



- THIS SCENARIO IS ONLY APPLICABLE FOR DEPRESSIONS AND INTERMITTENT SMALL CREEKS NOT FOR PERENNIAL OR LARGER SYSTEMS.
- AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER.
- ADDITIONAL BATTER PROTECTION (e.g GEOFABRIC) TO BE PROVIDED WHEN SIGNIFICANT RAINFALL FORECAST THAT MIGHT EXCEED PIPE CAPACITY.

LEGEND

- >--- OFFSITE WATER DIVERSION DRAIN (SD 5-6)
- >--- ONSITE WATER DRAINS (SD 5-6)
- SURFACE CONTOURS
- ⊗ ROCK STABILISED OUTLET (SD)
- ⊥ CUT/FILL BATTER
- ⊖ DIVERSION BERM (SD)
- CREEK/PIPE FLOW ROUTE
- ⊗ AREA TO BE LINED
- ⊏ SPILLWAY
- s— SEDIMENT FENCE (SD 6-8)

CONSTRUCTION NOTES

THESE STEPS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW.

Stage 1: Establish Temporary Diversion

1. Monitor creek flows ensuring flow levels are not too high.
2. Establish diversion drains for offsite water.
3. Position the temporary pipe and construct the stabilised inlet and outlets for this pipe.
4. Establish the diversion berm (including lining where applicable) to direct water into the temporary pipe.
5. Line the collection sump up to the height of the top pipe level.
6. Flows to be diverted into the temporary pipe. This is to take place prior to undertaking any bulk earthworks, stripping or culvert constructions.

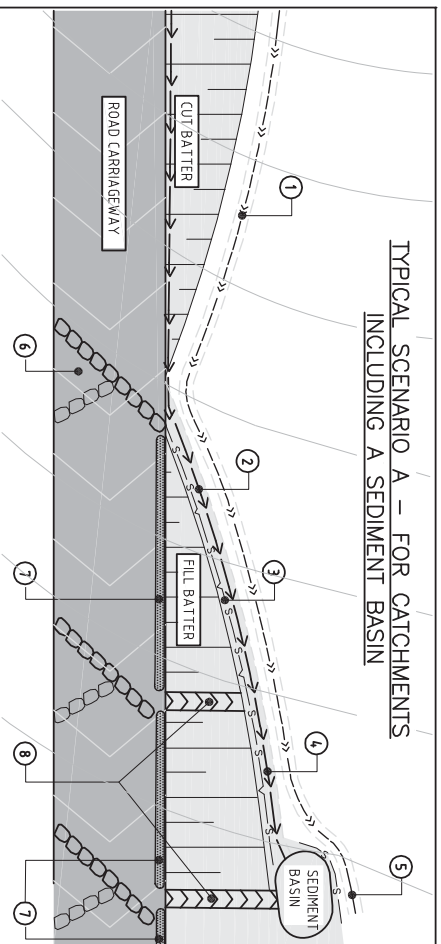
Stage 2: Culvert Construction Works

7. Prior to undertaking any stripping, earthworks or culvert construction works, 'onsite' soil and water management controls are to be established.
8. Complete bulk earthworks and construct the new culvert including the stabilised culvert inlet and outlets.
9. Once the bulk earthworks and the culvert constructions including stabilisation of culvert inlet / outlets have been completed, creek flows can be diverted into new culvert and temporary pipe removed or capped / sealed.

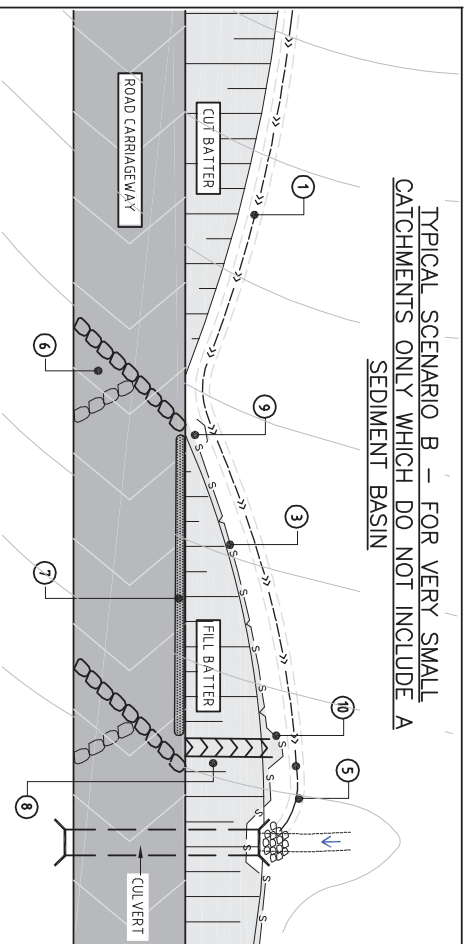
GENERAL NOTES

- An offset pipe is to be used where depressions are to be filled before culvert works (eg. to provide access during bulk earthworks).
- Ensure offsite flows are diverted into the temporary pipe prior to undertaking any stripping, bulk earthworks or culvert construction works.
- Include seepage collars on the temporary pipe.
- Temporary pipes are to include seepage collars.
- Water will pool in the collection sump up to the level of the temporary pipe invert. The area of the collection sump up to the height of the top of pipe level should be lined with rock, geofabric, plastic or similar (NOT BARE SOIL).
- The inlet and outlets of the temporary pipe are to be stabilised with rock.
- The diversion berms used to direct 'offsite' flows into the temporary pipe are to be constructed out of either rock or lined earth berms.
- Where sediment basins are not possible to construct in steep locations with space restrictions an alternative sediment device must be implemented (i.e. a sediment trap made out of sediment fence, sandbags or lined earth bunding). This is only suitable in very small catchments.
- Creek flows can only be re-diverted into the new culvert once culvert constructions have been completed and the culvert inlet and outlets have been rock lined and stabilised.
- If required, temporary pipes can be left in place after culvert works are completed.
- If temporary pipes are to remain in place, drain them, then cap or seal them to minimise the risk of water ingress.
- Note that not all onsite water management and sediment controls are shown here.

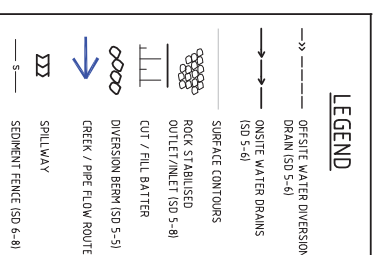
CUT / FILL BATTER WATER MANAGEMENT



TYPICAL SCENARIO A – FOR CATCHMENTS INCLUDING A SEDIMENT BASIN



TYPICAL SCENARIO B – FOR VERY SMALL CATCHMENTS ONLY WHICH DO NOT INCLUDE A SEDIMENT BASIN



CONSTRUCTION NOTES

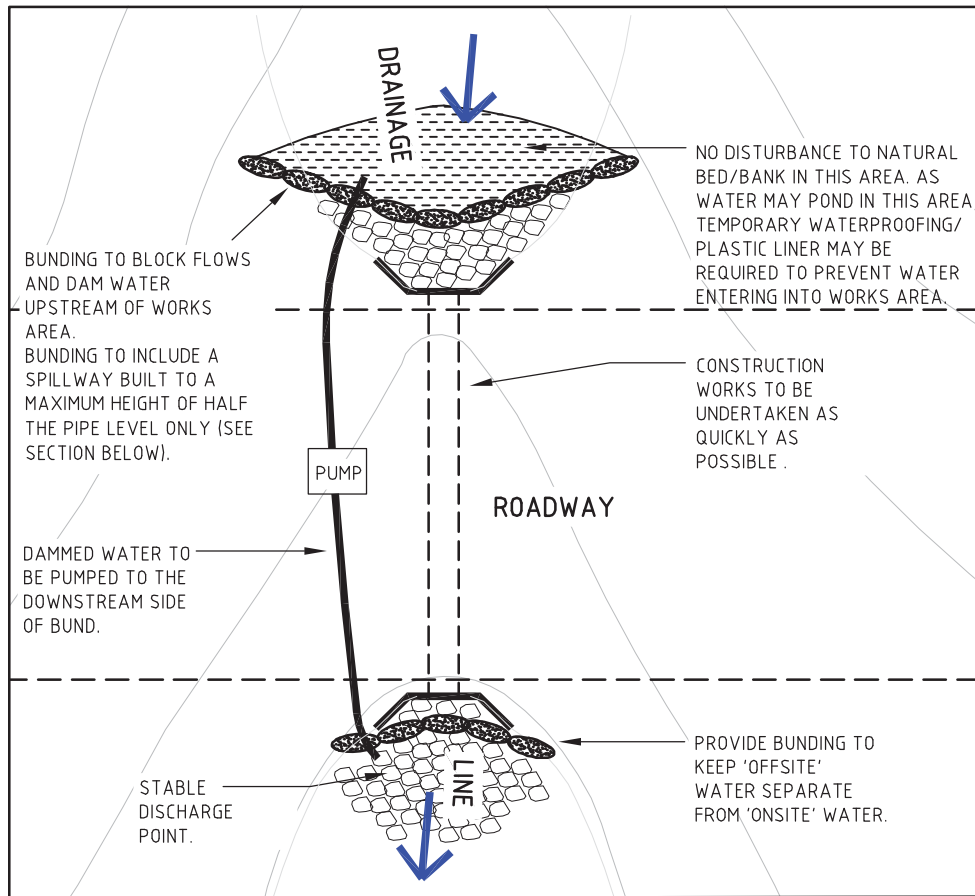
THE FOLLOWING WORKS ARE TO BE UNDERTAKEN AS SHOWN ON THE RELEVANT DIAGRAMS

- Lined permanent diversion drains to be used as 'offsite' water drains during construction. Must convey water all the way to a watercourse or depression and onto a stabilised outlet point.
- Provide sufficient room between toe of fill and 'offsite' water drain for management of 'onsite' water. 'Onsite' water diversion (temporary drain) - to drain to sediment basin.
- Sediment fence at toe of batter. Include returns at 20m intervals.
- 'Onsite' water diversion (temporary drain) - to drain to sediment basin.
- Ensure 'offsite' water drain extends all the way to drainage line and onto a stabilised outlet point.
- Use earth bank or sandbags to divert runoff at cut / fill line to onsite drain or sediment trap. Do not mix with 'offsite' water in cut-off drain. Use arrowhead shape if water is being shed from both sides of formation. It is only required at end of day or when rain is imminent.
- Earth or sandbag windrow for directing water into drop-down flume. To be installed at end of day or when rain is imminent.
- Lined drop-down chute to carry 'onsite' water to basin or trap. Only required when rain is imminent.
- Install sediment trap at cut/fill line if runoff is not flowing to a basin.
- Install sediment trap at base of drop-down flume if runoff is not flowing to a basin. This can simply be formed as a section of the sediment fence with returns both sides.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

ONLINE PIPE REPLACEMENT/INSTALLATION – SMALL INTERMITTENT DEPRESSIONS ONLY (PUMP OPTION)



SITE STABILISATION

THIS METHOD IS ONLY SUITABLE FOR SIMPLE DEPRESSIONS WITH INTERMITTENT FLOWS. TO BE IN PLACE FOR NO MORE THAN 3 MONTHS.

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

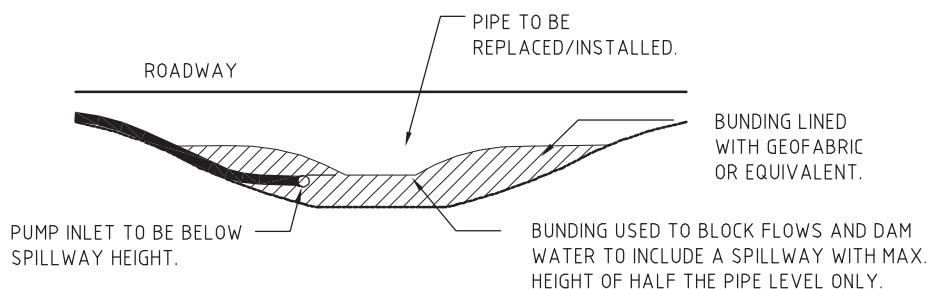
1. Ensure suitable temporary groundcover materials (e.g. geofabric, blankets) are located on site.
2. Ensure a suitable pump is available.
3. Watch the weather forecast to ensure rainfall is not forecast and monitor creek flows ensuring flows are minimal.
4. Position the bunding and line if required.
5. Undertake construction works (including inlet and outlet stabilisation) as quickly as possible. Drainage line to be blocked for no more than 3 months.

At any time during steps 4 - 5 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

LEGEND

	OFFSITE WATER DIVERSION DRAIN (SD 5-6)
	ONSITE WATER DRAINS (SD 5-6)
	SURFACE CONTOURS
	ROCK STABILISED OUTLET (SD 5-8)
	CREEK/PIPE FLOW ROUTE
	SEDIMENT FENCE (SD 6-8)
	BUNDS

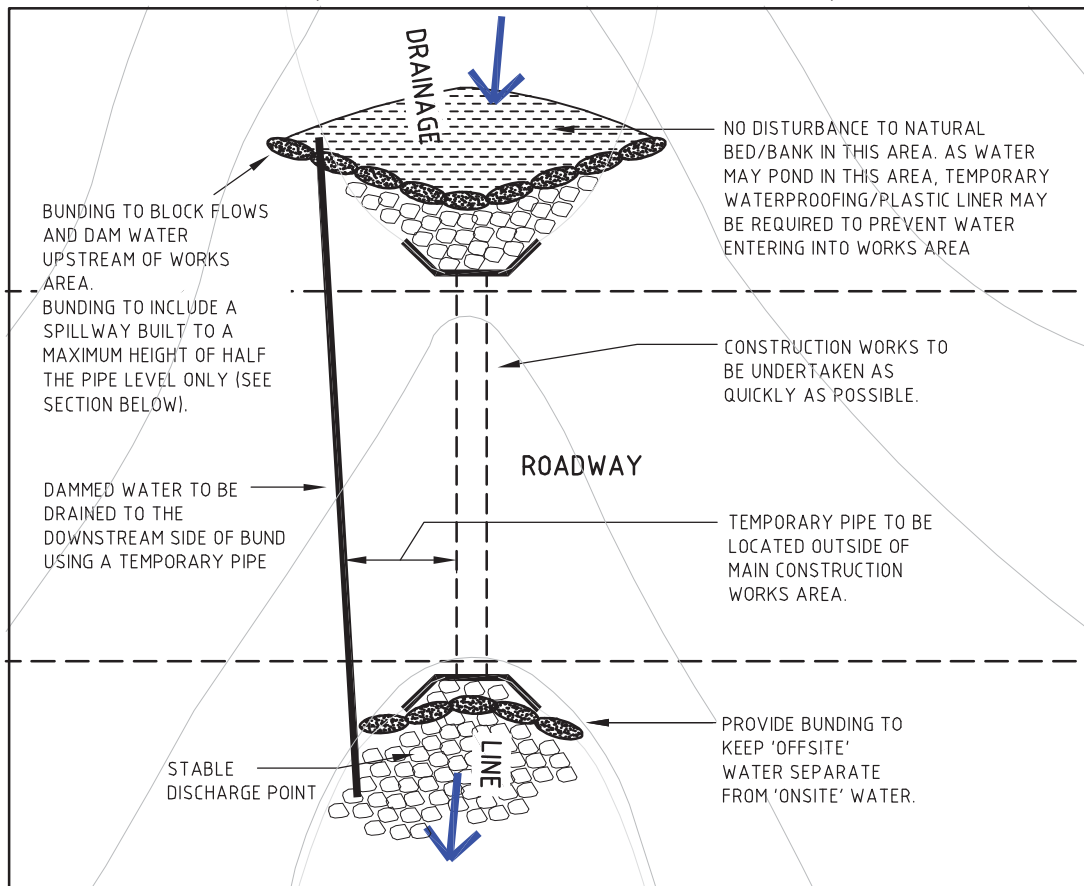
NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.



SECTION THROUGH BUNDING LOCATION

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

ONLINE PIPE REPLACEMENT/INSTALLATION – SMALL INTERMITTENT DRAINAGE LINES (TEMPORARY PIPE OPTION)



SITE STABILISATION

THIS METHOD IS ONLY SUITABLE FOR SMALL CHANNELS WITH INTERMITTENT FLOWS.

TEMPORARY PIPE TO BE SIZED TO AT LEAST HALF THE PERMANENT PIPE.

- e.g. - PERMANENT: 600 ϕ
- TEMPORARY: MINIMUM 300 ϕ

THIS METHOD (TEMPORARY PIPE SYSTEM) WILL NOT BE SUITABLE IN STEEP LOCATIONS WHERE TEMPORARY PIPE CANNOT BE LOCATED OUTSIDE OF WORKS AREA.

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

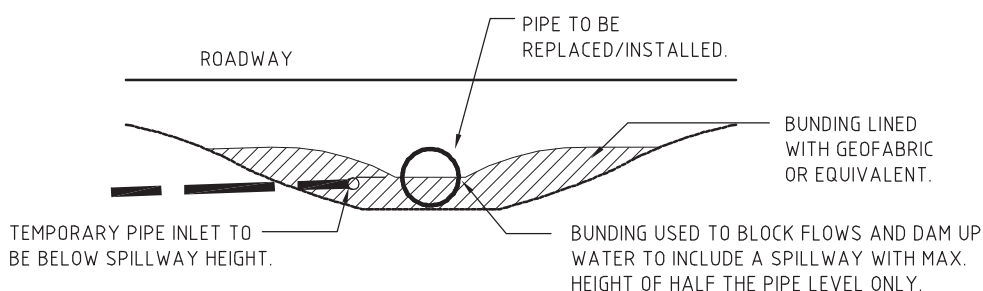
1. Ensure suitable temporary groundcover materials (eg. geofabric, blankets) are located on site.
2. Ensure a temporary pipe is available. Install temporary pipe to ensure flow, preferably by providing continuous fall.
3. Watch the weather forecast to ensure rainfall is not forecast and monitor creek flows ensuring flows are minimal.
4. Position the bunding within the channel to secure the site.
5. Undertake construction works (including inlet outlet stabilisation) as quickly as possible.

At any time during steps 4 - 5 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

LEGEND

- OFFSITE WATER DIVERSION DRAIN (SD 5-6)
- ONSITE WATER DRAINS (SD 5-6)
- SURFACE CONTOURS
- ROCK STABILISED OUTLET (SD 5-8)
- CREEK/PIPE FLOW ROUTE
- SEDIMENT FENCE (SD 6-8)
- BUNDS

NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.



SECTION THROUGH BUNDING LOCATION

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

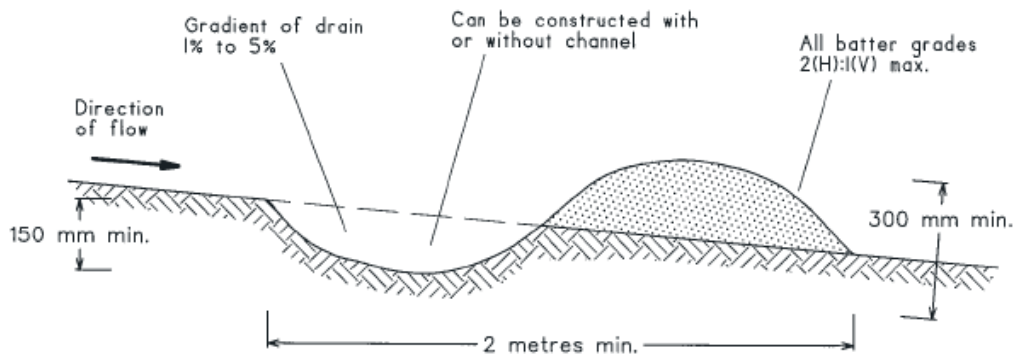
Appendix B: Additional Figures

Table 5.2 – Maximum Design Flow in Waterways (Landcom, 2004)

Material		Aggregate size (mm)		Critical velocity (m/second)
Type	Thickness (m)	120-250	100-200	
Gabions and reno mattresses	0.50	6.4	5.8	Assume that all soils with 10 percent or more dispersible fines have high erodibilities. Of those with less, soils with K-factors below 0.02 have low erodibilities, those between 0.02 and 0.045 have moderate erodibilities, while those above 0.045 have high erodibilities. In addition, the figures here assume slope gradients of less than 10 percent and, where appropriate, good (>80 percent) ground cover. If good ground cover is not expected to be maintained properly (might die back seasonally or during short periods of drought) and is critical to the system, reduce all velocities by 1.0 metre per second. Alternately, seek the manufacturer's advice if these conditions are unlikely to be met.
	0.50	5.8	5.0	
	0.30	4.2	3.6	
	0.25	3.6	3.5	
	0.17	3.5		
Loose rock (assume 100 percent soil cover)	Weight each (kg)	Turbulent flow	Normal flow	
	1,000	4.8	6.6	
	500	4.2	5.7	
	100	3.3	4.5	
Revetment mattresses	50	2.8	3.8	
	10	2.3	3.0	
	Form			
	Storm mattress	>6.0		
	200 mm fp 125 mm fp 100 mm fp	6.0 4.0 2.0		

Material	Critical velocity (m/second)					
	Inundation <6 hours		Inundation <12 hours		Inundation <24 hours	
	Low	Moderate	High	Low	Moderate	High
High performance bonded plastic fibres (vegetated)	7.0	7.0	7.0	6.0	6.0	6.0
Plastic fibres with netting	5.0	5.0	5.0	4.3	4.3	4.3
Mesh reinforced pregrown turf	3.0	2.7	2.4	2.6	2.3	2.0
Kiku yu	2.5	2.2	1.9	2.1	1.9	1.6
Jute or coir mesh (close weave, bitumen sprayed)	2.3	2.0	1.7	1.9	1.7	1.5
Coconut/ jute fibre mats	2.3	2.0	1.7	1.9	1.7	1.5
Couch , carpet grass , Rhodes grass , etc.	2.0	1.8	1.4	1.7	1.5	1.2
Bare soil	0.7	0.5	0.3	0.6	0.4	0.3

Standard Drawing 5-5 (Landcom, 2004)

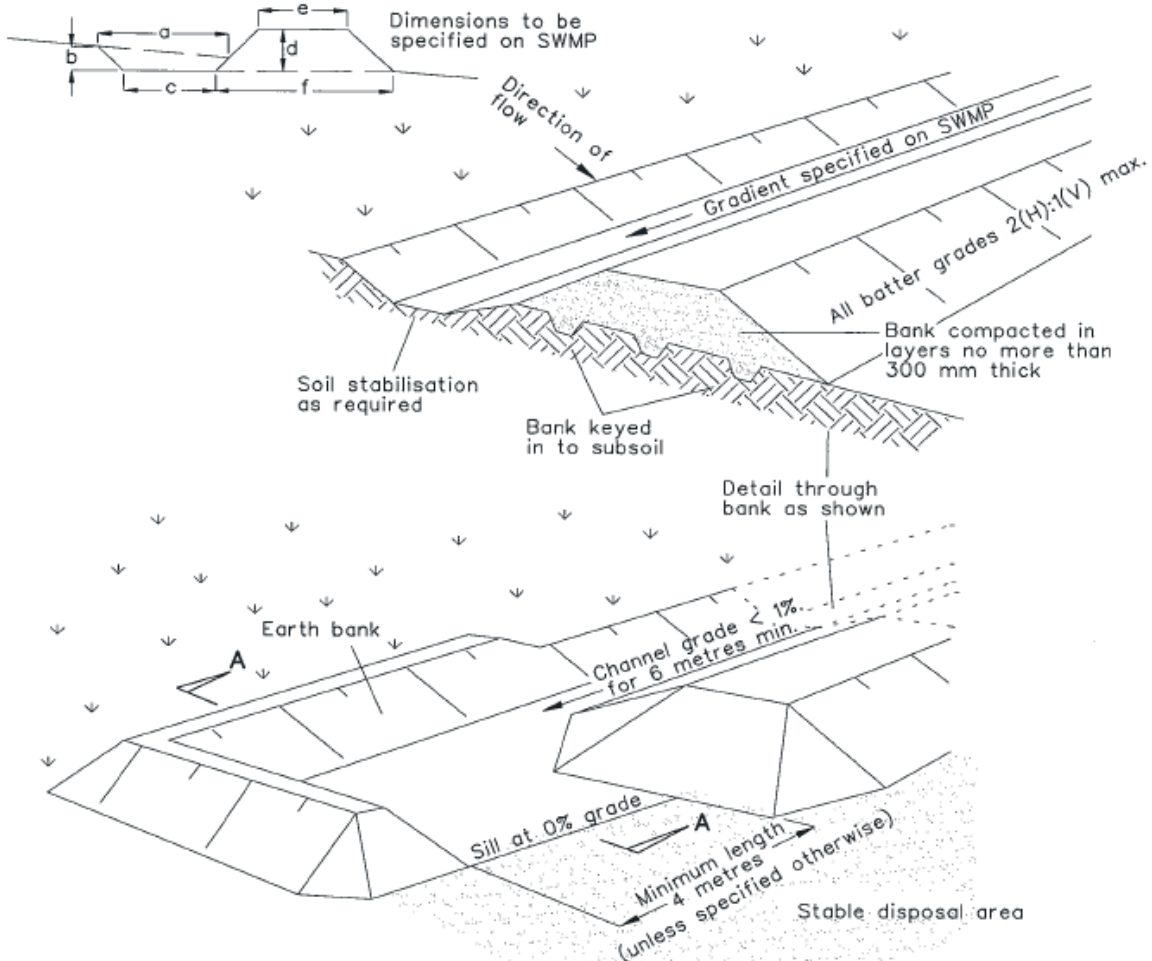


NOTE: Only to be used as temporary bank
where maximum upslope length is 80 metres.

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.

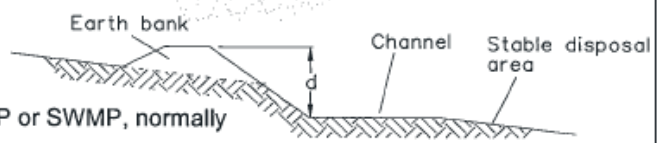
Standard Drawing 5-6 (Landcom, 2004)



Level Spreader (or Sill)

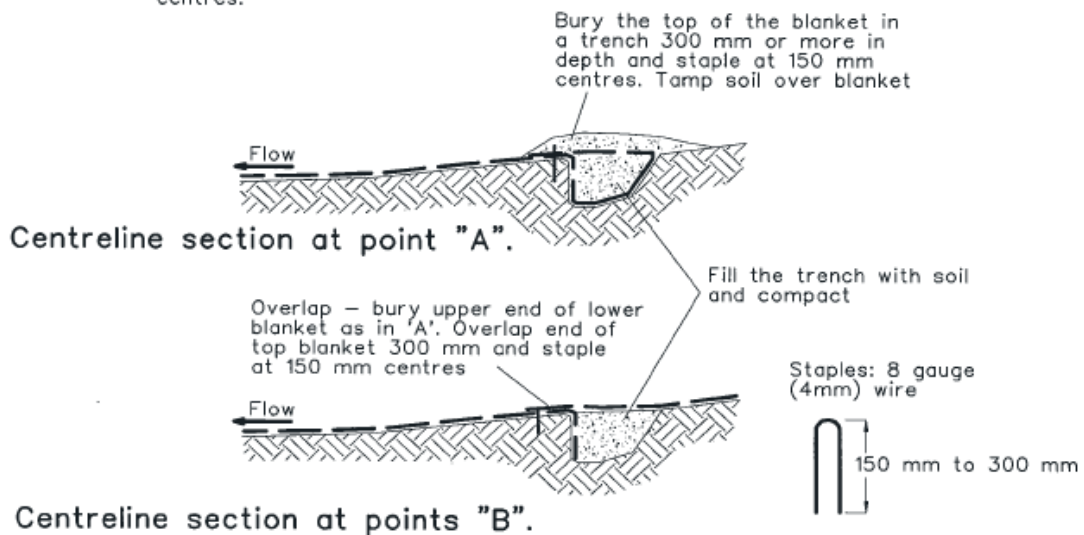
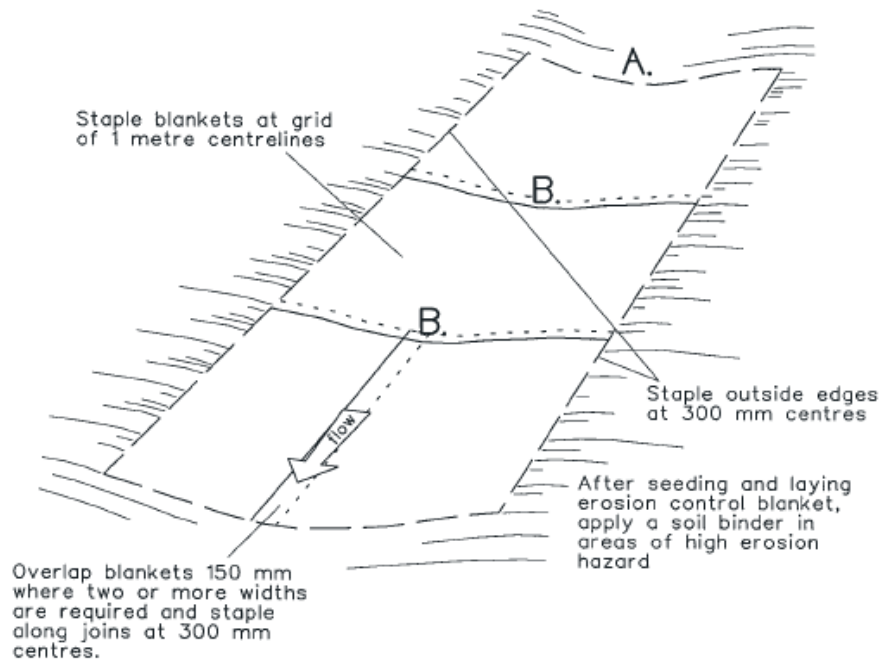
Construction Notes

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.



Section AA

Standard Drawing 5-7 (Landcom, 2004)



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.

Appendix C: Photographs of Temporary Clean Water Diversions on RMS Projects



Figure 1. A vegetated temporary clean water diversion traversing a work zone during early works. Vegetation in the diversion will aid to capture any sediment that may enter into the channel and will assist in dissipating flow energy in low velocity flows. A pipe has been successfully used to allow the vehicle and plant movement over the diversion and a geofabric lining has prevented the generation of sediment as the water flows along the length of the diversion. Mulch bunds either side of the diversion place a crucial part in eliminating the movement of dirty water into the channel. Note that mulch used for bunds should be removed if it is observed to generate leachate which could contaminate clean water flows. And the use of aged mulch is encouraged to be used in appropriate volumes - refer RMS Environmental Direction – Management of Tannins from vegetation mulch (January 2012) for further information.



Figure 2. A geofabric lined temporary clean water diversion on the edge of a work zone. Geofabric has been anchored using wooden pegs and sand bags have been placed at intervals along the length of flow to dissipate flow energy and aid in capturing any sediment that may enter the channel. Areas surrounding the diversion are vegetated to prevent additional sediment entering the diversion and sediment fencing has been incorporated on the works side in accordance with the higher risk of sediment generation. It is important to also note sufficient space has been allocated in the clearing limits to allow for the diversion. Note that stones/rock used to dissipate flows should be clean and free of fines. Maintain work, health and safety constraints to minimise rock material being washed away,



Figure 3. A geofabric lined temporary clean water diversion traversing a work zone during installation of cross drainage. The geofabric has been anchored at the top with star pickets at regular intervals. The star pickets are also integral to sediment fencing preventing sediment from entering the channel along the length of the diversion. Within the channel larger rock is used to aid in energy dissipation. Orange safety fencing effectively delineates the diversion and allows.