



Transport
Roads & Maritime
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APPENDIX B11

Construction Acid Sulphate Materials Management Plan

Halfway Creek to Glenugie

MAY 2015

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Glossary / Abbreviations

AASS	Actual Acid Sulphate Soils
ASS	Acid Sulphate Soils
CEMP	Construction Environmental Management Plan
CASSMP	Construction Acid Sulphate Soil Management Plan
CoA	Condition of approval
CMC	Civil Mining and Construction Pty Ltd
DP&I	Former NSW Department of Planning and Infrastructure (now DP&E)
DP&E	NSW Department of Planning and Environment
EIS	Woolgoolga to Ballina Pacific Highway Upgrade Environmental Impact Statement (December, 2012)
EPA	NSW Environment Protection Authority
EP&A Act	<i>NSW Environmental Planning and Assessment Act 1979</i>
EWMS	Environmental Work Method Statements

Minister, the	NSW Minister for Planning
NPW Act	<i>NSW National Parks and Wildlife Act 1974</i>
OEH	NSW Office of Environment and Heritage
PASS	<i>Potential Acid Sulphate Soil</i>
PoEO Act	<i>NSW Protection of the Environment Operations Act 1997</i>
Project, the	Halfway Creek to Glenugie Section 2 Woolgoolga to Ballina Pacific Highway Upgrade Project
Secretary	Secretary of the Department of Planning and Environment
SPIR	Woolgoolga to Ballina Pacific Highway Upgrade Submissions Preferred Infrastructure Report (November, 2013)
Roads and Maritime	NSW Roads and Maritime

1 Introduction

This Construction Acid Sulphate Materials Management Plan (CASMMP or Plan) forms part of the Construction Environmental Management Plan (CEMP) for the upgrade of the Pacific Highway from Halfway Creek to Glenugie (the Project). The Project is Section 2 of the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project, approved by the Minister for Planning in June 2014.

This CASMMP has been prepared to address the requirements of the Minister's Conditions of Approval (CoA), updated mitigation and management measures listed in the Pacific Highway Upgrade Woolgoolga to Ballina Submissions / Preferred Infrastructure Report (Nov 2013) (SPIR) and all applicable legislation.

The existing Glenugie Upgrade Project ties into the northern extent of the Project. The Glenugie Project was approved separately by the Minister for Planning and relevant conditions of this approval have been referenced in the CEMP and this plan as appropriate.

1.1 Background

The Pacific Highway Upgrade Woolgoolga to Ballina Environmental Impact Statement (EIS) (December 2012) and the Acid Sulphate Soil and Rock Investigation Report (June 2013) assessed the impacts of actual and potential acid sulphate materials on the construction and operation of the Project.

The EIS proposed the implementation of the mitigation and management measures, including further survey and monitoring.

The EIS management measures were subsequently updated within the Woolgoolga to Ballina SPIR, with applicable management measures incorporated into this Plan.

1.2 Environmental management systems overview

The overall Environmental Management System for the Project is described in the Construction Environmental Management Plan (CEMP).

The CASMMP is part of the CMC environmental management framework for the Project, as described in Section 4.1 of the CEMP. In accordance with CoA D26(c)(v) this Plan has been developed in consultation with the EPA, Department of Primary Industries (Fisheries), New South Wales Office of Water (NOW), Clarence Valley Council and the Commonwealth Department of the Environment. Ongoing consultation would be in accordance with Chapter 6 of the CEMP.

Mitigation and management measures identified in this Plan will be incorporated into site or activity specific Environmental Work Method Statements (EWMS).

EWMS will be developed and signed off by environment and management representatives prior to associated works and construction personnel will be required to undertake works in accordance with the identified mitigation and management measures.

Used together, the CEMP, strategies, procedures and EWMS form management guides that clearly identify required environmental management actions for reference by CMC personnel and contractors.

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

1.3 Acid Sulphate soils

The National Strategy for the Management of Coastal Acid Sulphate Soils (1999) provides a definition for ASS that is repeated in most other ASS management publications:

“Acid Sulphate Soil” is the common name given to naturally occurring soil and sediment containing iron sulfides, principally the mineral iron pyrite, or containing acidic products of the oxidation of sulfides. When sulfides are exposed to air, oxidation takes place and sulfuric acid is ultimately produced when the soil’s capacity to neutralize the acidity is exceeded. As long as the sulfide soils remain under the water table, oxidation cannot occur and the soils are quite harmless and can remain so indefinitely.”

Although ASS is concentrated in coastal environments, there is potential for other Acid Sulphate Material (ASM) to have widespread distribution in the landscape. If disturbed, all forms of ASM can cause unacceptable environmental impacts, including acidification of waterways, major fish kills, habitat destruction, loss of agricultural productivity, geotechnical instability and corrosion of concrete and steel structures.

Investigations by ‘RCA Australia’ have identified two sites within the project boundary where there is a likelihood to encounter ASS. These are at depths of approximately 6 metres at Halfway Creek and 3.5 metres at Wells Crossing. The only construction process that may intersect these strata is during pile boring activities.

2 Purpose and objectives

2.1 Purpose

The purpose of this Plan is to describe how potential and actual acid sulphate materials are to be managed and impacts on the environment and project personnel minimised.

2.2 Objectives

The key objective of the *CASMMP* is to ensure that *potential and actual acid sulphate materials* are minimised and managed. To achieve this objective, the following will be undertaken:

- Ensure controls and procedures are implemented during construction activities to avoid, minimise or manage potential adverse impacts.
- Ensure measures are implemented to address the relevant CoA outlined in Table 3.1 and the management measures detailed in the EIS.
- Ensure measures are implemented to comply with all relevant legislation and other requirements as described in Section 3.1 of this Plan.
- Provide a process for dewatering excavations and managing excavated material including treatment and storage; and
- Provide information to aid the decision-making process of the ROADS AND MARITIME and construction personnel.

2.3 Targets

The following targets have been established for the management of acid sulphate impacts during the project:

- Ensure full compliance with the relevant legislative requirements and CoA.
- No pollution due to acid sulphate exposure.

3 Environmental requirements

3.1 Minister’s Conditions of Approval

The CoA relevant to this Plan are listed **Error! Reference source not found.**. A cross reference is also included to indicate where the condition is addressed in this Plan or other Project management documents.

Table 3-1 Conditions of Approval relevant to the CFFMP

CoA No.	Condition Requirements	Document Reference
D26(c)	a Construction Soil and Water Quality Management Plan to manage surface and groundwater impacts during construction of the SSI. The Plan shall be developed in consultation with the EPA, DPI (Fisheries), NOW, Rous Water (in relation to the Woodburn borefield), DoE and the relevant council and include, but not necessarily be limited to:	Section 1.2
D26 (C) (v)	An Acid Sulphate Soils contingency plan, consistent with the Acid Sulphate Soils Manual, to deal with the unexpected discovery of actual or potential acid sulphate soils, including procedures for the investigation, handling, treatment and management of such soils and water seepage;	This document

3.2 Relevant legislation and guidelines

3.2.1 Legislation

Legislation relevant to acid sulphate management includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act)
- Protection of the Environment Operations Act 1997 (POEO Act)
- Contaminated Land Management Act, 1997

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A2 of the CEMP.

3.2.2 Additional approvals, licences, permits and requirements

Table 3.2 below identifies approval, licence, permits and other requirements that must be considered when managing PASS or ASS.

While acid Sulphate soils are not explicitly addressed in the EPBC Act, actions which may expose or disturb such soil must be referred to the Minister for the Environment if

they are likely to have a significant impact on any matters of national environmental significance. No significant impact is likely on this project.

Table 3-2 Requirements

Act	Activity / aspect	Requirement	Reference	Part 5.1 applicability
General				
<i>Environmental Planning and Assessment Act 1979</i>	All	Comply with the terms Minister for Planning's approval for the project. Obtain the Minister's approval for any project modifications that are not consistent with the planning approval.	S115ZI	Yes
<i>Protection of the Environment Operations Act 1997</i>	Harming the environment	Do not risk harming the environment by wilfully or negligently: <ul style="list-style-type: none"> • Disposing of waste unlawfully. • Causing any substance to leak, spill or otherwise escape (whether or not from a container). 	S115 S116 S117	Yes
<i>Protection of the Environment Operations Act 1997</i>	Water pollution	Do not cause <u>water pollution</u> (other than to a sewer), except in accordance with the conditions of any EPA licence.	S120 S122	Yes
<i>Contaminated material</i>				
<i>Protection of the Environment Operations Act 1997</i>	Land pollution	Do not cause or permit <u>land pollution</u> other than under authority of a licence or regulation. (However it is not a land pollution offence to place virgin excavated natural material or lawful pesticides and fertilisers on land, or by placing matter on land that has been notified to the EPA as an unlicensed landfill and which is operated in accordance with the regulations.)	S142A – S142E	Yes

Act	Activity / aspect	Requirement	Reference	Part 5.1 applicability
<i>Contaminated Land Management Act 1997</i>	Reporting contamination	Notify the EPA if <ul style="list-style-type: none"> Contaminants exceed thresholds contained in guidelines or the regulations where contamination has entered or will foresee ably enter neighbouring land, the atmosphere, groundwater or surface water. Contaminants in soil are equal to or exceed guideline levels with respect to the current or approved use of the land. Contamination meets other criteria that may be prescribed by the regulations. 	S60	Yes

3.2.3 Guidelines

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

- RMS QA Specification G36, – Environmental Protection (Management System)
- Dewatering Practice Note, Pacific Highway Projects May 2012
- RMS QA Specification G38 – Soil and Water management
- Acid Sulphate soil and rock investigation Pacific Highway Upgrade Woolgoolga to Glenugie (W2G), RCA June 2013
- RMS QA Specification G40– Clearing and Grubbing
- Acid Sulphate Soil Manual, NSW Acid Sulphate Soil Management Advisory Committee, 1998
- Guidelines for the Management of Acid Sulphate Materials: Acid Sulphate Soils, Acid Sulphate Rock and Monosulfidic Black Ooze, Roads and Traffic Authority, 2005
- Soil Management Guidelines in Queensland Acid Sulphate Soil Technical Manual, Version 3.8 - Dear, Moore, Dobos, Waitling and Ahern, 2002. Department of Natural Resources and Mines, Indooroopilly, Qld, Australia
- Laboratory Method Guidelines in Queensland Acid Sulphate Soil Technical Manual – Dear, Moore, Dobos, Waitling and Ahern, 2002. Department of Natural Resources and Mines, Indooroopilly, Qld, Australia
- Australian and New Zealand Guidelines for Assessment and Management of Contaminated Sites, ANZECC/NHMRC, 1992
- Assessment Classification and Management of Liquid and Non-Liquid Waste (EPA), 1999
- Waste Classification Guidelines Part 1: Classifying waste (EPA, 2014)
- Waste Classification Guidelines Part 4: Acid Sulphate soils (EPA, 2014)
- Relevant recovery plans, priority action statements and best practice guidelines.

4 Existing environment

Soil sampling and analysis undertaken by RCA Australia on behalf of Roads and maritime for the Ballina to Woolgoolga, Pacific Highway Upgrade Project to identify acid sulphate material issues for the project indicates there is a risk that excavation may disturb AASS within the project area primarily in the vicinity of Wells Crossing and Halfway Creek especially while boring piles. There is also a risk associated with dewatering boreholes, if required, for piling works. Containment and treatment is therefore required to reduce the risk of harm these materials may cause to the surrounding environment. The following paragraphs are an excerpt from the Acid Sulphate Soil and Rock Investigation, Pacific Highway upgrade, Woolgoolga to Glenugie (W2GS2). RCA Australia 2013.

'One sandy alluvial soil sample at a depth of 6.0 to 6.45m (51.6m AHD) from BH104/P at the Halfway Creek region of the alignment reported a pHF of 3.50 and would be described as an actual acid sulphate soil. This sample also contained 0.07%SCR and would also be described as a potential acid sulphate soil. Based on the net acidity criteria for a coarse textured soil disturbance (18moles H+/tonne or 0.03%SCR) an ASSMP would be triggered as a requirement for Halfway Creek, in particular the disturbance to soils at depth i.e. due to foundation installation.

One sandy alluvial soil sample at a depth of 3.0 to 3.45m from BH113 at the Wells Crossing region of the alignment reported a pHF value of 3.50 and would be described as an actual acid sulphate soil. This sample contained 0.008%SCR and based on the net acidity criteria for a coarse textured soil disturbance (18moles H+/tonne or 0.03%SCR) would not trigger the requirement for a management plan. However, owing to the low pH value reported for this sample it is recommended that soils from Wells Crossing be managed in accordance with an ASSMP.' RCA, June 2013

Activities that require deep excavations in the areas of Wells Crossing between chainages 22350 to 22450 and Halfway Creek between chainages 27000 to 2800 will need to be monitored for the existence of AASS, this will include the boring for piles.

5 Environmental aspects and impacts

5.1 Construction activities

Due to the depth of the identified acid sulphate soils the only construction activity that is likely to encounter PASS or ASS is the boring for bridge pile placement at Halfway Creek and Wells Crossing.

Refer also to the Aspects and Impacts Register included in Appendix A2 of the CEMP.

Impacts that may occur if ASM is not managed correctly includes:

- 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.

6 Environmental mitigation and management measures

6.1 Management

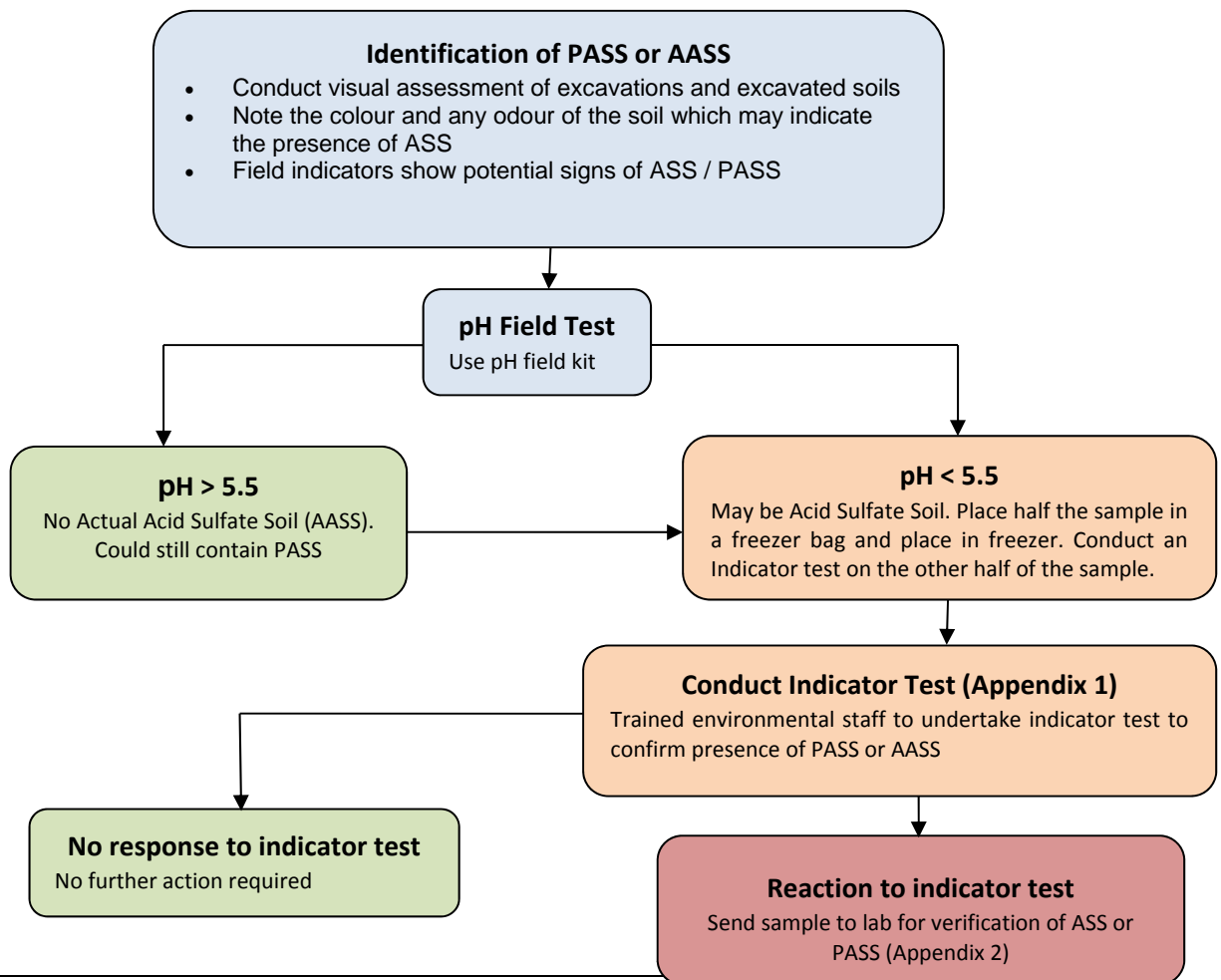
AASS has been identified to likely to be encountered during deep excavations (pile boring) in the vicinity of Halfway Creek and Wells Crossing. The Environmental Manager/Officer or other person trained in the identification, testing and management of AASS will monitor all such activities to identify and manage actual or potential acid sulphate soils. If identified they will be managed in accordance with the following principles.

6.2 Identification

The following field procedures have been developed to determine whether the soils may contain acid generating potential to levels requiring treatment. It has been developed based on information in the NSW ASSMAC guidelines (1998).

The following flow chart shall be used to assist in the initial identification process of soils which have not already been assessed or confirmed as being ASS or PASS.

Figure 1 New find ASS identification process



6.3 Management of ASS

6.3.1 Introduction

The following principles of Acid Sulphate Soil Management are in accordance with the Acid Sulphate Soil Management Advisory Committee (ASSMAC) Management Guidelines (1998) and are the fundamental strategies that underpin the management of ASS:

- Avoidance is the soundest strategy and the proposed works should always attempt to modify work practices in order to avoid unnecessarily exposing or disturbing ASS. The proposed works should also where possible avoid activities that result in the fluctuation of the groundwater, in particular the lowering of groundwater;
- Minimisation of the disturbance of ASS materials. Appropriate handling techniques and treatment of excavated soil are to be used to minimise and or prevent the disturbance of ASS. Furthermore, earthworks activities should be managed to minimise or mitigate the potential of ASS to impact on the surrounding environment; and
- Neutralisation of excavated soils using lime in order to neutralise acid that is generated over time due to the gradual oxidation of ASS. Neutralising agent should also be applied to acidified run-off and water extracted during dewatering.

The proposed works aim to employ a combination of these management techniques as follows:

- Minimisation:
 - Deep excavations will be avoided and where necessary kept to the minimum size.
- Neutralisation:
 - Actual Acid Sulphate Soils (AASS) materials occur within the soil profile at various depths, therefore all excavation works that disturb the AASS soil profile will require neutralisation with lime as outlined in Section 6.3.3 below; and
 - Samples of potential or AASS will be sent to a NATA certified testing laboratory to determine the applicable liming rate
 - Stockpile leachate and/or water extracted during dewatering must be in accordance water quality objectives listed in the Roads and Maritime document Technical Guideline: Environmental Management of Construction Site Dewatering (EMCSD) and in accordance with the Protection of the Environment Operations Act 1997 (POEO Act).

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 or treatment site/s. Aglime is non-corrosive, and requires no special handling – it will 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.

Aglime storage shall be managed such that any runoff generated is captured, and treated to correct pH if necessary, to prevent alkaline runoff to waterways. Availability of Aglime from local suppliers will be confirmed prior to ASS disturbance and lead time for deliveries established.

ASS management will be recorded on an Acid Sulphate Treatment Log which is provided in Annexure 5.

6.3.2 Immediate Reuse

In the case of immediate reuse on site (e.g. trenching and backfilling within a day), there is a reduced likelihood that PASS will be exposed long enough to oxidise and become AASS. Immediate reuse (same day) may be appropriate if PASS are of low to moderate strength. It is recommended that lime application occur prior to backfilling as a precautionary measure.

Further, the soil material will require backfilling in the reverse order of excavation (i.e. last out first in).

Note: the majority of situations are not conducive for immediate reuse and as such the decision for immediate reuse can ONLY be made by the Environment Manager

6.3.3 Treatment of ASS onsite

- The ASS treatment area should be established prior to works that are likely to encounter ASS or PASS
- Where possible, prior to soil disturbance, add required amounts of lime over the area to be disturbed to ensure mixing occurs as early as possible
 - Note - Figure 2 provides further guidance on the amount of lime required
 - Note - Any laboratory analysis undertaken as per Appendix 2 will provide specific liming rates.
- Transfer soil to treatment area.
- Soil shall be laid in 150mm to 300mm layers on a treatment pad (and fine lime added in accordance with the calculated liming rates if not already added during excavation). See Appendix D for typical treatment pad design.
- If sufficient mixing did not occur during excavation and initial in situ lime addition, the soil shall be turned over/ mixed in a manner such that lime will be distributed throughout the soil matrix.
- The material is then left on the treatment pad for approximately 4-5 days to allow neutralisation to occur (or less if neutralisation can be achieved sooner), turning the soils when the surface dries out, and so increasing the rate of oxidation. Effective drying and mixing of lime with clay is often very difficult. The drying rate is dependent on the temperature and in cooler climates the methods may be too slow to be practicable.
- Water contained within the collection sumps will need to be sampled to assess requirements for treatment prior to discharge (6.6).

- This material shall remain banded until validation results are available and return concentrations less than the respective criteria (detailed in Appendix 2). Should the stockpile validation results exceed the criteria, additional lime will be added as required and further validation samples collected.

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)	Note: Lime rates are for pure fine aglime, CaCO ₃ 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 <i>Information Sheets on Neutralising Agents – Neutralising Considerations</i>).
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)	
NH	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_{PO}) and Total Oxidisable Sulfur (S_{TO}). 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 Soil: Technical Manual, Laboratory Methods Guidelines*.

Figure 2 ASS neutralisation rates

6.3.4 Reuse of ASS on site

Once stockpile validation results confirm the criteria described above has been complied with, reuse of the material on site is permitted.

If material cannot be reused on site and off-site disposal is required, procedures outlined within the document Waste Classification Guidelines, Part 4: Acid Sulphate Soils shall be implemented, as detailed in the following sections.

6.3.5 Disposal of PASS offsite

- Keep PASS wet at all times during excavation and subsequent handling, transport and storage until they can be disposed of safely.
- Material must be received at the disposal point within 16 hours of being dug up.
- PASS may be disposed of in water below the permanent water table, provided:
 - this occurs before they have had a chance to oxidise, i.e. within 24 hours of excavation
 - they meet the definition of 'virgin excavated natural material' (VENM) under the Protection of the Environment Operations Act 1997, even though they contain sulfidic ores or soils.
- Documentation must be provided to the occupier of the landfill for each truckload of material received, indicating that the soil's excavation, transport and handling have been in accordance with the Acid Sulphate Soil Manual, thus preventing the generation of acid.
- Soil that has dried out, undergone any oxidation of its sulfidic minerals, or which has a pH of less than 5.5 must be treated by neutralisation (as per below ASS disposal requirements) and disposed of at a landfill that can lawfully accept it.

- The disposal site's licence will outline what documentation needs to be kept and for how long.
- For any transport of PASS:
 - Lime the bottom of the truck;
 - Load PASS and coat top layer with lime; and
 - Cover spoil load.

6.3.6 Disposal of AASS soils

- AASS must be treated by the generator of the waste before it can be disposed offsite. Treatment should be in accordance with the neutralising techniques outlined above in Section 6.4.3.
- Following neutralisation, the generator of the waste must chemically assess the soil in accordance with Step 5 of the Waste Classification Guidelines: Part 1 – Classifying Waste DECCW 2014.
- A review of the analytical results will be undertaken on a range of parameters (not AASS or PASS) that may impact on the waste classification for offsite disposal.
- Once classified, the waste must be taken to a landfill licensed to accept that class of waste.
- The landfill should be informed that the AASS has been treated in accordance with the neutralising techniques outlined in the NSW Acid Sulphate Soil Manual and that the waste has also been classified in accordance with Waste Classification Guidelines: Part 1 – Classifying waste (EPA, 2014) and Waste Classification Guidelines Part 4:. A copy of the analytical results will be required by the Landfill prior to disposal.

6.4 Excavations works

The following mitigation measures are to be implemented if ASS or PASS soils are identified during excavation works in other areas:

- Soils identified as Potential Acid Sulphate Soils (PASS) and/or AASS shall be disturbed to a minimum;
- The time PASS/ASS materials are exposed to the atmosphere shall be minimised by backfill as soon as possible; and
- Where excavated ASS material will be exposed for more than 24 hours, it must be treated by neutralising with the application of lime (refer procedure below);
- where ASS materials would be exposed in situ such as at the base of the road alignment:
 - Where possible, reduce exposure to less than 24 hours by construction scheduling;
 - For areas where exposure would exceed 24 hours, backfill with a minimum 300mm clean fill within 24 hours. This could be achieved by: excavating 300 mm greater than the finished level then backfilling with 300mm clean fill; or
 - Placing a minimum of 300 mm clean fill temporarily over the base. The 300 mm clean fill would require removal immediately (less than 24 hours) prior to the next stage of construction;

- Where the above options are not feasible
 - Apply lime to the surface of the exposed base.
- Runoff would be captured and treated through the erosion and sediment control measures for sediment basins. Note this is the least preferred method, as lime applied to the surface will only neutralise surface ASS materials or ASS materials captured in runoff, with limited neutralisation of oxidised subgrade ASS materials. It is also recommended that lime is re-applied to the surface prior to backfill/road subgrade construction to provide some neutralising effect to the subgrade ASS materials via water infiltration down through the lime to the oxidised subgrade ASS materials.

The treatment and handling of ASS must be carried out in accordance with standard Occupational Health and Safety guidelines.

6.5 Stockpile management

Should temporary stockpiling of soils be required the following mitigation measures are to be implemented:

- Excavated PASS/ASS material will be separated from overlying topsoil and temporarily stockpiled, and the liming procedure detailed below should be adopted;
- If ASS material must be stockpiled temporarily, the stockpile area must be located 50 metres away from waterways; and waterbodies including wetlands;
- The stockpiles are to be bunded with a sump point to collect water, and soils covered to slow oxidation and prevent ingress of rainfall;
- Treatment using the liming procedure (6.3.3) should immediately follow excavation;
- Upstream flow diversion and downstream leachate collection measures shall be installed around the stockpiles;
- Any stockpile leachate and/or sediment basin dewatering is to be undertaken in accordance with Sediment basin Management Plan and RMS Technical Guideline Environmental Management of Construction Site Dewatering;
- Discharge water quality must be in accordance with the POEO Act (Protection of the Environment Operations Act 1997), EPL and the EMCSD. Section 4.6 of the EMCSD requires water quality objectives criteria as follows: (to be updated to EPL requirements)
 - Total suspended solids 50mg/L
 - pH 6.5 – 8.5
 - oil and grease no visible trace
- Supervision of dewatering activities must be in accordance with Section 5.4 of the EMCSD.

6.6 Dewatering

Where excavations are to be dewatered where PASS or ASS has been identified it shall be done in accordance with the Construction Soil and Water Management Plan (CSWMP) and Appendix 4.

The sedimentation basins are proposed in low lying areas within the site; excavation may intercept the water table and dewatering may be required to enable the construction of the sedimentation basins.

Dewatering is to be undertaken in accordance with the CSWMP. Discharge water must comply with water quality objective criteria listed in Section 4.6 of the CSWMP. Supervision of dewatering must comply with Section 5.4 of the CSWMP.

The pH of the groundwater should be measured prior to the commencement of dewatering to establish the baseline value. Monitoring of pH is recommended at hourly intervals for first 8 hours, and twice daily after that until dewatering ceases. If the pH of the extracted water varies by more than 0.2 units from the adopted baseline value, the water should be captured and treated to amend the pH prior to disposal.

Any water discharged (despite any pH changes) is required to meet the CSWMP water quality objectives criteria as follows:

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

This CASSMP assumes that sediment basins will be constructed so as to ensure that the surrounding groundwater table will not be lowered and (potentially acidic) groundwater will not seep into the sediment basins.

6.7 Waste Management

All wastes will be managed in accordance with the Construction Waste and Energy Management Plan.

7 Compliance management

7.1 Roles and responsibilities

The Project Team's 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 Section 6 of this Plan.

7.2 Training

All employees, contractors and utility staff working on site will undergo site induction training relating to *acid sulphate material* management issues. The induction training will address elements related to *acid sulphate material* management including:

- Existence and requirements of the CASMMP.
- Relevant legislation.
- General awareness of acid sulphate materials and their potential locations on site.
- Mitigation and management measures, including excavation procedures and stockpile management.
- Specific responsibilities.

An onsite meeting must be held with each relevant contractor, construction staff, and site personnel before the commencement of works in areas identified as containing PASS or AAS. The purpose of the meeting is to discuss the environmental safeguards/approval conditions that are required to be implemented for the relevant phase of works. The meeting shall include acid sulphate soil awareness and toolbox talks. Relevant environmental aspects to be considered include the limit of works, environmentally sensitive areas (i.e. ASS treatment areas), ASS treatment, monitoring and contingency measures.

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

7.3 Monitoring and inspections

Following liming, the pH of the treated soils is to be monitored twice a day for one week to ensure there is adequate lime application. The pH of the neutralised soil needs to be in the range of 5.5 to 8.5. If pH is below this level additional small amounts of lime should be added and incorporated to bring the soil to the range of 5.5 to 8.5. Analysis of soil pH is to be undertaken weekly thereafter if there is no significant change.

For water extracted during dewatering and neutralised, the pH of the water is to be monitored twice a day following treatment until disposal. CSWMP and ANZECC Water Quality Criteria require that pH of water discharged into the environment must be between 6.5 and 8.5 and must be in accordance with EPL requirements.

Requirements and responsibilities in relation to monitoring and inspections are documented in Section 8.2 of the CEMP.

7.4 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this plan, CoA and other relevant approvals, licenses and guidelines.

Audit requirements are detailed in Section 8.3 of the CEMP.

7.5 Reporting

Reporting requirements and responsibilities are documented in Section 8.3 of the CEMP.

8 Review and improvement

8.1 Continuous improvement

Continuous improvement of this plan 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.
- Make comparisons with objectives and targets.

8.2 CASMMP update and amendment

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

Any revisions to the CASMMP will be in accordance with the process outlined in Section 1.6 of the CEMP.

A copy of the updated plan 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 1 Guide to Acid Sulphate field tests

(Attached)

1 ACID SULFATE SOIL FIELD pH TESTS

KM Watling, CR Ahern and KM Hey

1.1 INTRODUCTION

The field pH (pH_F) and field pH peroxide (pH_{FOX}) tests have been developed for a rapid assessment in the field of the likelihood of acid sulfate soils. These tests are easy to conduct, quick, and have a minimum set-up cost. The field tests have been developed to give reasonable prediction for many soils (provided the tests are performed properly) whilst at the same time being relatively easy to perform with a minimal amount of equipment. Soil field pH tests provide a useful indication of the existing and potential acidity levels in the soil. Although these field tests may provide an indication of ASS presence, they are purely qualitative and do not give any quantitative measure of the amount of acid that has been or could be produced through the oxidation process.

Field pH tests should be part of any ASS investigation. The field pH tests (both pH_F and pH_{FOX}) should be conducted at 0.25 m intervals on the soil profile, ensuring at least one test per horizon. It is recommended that field tests be conducted on-site, in the field. If the tests can't be performed in the field on-site, tests should be conducted within 24 hours of soil sample collection, ensuring appropriate sample handling procedures (see Section B). Samples suspected of containing monosulfides should undergo field pH testing immediately in the field.

1.2 FIELD pH TEST (pH_F)

The procedure for the field pH test (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 violent. 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 0.25 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. For example, DO NOT take ½ teaspoon of soil from the 0–0.25m depth that is grey mud, while selecting ½ teaspoon from the same depth that is a yellow mottled sample. These will obviously give different results independent of the type of test conducted.
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. This will reduce the risk of sulfide oxidation—the pH_F is designed to indicate the existing pH of a soil in the field; any oxidation subsequent to the soil's removal from the ground will not reflect the true field pH. In some instances, in less than 5 minutes, monosulfidic material may start to oxidise and substantially affect the pH_F results.

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. Never stir the paste with the electrode. This will damage the semi-permeable glass membrane.
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.**

1.3 FIELD pH PEROXIDE TEST (pH_{FOX})

It is recommended that 30% hydrogen peroxide (H_2O_2) be used in the pH_{FOX} test. 30% H_2O_2 is highly corrosive and care should be taken when handling and using the peroxide. Safety glasses and gloves should be worn when handling and using peroxide. All chemical bottles should be clearly labelled and Material Safety Data Sheets (MSDS) should be kept with the chemicals at all times. Appropriate health and safety precautions should be adhered to. Peroxide should be kept in the fridge when not in use.

The procedure for the field pH peroxide test (pH_{FOX}) is outlined below:

1. **Adjust the pH of the hydrogen peroxide to pH 4.5–5.5 before going into the field.** This can be done by adding a few drops of dilute NaOH stirring and checking the pH with the electrode regularly until the correct range is reached. NaOH is highly caustic so safety precautions must be exercised. NaOH can raise the pH quickly or slowly, so the pH needs to be monitored. Recheck the pH after allowing the peroxide to stand for 15 minutes. Do NOT buffer a large quantity of hydrogen peroxide at one time. Only buffer the amount to be used in the field for about a month. This must be kept in a fridge, well labelled with only small quantities to be taken into the field at one time. This will ensure the longevity of the peroxide. Further, over time, the pH of the peroxide that has already been buffered may change. It is important to check the pH of the peroxide in the morning before departing to the field. Having a small quantity of NaOH in the field kit is recommended so the peroxide can be buffered if required.
2. **Calibrate battery powered field pH meter** according to manufacturer's instructions.
3. **Prepare the test tubes in the test tube rack as for pH_F test.** Make sure the rack is marked with the depths so there is not 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 violent. It is important to use **heat-resistant test tubes** for the pH_{FOX} test as the reaction can generate considerable heat (up to 90°C). It is recommended that a tall, wide tube be used for this test as considerable bubbling may occur, particularly on highly sulfidic or organic samples.
4. **Conduct pH_{FOX} tests at intervals on the soil profile of 0.25 m or at least one per horizon** whichever is lesser.
5. **From the teaspoon of soil previously collected for the pH_F test, place approximately 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. For example, DO NOT take ½ teaspoon of soil from the 0–0.25m depth that is grey mud, while selecting ½ teaspoon from the same depth that is a yellow mottled sample. These will obviously give different results independent of the type of test conducted.
6. **Add a few millilitres of 30% H_2O_2 (adjusted to pH 4.5–5.5) to the soil** (sufficient to cover the soil with peroxide) **and stir the mixture.** Do NOT add the peroxide to the test tube in which the pH_F test was conducted, that is, the pH_{FOX} test tube should not have any deionised water in it. Beakers can be used, however glass is usually easily broken when conducting field work, and when multiple tests are being conducted it is difficult to handle large beaker sizes efficiently. Do NOT add more than a few millilitres at a time. This will prevent overflow and wastage of

peroxide. A day's supply of peroxide should be allowed to reach room temperature prior to use (cold peroxide from the fridge may be too slow to react).

7. **Rate the reaction of soil and peroxide using a XXXX scale** (see below and Table H1.1).
8. **Ideally, allow approximately 15 minutes for any reactions to occur.** If substantial sulfides occur, the reaction will be vigorous and may occur almost instantly. In this case, it may not be necessary to stir the mixture. Careful watch will be needed in the early stages to ensure that there is no cross contamination of samples in the test tube rack. If the reaction is violent and the soil:peroxide mix is escaping from the test tube, a small amount of deionised water (or demineralised water; not tap water) can be added (using a wash bottle) to cool and calm the reaction. Usually this controls overflow. Do NOT add too much deionised water as this may dilute the mixture and affect the pH value. It is important to only use a small amount of soil otherwise violent reactions will overflow and the sample will be lost.
9. **Steps 6 to 8 may be repeated** until the soil:peroxide mixture reaction has slowed. This will ensure that most of the sulfides have reacted. In the lab this procedure would be repeated until no further reaction occurs, however in the field, best judgement is recommended. Usually one or two extra additions of a few millilitres of peroxide are sufficient.
10. If there is no initial reaction, individual test tubes containing the soil:peroxide mixture can be placed into a container of hot water (especially in cooler weather) or in direct sunlight. This will encourage the initial reaction to occur. When the sample starts to 'bubble', remove the test tube immediately from the hot water and replace into test tube rack.
11. **Wait for the soil:peroxide mixture to cool** (may take up to 10 minutes). The reactions often exceed 90°C. Placing an electrode into these high temperature situations may result in physical damage and inaccurate readings. Check the temperature range of the pH meter and probe to see what temperature is suitable. Note that a more exact pH is achieved if a temperature probe is also used, however this may be impractical in some field situations.
12. **Use an electronic pH meter (preferred method) to measure the pH_{FOX} .** Place a spear point electrode into the test tube, ensuring that the spear point is totally submerged in the soil:peroxide mixture. Never stir the mixture with the electrode. This will damage the semi-permeable glass membrane.
13. **Wait for the reading to stabilise and record the pH_{FOX} measurement.**
14. **All measurements should be recorded on a data sheet.**

a) 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 H1.1 indicates the reaction scale for pH_{FOX} tests.

Table H1.1 Soil reaction rating 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 commonly $>80^{\circ}\text{C}$

1.4 INTERPRETATION OF FIELD pH TESTS

For details on how to interpret the field pH tests (pH_{F} and pH_{FOX}) please refer to the following references:

Ahern CR, Ahern MR and Powell B (1998). *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998*. Department of Natural Resources, Indooroopilly, Queensland, Australia. pp. 28–30.

Ahern CR, Stone Y and Blunden B (1998). *Acid Sulfate Soils Assessment Guidelines*. Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia. pp. 56–58.

Hey KM, Ahern CR and Watling KM (2000). Using Chemical Field Tests to Identify Acid Sulfate Soils Likelihood. In *Acid Sulfate Soils: Environmental Issues, Assessment and Management, Technical Papers*. Ahern CR, Hey KM, Watling KM and Eldershaw VJ (eds), Brisbane, 20–22 June, 2000. Department of Natural Resources, Indooroopilly, Queensland, Australia. pp. 16-9–16-12.

Hey KM (ed) (2002). *Field Testing, Sampling and Safety for Acid Sulfate Soils*. Department of Natural Resources and Mines, Indooroopilly, Queensland, Australia. pp. 12–16.

2 EFFERVESCENCE TEST ('FIZZ TEST') FOR CARBONATES

This test is used to determine the presence of carbonates in soil. It is a quick, easy, cheap test to conduct in the field. The test should be conducted on samples suspected of containing carbonates (eg. fine shell, crushed coral etc).

The procedure for the fizz test is outlined below:

1. **Place a small sample of soil (approximately one teaspoon) into a clear test tube.** Clear test tubes are preferred as this makes it easier to see any reactions. It is important that test tubes used in the fizz test are not used for the field pH tests as cross-contamination may occur, affecting pH readings.
2. **Place two or three drops of 1 M hydrochloric acid (HCl) onto the soil sample.** HCl is highly corrosive so safety precautions must be exercised.
3. **Rate the reaction** (see Table H2.1).
4. **All measurements should be recorded on a data sheet.**

Table H2.1 Soil reaction rating scale for the fizz test (as described in McDonald *et al.* 1990, pp. 147–148).

Reaction scale	Rate of reaction
N – non-calcareous	No audible or visible effervescence
S – slightly calcareous	Slightly audible but no visible effervescence
M – moderately calcareous	Audible and slightly visible effervescence
H – highly calcareous	Moderate visible effervescence
V – very highly calcareous	Strong visible effervescence

References

McDonald RC, Isbell RF, Speight JG, Walker J and Hopkins MS (1990) 'Australian Soil and Land Survey Field Handbook, 2nd Ed'. (CSIRO Publishing: Canberra)

Appendix 2 Ass Sampling

In situ soil sampling for laboratory analysis

If indicator tests (Appendix 1) indicate a positive reaction, the following will occur. In situ soil samples will be collected by a person trained or experienced in the collection of acid sulphate soil including knowledge of sample handling.

Care will be taken to remove as much air as possible from each sample prior to placing in an esky with ice. The soil samples will then be placed in a freezer as soon as possible and as a minimum at the end of each day of sampling.

Samples are then to be re-batched the following morning, with ice in eskies for dispatch to the laboratory. The soil samples will be sent express to the NATA accredited laboratory such that samples will be received by the laboratory within 24 hours of dispatch. Soil sample collected on a Friday or over the weekend will be retained frozen for dispatch on the following Monday.

Samples will be tested for Equivalent Sulphur and Equivalent Acid. (Note - The action criteria for the management of soils as ASS/PASS will be an Equivalent Sulphur (%S) of >0.03 and Equivalent Acid (mol H⁺/tonne) of >18).

(Note – laboratory results will also indicate neutralisation requirements to be followed in Section 7.4)

Soil Validation sampling

For treated ASS, one soil sample should be collected per 250m³ of treated soil and analysed for the suite of analytes used to calculate the total potential acidity by acid based accounting methods.

The objective of ameliorating ASS 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. When submitting samples for validation to a laboratory, it will be made clear that they require validation testing to ensure the correct methods are used. For validation testing both the Suspension Peroxide Oxidisable Combined Acidity Sulphur (SPOCAS) and Chromium Reducible Sulphur (SCR) suites can be used. The validation assessment will use the following equation:

(EQ1) Net Acidity = Potential Sulphidic Acidity – measured Acid Neutralising Capacity (ANC)/Fineness Factor (FF)

The final net acidity calculation must be either zero or preferably a negative value (having applied the appropriate fineness factor to the ANC). The soil pH must be greater than 5.5 after neutralisation and not above 8.5 (ASSMAC, 1998; QASSIT, 2004).

Appendix 3 Treatment Pad

Refer to: Queensland Acid Sulphate Soils Technical Manual, Soils Management Guidelines V3.8'

Design

Treatment pad locations will be located in areas approved for operation as ancillary facilities or on the road alignment if necessary. Treatment pads will be constructed as follows:

- The base of the pad is to be graded such that all surface water flows to one or multiple collection sumps. The treatment pad can be divided into cells (this may be required to minimise construction works to achieve adequate grade for water management (likely storm water and seepage water management from the material undergoing treatment);
- Appropriate sedimentation controls are to be constructed around each collection sump (if more than one).
- The base of the treatment pad will be constructed with a low permeable base.
- Crushed limestone will be placed over the low permeable material.
- A bund wall is to be constructed surrounding the treatment pad such the storm water flow outside the treatment pad is restricted from flowing into the treatment pad and storm water within the treatment pad is restricted from flowing beyond the collection sump/s.
- An example treatment pad design is provided below.

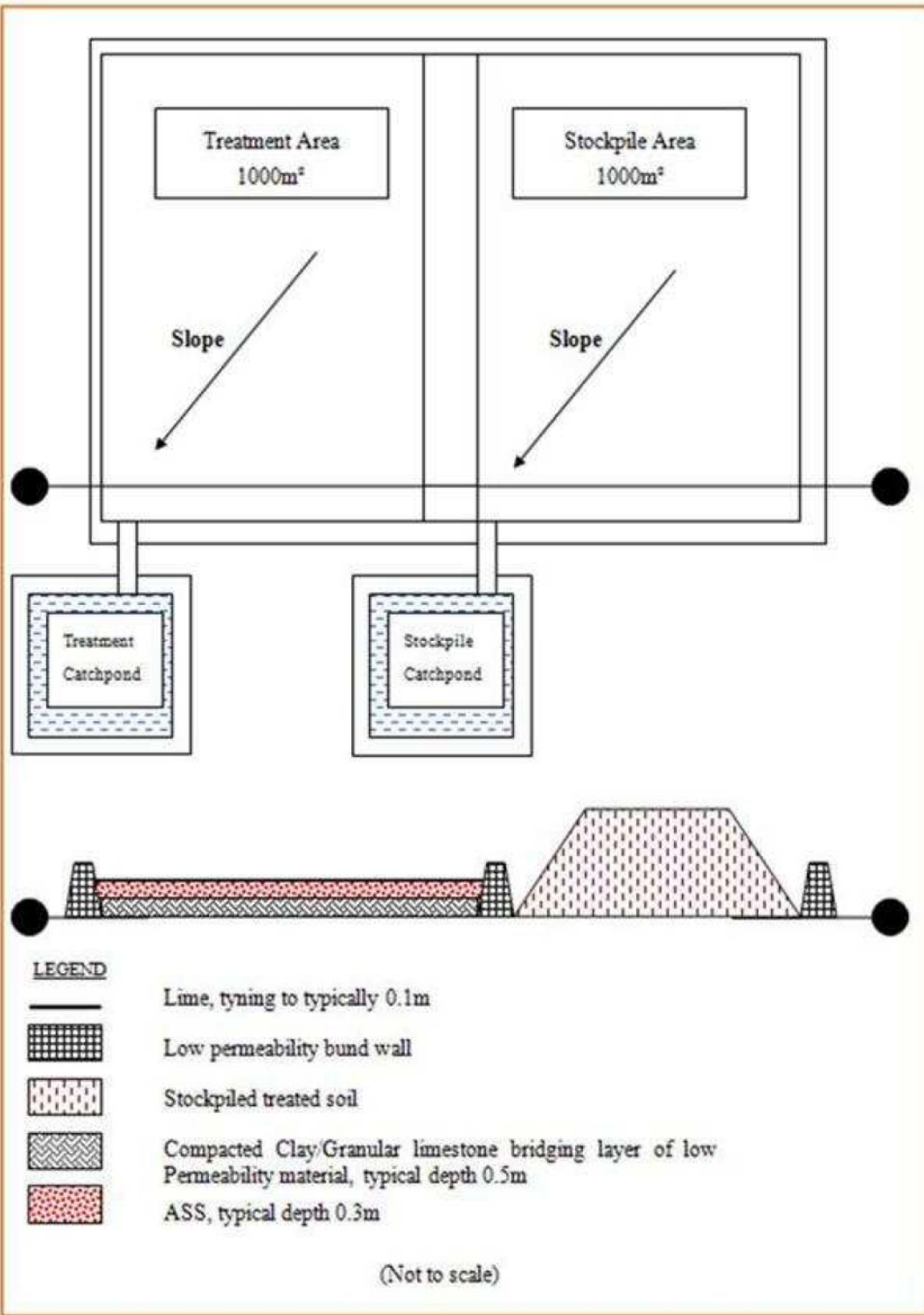
Treatment pad dimensions

For each treatment pad, the estimated *in-situ* volume of ASS material will need to be calculated, the program of excavation/treatment determined; and the treatment pad designed to accommodate this volume/rate of material.

Following excavation of the ASS some bulking will occur. From this volume (including a bulking factor), and the rate expected to be excavated, the dimensions of the treatment pad can be calculated.

The treatment area dimensions are also dependent on the thickness of the treatment layer and whether multiple layers will be placed atop one another. Due to space constraints in the Project, it is likely that multiple layers will be used.

Typical ASS Treatment Pad and Stockpile Sketch (1)



Appendix 4 Water Sampling and Treatment

Initial water sampling

Water collected in the sump of the treatment pad or excavation will initially be tested using a water quality monitoring probe to test pH and turbidity.

If this initial testing (prior to any neutralisation) shows pH of 6.5 to 8.5 and other parameters within EPL criteria, then no further testing is required and discharge may occur if required at a licenced discharge point with approval from environmental personnel.

Water treatment

If the water in the sumps has not been pre-treated (i.e. addition of a neutralising agent) and the pH is within the range of 6.5 – 8.5, the water is considered suitable for both discharge and reuse on site (provided other water quality parameters in the EPL are complied with).

If discharge is proposed and initial water sampling indicates pH below that allowed to discharge, neutralisation will occur in accordance with the table below.

If initial water sampling indicates pH above that allowed to discharge, then neutralisation will occur through pool acid or other suitable methods.

Water which has had a pre-treatment should also be tested for those parameters detailed below, and those parameters must be below relevant EPL or ANZECC guidelines prior to discharge or reuse on site.

Neutralised water sampling

If the water in the sump of the treatment pad has been neutralised from a low pH (i.e. to treat acidity caused by ASS), then prior to discharge of the treatment pad sump water, samples will be collected and analysed to ensure EPL and ANZECC water quality guidelines are complied with and shall include the following suite of parameters:

- Total Suspended Solids (TSS).
- pH.
- Conductivity.
- Oil and Grease (visual)
- Dissolved Aluminium
- Dissolved Iron.

Water samples to be sent for laboratory testing are to be collected using laboratory supplied bottles and immediately placed in an esky with ice. Water samples are to be collected in the morning so that they can be dispatched to the laboratory to arrive on the day of sampling. Water samples are to be collected by suitable trained and experience personnel.

Table 7.1 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: 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:



- 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.

Appendix 5 Acid Sulphate Treatment Log

