Transport
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Services

Waterfall Way Upgrade Pacific Highway to Connells Creek

Preliminary Acid Sulfate Soil Management Plan

Roads and Maritime Services

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Preliminary Acid Sulfate Soil Management Plan
November 2012

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Contents

Appendices

1 Introduction

NSW Roads and Maritime Services (RMS) have prepared a Route Options Development Report (RODR) for the proposed upgrade of Waterfall Way, from the Pacific Highway to Connell's Creek. This preliminary Acid Sulfate Soil Management Plan (ASSMP) will form part of the RODR.

The site is located within the Bellingen Shire Council (BSC) Local Government Area (LGA). Specific details of the site location and Proposal are provided in the corresponding RODR . The site locality is shown in Illustration 1.1.

The assessment concludes that the works will potentially impact on Acid Sulfate Soil (ASS) and an ASSMP is required.

1.1 Background

This report provides an assessment of the Proposal's compliance with:

- Acid Sulfate Soil Management Advisory Committee (ASSMAC) *Acid Sulfate Soil Manual* (1998);
- NSW Environmental Protection Authority (EPA) *Sampling Design Guidelines* (1995); and
- NSW Roads and Traffic Authority *Guidelines for the Management of Acid Sulfate Materials: Acid Sulfate Soils, Acid Sulfate Rock, and Monosulfidic Black Ooze* (2005).

ASS is a naturally occurring soil type which contains significant concentrations of iron sulfides, principally pyrite. Un-oxidised pyritic soils are referred to as potential ASS (PASS). When the soils are exposed, oxidation of sulfides results in generation of sulphuric acid and acid leachate. The soils are then referred to as actual ASS (AASS).

ASS materials in subsurface sediments do not pose a problem if left undisturbed. However, when exposed to air by either lowering of the watertable or by excavation, the ASS materials oxidise and in the presence of water will form sulphuric acid. This can occur through natural processes such as dry periods without rainfall resulting in a lowering of the watertable and formation of acid pools, which are later released during flooding events.

Exposure of ASS can cause significant damage to the environment, agricultural productivity and infrastructure including:

- inducing soil toxicities such as aluminium, iron and manganese;
- inducing soil deficiencies in phosphorous, potassium and calcium;
- degradation of water quality through severe acidification, de-oxygenation and contamination;
- loss or change in habitat in waterways and on land;
- fish disease, fish kills and decline;
- corrosion of infrastructure such as roads, bridges, pipes, and foundations; and
- diminished agricultural productivity and food production.

1.2 Description of proposal

The study area on Waterfall Way (Main Road 76) consists of a 3.1 km length of road between the Pacific Highway and Connells Creek. Illustration 1.2 shows the extent of the study area.

Works include upgrade of sections of the Waterfall Way between the Pacific Highway and Connells Creek that currently do not meet the RTA standards and may include:

road realignment to improve horizontal and vertical alignment;

- improving flood immunity;
- road and shoulder widening;
- culvert extension (including potential dewatering);
- improvements to pavement;
- intersection upgrades, particularly Short Cut Rd; and
- private access improvements.

Components of the Proposal that will potentially impact on ASS are excavation works, and sediment basin construction, dewatering and drainage works. The maximum anticipated depth of excavation is 1 m for road works, and 2.5 m for sedimentation basins. Any excess of excavated soil will be either reused on site, removed from the site and stockpiled or disposed of at a licensed and approved landfill facility.

Installation of sediment basins will comprise the following construction activities:

- remove all vegetation and topsoil from the entire footprint of the designated sediment basin, including the storage area and batters;
- construct a cut-off trench 600 mm deep and 1,200 mm wide along the centreline of the batter crest. Ensuring the trench does not fill with water, backfill it with impermeable clay and compact to 95 per cent. All fill material is to be free of roots, wood, rock, large stone and foreign material.
- prepare the site under the fill batters by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
- spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content.
- install pipe outlet and 'full of sediment' marker.
- form batter grades as per the detailed design plans.
- construct the spillway, including placing of rock for scour protection.
- rehabilitate the structure as per the detailed design plans.

Table 1.1 Construction Details of the Proposal and Potential ASS Triggers

How long will earth works take?	Up to 1 year
What is the depth of disturbance of the soil?	Excavation up to 1.4 m for road and culvert works, and up to 2.5 m for sedimentation basins
How much natural floodplain terrain sediment soil will be disturbed?	Approximately 1.3 ha
What is the fate of soil material (e.g. disposal or reuse on site)?	Excavated soil would be reused on site; any excess soil would be stockpiled or disposed of at a licensed landfill facility. ASS materials would be neutralised prior to reuse, stockpile or disposal.
Will the works disturb acid sulfate soils?	Yes (refer to Section 3)
Will the works lower the watertable?	No

1.3 Objectives of this report

The overall objective of this assessment is to guide on-ground works to ensure that appropriate measures are implemented to minimise the impacts of the Proposal on the environment in regard to ASS. Furthermore, this assessment:

- identifies the characteristics of the Proposal with regards to potential disturbances to ASS terrain (e.g. excavation or lowering of watertable);
- establishes the presence or absence of ASS on site and the need for an ASSMP;
- provides an ASSMP if required for dewatering and excavated material including treatment and storage; and
- provides information to aid the decision-making process of the RTA and construction personnel.

Information shown is for illustrative purposes only

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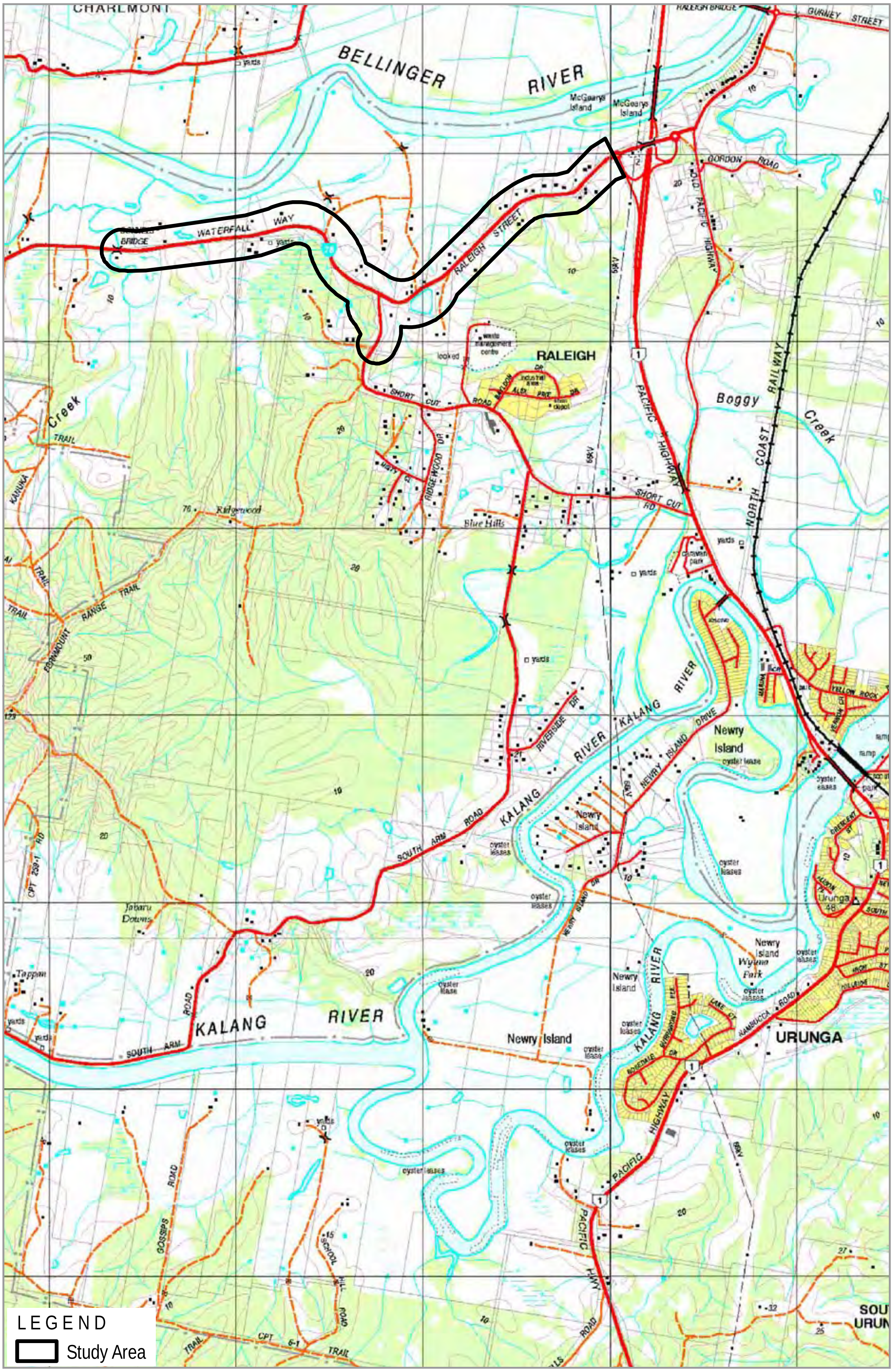
Source of base data: Bellingen Topographic Map 94372S



Site Locality

Illustration 1.1

Acid Sulfate Soil Management Plan: Waterfall Upgrade
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The Study Area

2 Site Description

2.1 Site description

The study area on Waterfall Way (Main Road 76) consists of a 3.1 km length of road between the Pacific Highway and Connells Creek, east of Bellingen, within the BSC LGA, on the Mid North Coast of NSW.

The site lies to the south of the Bellinger River, and varies in proximity from 170 m to 890 m from the river. The western extent of the site (approximately 1.1 km of road length) has an elevation of 5 to 12 m Australian Height Datum (AHD) and lies within the Bellinger River Floodplain. The elevation of the eastern extent of the site ranges from 12 to 29 m AHD and is not on floodplain terrain. The eastern and western extents are shown in Illustration 1.2.

ASS materials in coastal environments are generally found in soils at elevations of less than 5 m AHD and are associated with low lying floodplain estuarine areas. Therefore the low lying floodplain areas on the site are the subject of this assessment.

Site characteristics are summarised in Table 2.1.

Table 2.1 Site Characteristics

Characteristic	Site
Elevation of the soil surface	5.0 – 12 m AHD (western extent 1.1 km length) 12 – 29 m AHD (eastern extent 2 km length)
Depth of watertable	Watertable was observed at depths of 1.8, 1.2 and 0.4 m depth in the three sampling locations undertaken as part of this assessment. (refer to Plates 3.1-3.4 & Illustration 3.2)
Vegetation species present	Grassed surface, highly modified road and agricultural environment in low lying areas. Scattered sedges present at all three sampling sites. A wetland containing Melaleuca sp. lies adjacent to Waterfall Way and within the study area at Cameron's Corner.

2.2 Soil landscapes

The land within the study area traverses several different soil landscapes, described by Milford (1999) as Pine Creek, Charlmont, Gleniffer and Raleigh (refer to Illustration 2.1).

The Pine Creek soil landscape occurs within the eastern extent of the site and is generally associated with elevated parts of the study area. This soil landscape is an erosional landscape. Soils are deep, moderately well-drained structure Brown Earths and Yellow Earths on crests and slopes, with moderately well-drained Brown Podzolic Soils and Yellow Podzolic soils on steeper slopes. These soils are strongly to very strongly acid, with moderately low fertility, high aluminium toxicity, high topsoil organic matter, low topsoils / shallow subsoil wet bearing strength and slow subsoil permeability. Additionally limitations include high erosion hazard, high run-on and steep slopes

The Charlmont soil landscape is a swamp landscape, dominated by broad, flat to gently inclined, occasionally elongated swampy floodplains and backplains along lower intertidal reaches of the Bellinger River. This soil landscape traverses the study area at Cameron's Corner. Slopes are less than 2% with elevations of less than 10 m AHD. Soils within this landscape are deep, poorly drained Yellow Podzolic Soils, structure plastic clays and Gleyed Podzolic Soils. These soils are strongly to extremely acid, sodic, saline soils with high aluminium toxicity potential, high organic matter, low to very low wet bearing strength and slow subsoil permeability. Additional limitations include flood hazard, waterlogging, permanently high watertable, high to severe foundation hazard and high to severe acid sulfate soil hazard (Milford1999).

The Raleigh soil landscape is an alluvial landscape dominated by long, narrow curved fluvial levees and scrolls on the meander plain of the tidal Bellinger River. This soil landscape is located generally to the north of Waterfall Way within the western 1 km of the study area. Slopes are generally less than 2% with elevations of less than 10m AHD. Soils are deep, moderately well-drained to poorly drained Earthy Sands, alluvial loams, alluvial clays, Yellow Podzolic Soils and Gleyed Podzolic Soils. These soils are strongly acid soils with high aluminium toxicity potential, low to very low wet bearing strength, high erodibility and low subsoil fertility. Additional limitations include high water erosion hazard, flood hazard, seasonal waterlogging and foundation hazard (Milford1999).

The Gleniffer soil landscape is also an alluvial landscape, dominated by level to undulating alluvial terraces in the Bellinger and Orara Valleys. This soil landscape is found in two smaller portions of the study area, at Cameron's Corner, and adjacent to Connells Creek. Slopes are 0-10%, with elevations 10 to 30 m. Soils are deep well-drained structured Red Earths in the Bellinger Valley. These soils are strongly acid soils, with low wet bearing strength, low subsoil fertility, high aluminium toxicity potential, very high subsoil erodibility, high foundation hazard and water erosion hazard (Milford1999).

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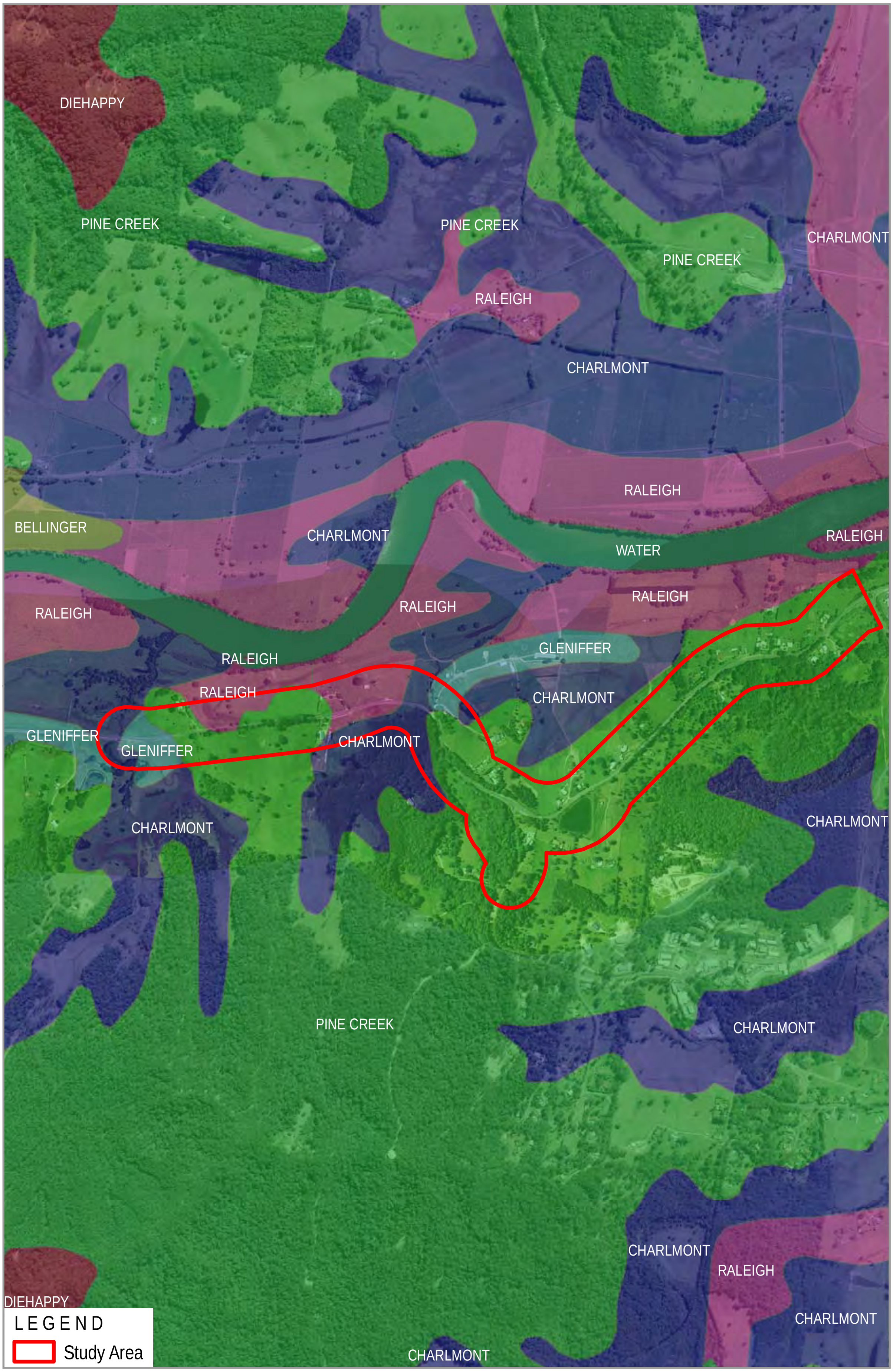
Source of base data: NSW Roads and Traffic Authority and Department of Land and Water Conservation



North

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Soil Landscapes

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Acid Sulfate Soil Management Plan: Pacific Highway to Connells Creek Upgrade Illustration 2.1
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3 Preliminary Assessment

3.1 Site indicators of ASS

GeoLINK conducted a site investigation on 28 July 2011. The study area is within an undulating rural area to the south of the Bellinger River and associated with the river floodplain. The landscape contains Casuarina and Melaleuca species in a broader context in uncleared areas (Plate 3.1). In low-lying cleared areas, scattered sedges are present where the water table was at or near the ground surface, such as the soil sampling sites (refer to Plate 3.2). Potential iron precipitate associated with ASS was visible in the swamp area (refer to Plates 3.3 and 3.4).

Floodplain with distant Casuarina sp. and Melaleuca sp. viewed from Soil Sampling Location 1

Sedges adjacent to Soil Sampling Location 2

Iron precipitate adjacent to Soil Sampling Location 3

Potential Iron precipitate in swamp adjacent to Soil Sampling Location 3

3.2 Review of previous assessment within the study area

A Geotechnical Investigation Report was prepared by the NSW RTA in 2004 for former proposed works to realign the Camerons Corner section of Waterfall Way. The investigation included analysis of ASS materials at two sampling locations to depths of 1.7 and 1.8 m. Sampling locations are identified on Illustration 3.2. Seven samples were collected. The laboratory results are attached at Appendix E, and the findings are summarised below.

One sample at location CC4 and depth 1.1-1.5m was classified as Potential Acid Sulfate Soil (PASS). Six of the seven samples analysed were classified as Actual Acid Sulfate Soil (AASS).

One sample was not classified as either PASS or AASS from sampling location CC3 at 1.5-1.8 m depth. The assessment provided a liming rate of 9.7 kg/m^3.

The findings indicate that excavation will disturb ASS and therefore an Acid Sulfate Soil Management Plan (ASSMP) is required.

The results of the NSW RTA 2004 assessment have been included in the preparation of this ASSMP. It should be noted that additional sampling has not been undertaken in the Camerons Corner vicinity for this current assessment.

3.3 ASS mapping

Reference to the Bellingen ASS Risk Map indicates the study area contains three areas that are mapped as having a high probability of occurrence of ASS (refer to Illustration 3.1). The areas are described as an alluvial swale, alluvial swamp and alluvial plain with elevations of 2 to 4 m AHD. ASS materials if present are mapped as being between 1 and 3 m below ground surface.

3.4 Soil sampling

Additional sampling was considered necessary in the western extent of the study area that was not included in the previous assessment. Twelve soil samples were collected on 28 July 2011 from three locations. Two of the three soil sampling locations were situated on river flats and one was adjacent to a swamp (refer to Illustration 3.2). Sample distribution is described as:

- two linear samples spaced at approximately 100 m distance at the western extent of the study area near Connell's Creek; and
- one location adjacent to a swamp.

At each location samples were collected at intervals of 0.5 m to a depth of 2 m.

Table 3.1 Compliance with Soil Sampling Requirements – Road works

Issue	ASSMAC Requirements	Soil Sampling Regime	Compliance
Sampling density	Linear at no more than 100 m intervals in ASS mapped areas	2 bore holes per 200 m length of mapped ASS area	Yes
Sampling depth	Collection of samples from each soil horizon or 0.5 m intervals to 2 m depth, or 1 m beyond maximum excavation depth, whichever is the greater	At 0.5 m intervals to a depth of 2 m	Not strictly, however sampling depth is considered adequate

The soil sampling regime for road works generally complies with ASSMAC guidelines for soil sampling density and depth. Sampling depth is not strictly in accordance with guidelines however it is 0.6 m below excavation depth and is considered adequate.

However, soil sampling was not undertaken within the proposed sediment basins. Given the depth of excavation is to 2.5 m, additional sampling is required to identify the presence of ASS within these areas. This additional sampling should occur following determination of preferred route during REF preparation with the report to be updated to reflect sampling results. All future sampling is to be consistent with guidelines. This is discussed further in Section 3.5 below.

Samples were collected using a hand auger, chilled and stored in an esky and sent to NATA registered laboratory, Environmental Analysis Laboratory at Southern Cross University, Lismore.

Samples were tested for Chromium Reducible Sulfur (CRS) and Titratable Actual Acidity (TAA) to determine if the soil is Actual Acid Sulfate Soil (AASS) or Potential Acid Sulfate Soil (PASS). The samples were screened for the presence of PASS using the methods 21Af and 21Bf of ASSMAC (1998).

3.5 Additional Soil Sampling Required for Sediment Basins

Further ASS sampling and assessment is required in the area of the proposed sediment basins as their excavation depth is greater than 1 m, and they are non-linear. Sampling is proposed in accordance with the Guidelines for Sampling and analysis of Lowland Acid Suflate Soils in Queensland, 1998 (Ahern et al).

Obtaining samples from two boreholes within the footprint of each of the sediment basins identified as C4b, C5 and C6 is required. Samples are to be collected from 0.5 m depth intervals to a total depth of 4.0 m, making a total of 48 samples.

This sampling methodology is based on maximum proposed depth of excavation being 3 m (ie. sampling should be at least 1 m deeper than the maximum depth of excavation). The borehole and number of samples assumes consistent soil profiles. Additional borehole locations will be required if soil profiles are inconsistent within the footprint.

The ASSMP will require amendment to incorporate additional soil sampling methodology and analysis results and consideration of water quality issues for the management of sediment basins and dewatering.

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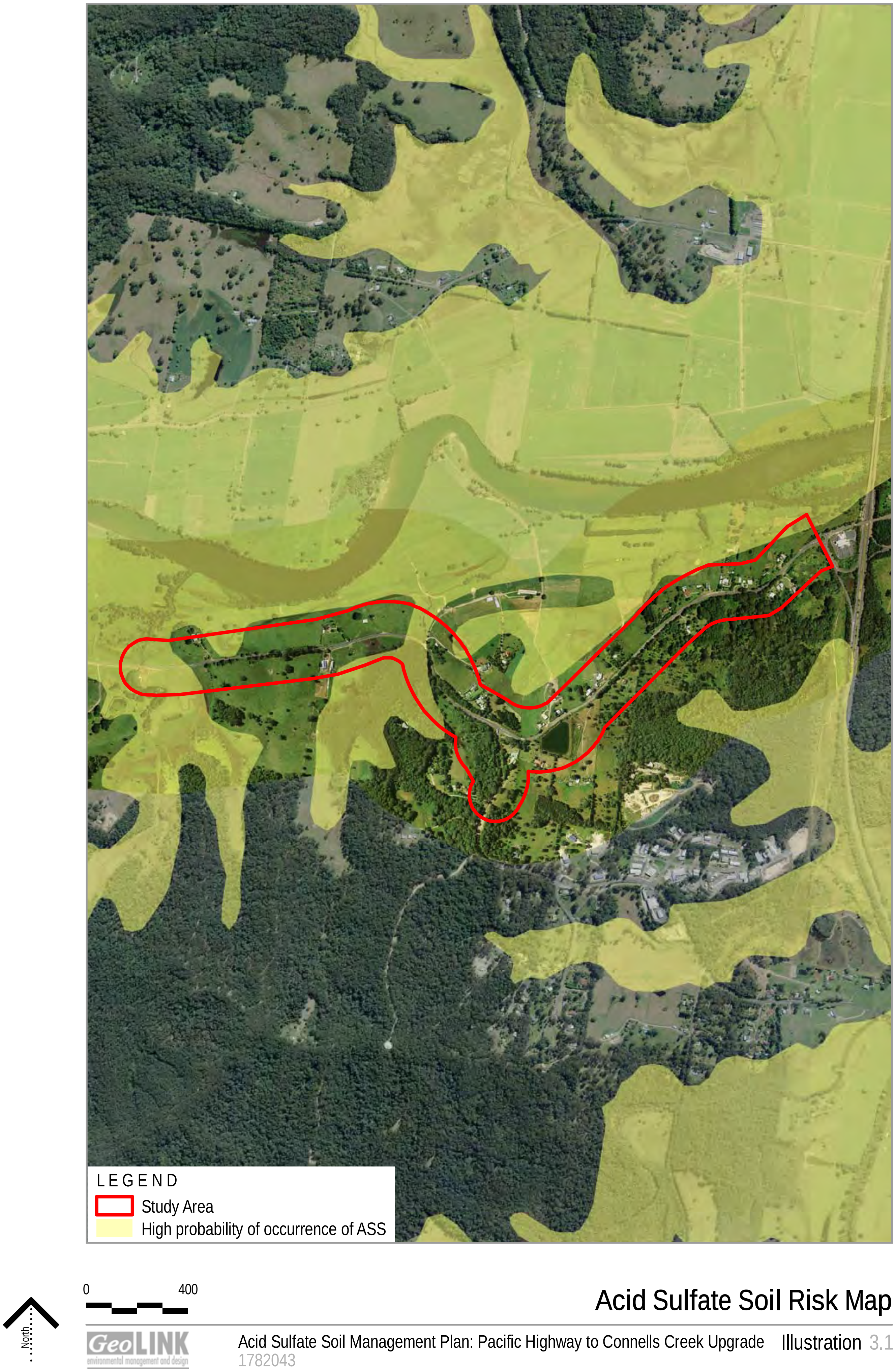
Source of base data: NSW Roads and Traffic Authority and Department of Land and Water Conservation



Acid Sulfate Soil Risk Map

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Acid Sulfate Soil Management Plan: Pacific Highway to Connells Creek Upgrade
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Illustration 3.1

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Source of base data: NSW Roads and Traffic Authority

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Acid Sulfate Soil Management Plan: Pacific Highway to Connells Creek Upgrade
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Soil Sampling Locations and ASS Treatment Areas

Illustration 3.2

Plate 3.5 Soil Sampling Location 1

Plate 3.6 Soil Sampling Location 2

Plate 3.7 Soil Sampling Location 3

3.6 Acid sulfate soil assessment results

Results of the laboratory testing are presented in Appendix B and summarised in Table 3.2 for PASS testing and Table 3.3 for AASS testing. PASS was not identified within any of the 12 samples analysed. AASS was identified in 11 of the samples.

Table 3.2 Summary of Results for Potential Acid Sulfate Soil Analysis

Sample	Sample Depth (m)	Texture	Criteria for classification of PASS (%Scr)	Reduced Inorganic Sulfur (%Scr)	Classification of Potential Acid Sulfate Soil
A500	0.5	Fine	□0.1%S	<0.01	Not PASS
A1000	1.0	Fine	□0.1%S	<0.01	Not PASS
A1500	1.5	Fine	□0.1%S	0.01	Not PASS
A2000	2.0	Fine	□0.1%S	0.01	Not PASS
B500	0.5	Fine	□0.1%S	0.01	Not PASS
B1000	1.0	Fine	□0.1%S	0.03	Not PASS
B1500	1.5	Fine	□0.1%S	0.03	Not PASS
B2000	2.0	Fine	□0.1%S	0.02	Not PASS
C500	0.5	Fine	□0.1%S	0.02	Not PASS
C1000	1.0	Fine	□0.1%S	0.06	Not PASS
C1500	1.5	Fine	□0.1%S	0.05	Not PASS
C1800	1.8	Fine	□0.1%S	<0.01	Not PASS

Table 3.3 Summary of Results for Actual Acid Sulfate Soil Analysis

Sample	Sample Depth (m)	Texture	Criteria for classification of AASS (mole H+/tonne)	Titratable Actual Acidity (TAA) (mole H+/tonne)	Classification of Actual Acid Sulfate Soil
A500	0.5	Fine	□62	86	AASS
A1000	1.0	Fine	□62	81	AASS
A1500	1.5	Fine	□62	105	AASS
A2000	2.0	Fine	□62	47	Not AASS
B500	0.5	Fine	□62	105	AASS
B1000	1.0	Fine	□62	162	AASS
B1500	1.5	Fine	□62	83	AASS
B2000	2.0	Fine	□62	88	AASS
C500	0.5	Fine	□62	89	AASS
C1000	1.0	Fine	□62	114	AASS
C1500	1.5	Fine	□62	90	AASS
C1800	1.8	Fine	□62	89	AASS

3.7 Need for acid sulfate soil management plan

The results of the soil tests undertaken exceed the action criteria for AASS. Therefore it is considered likely that ASS occurs on the site to the depth of the proposed excavations. In accordance with ASSMAC guidelines, an acid sulfate soil management plan (ASSMP) is required for these works.

4 Acid Sulfate Soil Management Plan

4.1 Consultation strategy

Soil sampling and analysis indicates there is a high risk that excavation may disturb AASS within the study area. There is also a high risk associated with dewatering, if required for culvert extension works. Containment and treatment is therefore required to reduce the risk of harm these materials may cause to the surrounding environment.

4.2 Acid sulfate soil management principles

The following principles of Acid Sulfate Soil Management are in accordance with the Acid Sulfate 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:
  - where possible, the proposed works will involve removal of topsoil only and placement of fill to attain a similar carriageway elevation to the existing road.
  - excavation of topsoil and placement of fill will occur within a 24 hour period, minimising exposure and oxidation of any ASS materials;
- neutralisation:
  - AASS materials occur within the soil profile to a depth of 2 m, therefore all excavation works that disturb the natural soil profile will require neutralisation with lime as outlined in Section 4.3.2 below; and
  - stockpile leachate and/or water extracted during dewatering must be in accordance water quality objectives listed in the RMS document *Technical Guideline: Environmental Management of Construction Site Dewatering* (EMCSD) and in accordance with the *Protection of the Environment Operations Act* 1997 (POEO Act).

4.2.1 Mitigation measures

The following mitigation measures are to be implemented where excavation occurs within ASS treatment areas identified on Illustration 3.2 or if ASS soils are identified during excavation works in other areas:

- soils identified as PASS and/or AASS shall be disturbed to a minimum;
- the time 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 to recommended liming rate and 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 300 mm clean fill within 24 hours. This could be achieved by:
    - excavating 300 mm greater than the finished level then backfilling with 300 mm 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.

Should temporary stockpiling of soils be required for longer than 24 hours the following additional mitigation measures are to be implemented:

- excavated 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 m away from waterways; and waterbodies including wetlands;
- the stockpiles are to be bunded, and soils covered to slow oxidation and prevent ingress of rainfall;
- treatment using the liming procedure (outlined below) should immediately follow excavation;
- upstream flow diversion and downstream leachate collection measures should be installed around the stockpiles;
- any stockpile leachate and/or sediment basin dewatering is to be undertaken in accordance with 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) and the EMCSD. Section 4.6 of the EMCSD requires water quality objectives criteria as follows:
  - 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.

4.2.2 Liming and treatment procedure for ASS

1. Lime the base of the stockpile pad with a 5 mm thick layer of fine grade-1 agricultural lime;

2. Spread excavated ASS onto the pad in layers 10 – 30 cm thick;
3. Apply lime at a standard rate of 10 kg of lime per tonne of soil excavated.
4. Note: windy conditions should be avoided for safety and efficiency;
5. Cultivate lime into the ASS layer well, preferably using a rotary hoe. Ensure an even homogenous mix of soil and lime is created before spreading the next soil layer;
6. Repeat steps 2 – 5 as required.

4.2.3 Sedimentation Basins: Soil Sample Analysis

Sedimentation basins are proposed for the works. Additional soil sampling and analysis to a depth of 4 m (being 1 m beyond the maximum excavation depth) is required prior to following determination of the preferred route during REF preparation with the report to be updated to reflect sampling results. Laboratory analysis will provide liming rates required to neutralise excavated soil for these sites and excavation depths. Additional soil sampling and analysis is to comply with ASSMAC guidelines.

4.2.4 Sedimentation Basins: Potential Dewatering

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

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

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 EMSCD water quality objectives criteria as follows:

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

This ASSMP 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.

General Water Quality Issues

Soils on site have been categorised as Type D Dispersible soils. These soils contain 10 per cent or more dispersible material and require a flocculation agent, such as gypsum, to assist with settling when captured in a sediment basin. Dosing should occur within 24 hours once the storm event generating runoff has concluded. When the total suspended solids levels have dropped below 50 milligrams per litre, the basin may be dewatered. This usually takes between 36 and 48 hours if gypsum has been used. Note that the design calls for each sediment basin to be settled and drained within five days of the conclusion of each storm event.

To protect downstream water quality, all pollutants, sediment and/or waste removed from sediment basins, sediment fencing and gross pollutant traps will be disposed in stabilised dumps where soil and water measures have been implemented to stop offsite movement of these pollutants. All rubbish and wastes will be collected and disposed of at an approved disposal depot or recycled during and upon completion of the works. Work will cease if any pollution problems are suspected or detected. This will be detected through visually monitoring the work site, keeping a fuel and chemical inventory which will be reconciled on a monthly basis, monitoring discharge waters and the downstream water bodies for sediment entrainment and physical changes.

Additionally, to prevent adverse impacts in relation to surface and ground water, the following mitigation measures will be *considered for inclusion in Review of Environmental Factors for the preferred route option:*

- erosion and sediment control measures will be fully implemented, managed and maintained for the duration of the construction activities;
- vegetated areas will only be cleared and stripped of topsoil immediately prior to excavations;
- works are to be carried out wherever possible during the cooler months, when rainfall events occur less frequently;
- the weather is to be monitored during the proposed period of works. Works (particularly pavement formations and excavations) are to be scheduled outside of forecasted significant rain events and postponed during unforeseen rain events;
- works will cease and all sediment control measures checked and repaired or reinstalled (if required) if heavy rainfall was forecast;
- all surface water runoff will be directed to a sediment retention basin prior to discharge from the site;
- sediment control features will be checked as soon as practical (within 24 hours) after significant rainfall events;
- disturbed areas will be stabilised and/or revegetated as soon as practicable;
- surface water runoff from rehabilitated areas will be directed around the works areas, keeping 'clean' runoff separate from 'dirty' runoff;
- all fuels and chemicals will be stored in a bunded area sufficient to hold 1.5 times the quantity of volume stored;
- a spill containment kit, including equipment to address both terrestrial and aquatic spills, would be available at all times. Staff would be trained in the effective deployment of the spill containment kit.
- refuelling of equipment and vehicles will only occur in an appropriately bunded area or offsite (e.g. at a depot);
- all equipment will be maintained and operated according to manufacturer's specifications; and

Potential for localised ground water displacement

Placing fill over soft soils causes settlement. Acid sulfate soils are known to have a low strength, thus any significant load placed over such soils will cause consolidation of the underlying material. Consolidation results in water being expelled from pores within the soil matrix over a period of time. In the case of acid sulfate soils, this water could be acidic and movement of this water could contaminate the surrounding environment and corrode susceptible buried infrastructure. The proposed upgrade works will require substantial volumes of fill placed over areas classified as ASS and PASS.

In order to minimise the risk posed by filling over underlying ASS, lime-rich sand can be placed as a filter layer along the downstream perimeter of these fill sites to neutralise the buried ASS.

The amount of lime within the sand is to be determined by the acidity of affected groundwater and designed to include a factor of safety between 1.5 and 2.0.

4.3 Monitoring

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. EMSCD and ANZECC Water Quality Criteria require that pH of water discharged into the environment must be between 6.5 and 8.5.

4.4 Training

All construction staff and site personnel must be made aware of their environmental responsibilities and safeguard measures from the ASSMP to minimise environmental impacts.

An onsite meeting must be held with each relevant contractor, construction staff, site personnel, RTA Project staff and the RTA's Northern Environmental Officer before the commencement of works/activities, including site establishment. 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 sulfate 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. Environmental awareness/toolbox talks must commence early in the program and continue as new personnel/contractors are engaged.

A field guide for the identification of ASS materials is attached at Appendix C.

5 Project Team

The project team members included:

Ali McCallum
Environmental Scientist - Assessment and Reporting

Tim Ruge
Environmental Engineer - Assessment and Reporting

6 References

Acid Sulfate Soil Management Advisory Committee (1998). *Acid Sulfate Soil Manual*

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Southern Cross GeoScience, (2009). *Professional Short Course, Acid Sulfate Soils: Identification, Assessment and Management, Course Manual*, NSW

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Department of Land and Water Conservation (1995). *1:25,000 Bellingen/Raleigh ASS Risk Map*. Edition 2.

7 Copyright and Usage

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Topographic information presented on the drawings is suitable only for the purpose of the document as stated above. No reliance should be placed upon topographic information contained in this report for any purpose other than that stated above.

Appendix A

Soil sampling chain of custody

CHAIN OF CUSTODY

B5255.

Environmental Analysis Laboratory

Delivery Address:

Environmental Analysis Laboratory
Southern Cross University
PO Box 157 (Military Road)
LISMORE NSW 2480

Phone: 02 6620 3678
Mobile: 0419 984 088 (Lab Manager)
Fax: 02 6620 3957
Email: eal@scu.edu.au
Website: www.scu.edu.au/eal

Submitting Client Details

Quote Id:
Job Ref: GEO01872
Company Name: GeoLINK
Contact Person: Ali McCallum
Phone: 02 6651 7666
Mobile: 0427 228 102
Fax: 02 6651 7733
Email: amccallum@geolink.net.au
Postal Address: PO Box 1446
COFFS HARBOUR NSW 2450

Billing Client Details

Quote Id:
Company Name: GeoLINK
Contact Person: Ali McCallum
Phone: 02 6651 7666
Mobile: 0427 228 102
Fax: 02 6651 7733
Email: amccallum@geolink.net.au
Postal Address: PO Box 1446
COFFS HARBOUR NSW 2450

Payment Method:
☐ Purchase Order
☐ Cheque
☒ Invoice (prior approval required)
☐ Credit Card Mastercard / Visa No: _____/_____/_____/_____

Exp. Date: Name on Card: Signature:

		Date	Signed
Relinquished By:		1/8/2011	amCall
Preservation: None / Ice / Ice bricks / Acidified / Filtered / Other: Frozen			
Received By:	C-Starr	2.8.11	Cr
Condition on receipt: Ambient / Cool / Frozen / Other:			

Comments:

Sample Analysis Request
Price List Code (e.g. SW-PACK-06)

Lab Sample No.	Sample ID	Sample Depth	Sampling Date	Your Client	Crop ID	Sample Type (e.g. water, leaf, soil)	AS-PACK-O1							
	A500	500	28/7/11	RTA		SOIL	✓							
	A1000	1000	28/7/11	RTA		SOIL	✓							
	A1500	1500	28/7/11	RTA		SOIL	✓							
	A2000	2000	28/7/11	RTA		SOIL	✓							
	B500	500	28/7/11	RTA		SOIL	✓							

CHAIN OF CUSTODY

ıents:

e	Sample ID	Sample Depth	Sampling Date	Your Client	Crop ID	Sample Type (e.g. water, leaf, soil)	AS-PACK-O1									
	B1000	1000	28/7/11	RTA		SOIL	✓									
	B1500	1500	28/7/11	RTA		SOIL	✓									
	B2000	2000	28/7/11	RTA		SOIL	✓									
	C500	500	28/7/11	RTA		SOIL	✓									
	C1000	1000	28/7/11	RTA		SOIL	✓									
	C1500	1500	28/7/11	RTA		SOIL	✓									
	C1800	1800	28/7/11	RTA		SOIL	✓									

Sample Analysis Request — Price List Code (e.g. SW-PACK-06)

Appendix B

Laboratory results

RESULTS OF ACID SULFATE SOIL ANALYSIS

12 samples supplied by Geolink on 2nd August, 2011 - Lab. Job No. B5255

Analysis requested by Ali McCallum. **Your Project: GEO01872 - RTA**

PO Box 1446, Coffs Harbour NSW 2450

Required if pH_{KCL} <4.5 (Retained Acidity); required if pH_{KCl} > 6.5 (Acid Neutralising Capacity)

Sample Site	EAL lab code	TEXTURE (note 6)	MOISTURE CONTENT		TITRATABLE ACTUAL ACIDITY (TAA) (To pH 6.5)		REDUCED INORGANIC SULFUR (% chromium reducible S)		RETAINED ACIDITY (HCL extract) (as $\%S_{HCL}$ - $\%S_{Kcl}$)	S_{NAS}	ACID NEUTRALISING CAPACITY (ANC_{BT})		NET ACIDITY Chromium Suite mole H^+/tonne	LIME CALCULATION Chromium Suite kg $CaCO_3$/tonne DW
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH_{KCl}	(mole H^+/tonne)	(%Scr)	(mole H^+/tonne)	($\%S_{NAS}$)	(mole H^+/tonne)	(% $CaCO_3$)	(mole H^+/tonne)	(based on %Scrs)	(includes 1.5 safety Factor when liming rate is $^+$ve)
Method No.													*note 5*	*note 4 and 6*
A500	*B5255/1*	Fine	25.9	0.35	4.51	86	<0.01	0	..	0	..	0	86	6.5
A1000	*B5255/2*	Fine	23.7	0.31	4.57	81	<0.01	0	..	0	..	0	81	6.1
A1500	*B5255/3*	Fine	25.0	0.33	4.50	105	0.01	6	..	0	..	0	112	8.4
A2000	*B5255/4*	Fine	20.6	0.26	4.57	47	0.01	6	..	0	..	0	54	4.0
B500	*B5255/5*	Fine	27.8	0.39	4.59	105	0.01	6	..	0	..	0	112	8.4
B1000	*B5255/6*	Fine	33.3	0.50	4.53	162	0.03	19	..	0	..	0	181	13.6
B1500	*B5255/7*	Fine	24.8	0.33	4.56	83	0.03	19	..	0	..	0	102	7.6
B2000	*B5255/8*	Fine	28.9	0.41	4.74	88	0.02	12	..	0	..	0	101	7.6
C500	*B5255/9*	Fine	35.4	0.55	4.54	89	0.02	12	..	0	..	0	102	7.6
C1000	*B5255/10*	Fine	42.9	0.75	4.58	114	0.06	37	..	0	..	0	151	11.3
C1500	*B5255/11*	Fine	29.7	0.42	4.55	90	0.05	31	..	0	..	0	121	9.1
C1800	*B5255/12*	Fine	20.9	0.26	4.64	89	<0.01	0	..	0	..	0	89	6.7

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)

2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & sulfate) and 'Chromium Reducible Sulfur' technique (Scr - Method 22B)

3 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines.*** QLD DNRME.

4 - Bulk Density is required for liming rate calculations per soil volume. Lab. Bulk Density is no longer applicable - field bulk density rings can be used and dried/ weighed in the laboratory.

5 - **ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Scrs or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF (with FF currently defaulted to 1.5)**

6 - The neutralising requirement, lime calculation, includes a 1.5 safety margin for acid neutralisation (an increased safety factor may be required in some cases)

7 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays

8 - .. denotes not requested or required. '0' is used for ANC and Snag calcs if TAA pH <6.5 or >4.5

9 - SCREENING, CRS, TAA and ANC are NATA accredited but other SPOCAS segments are currently not NATA accredited

10- Results at or below detection limits are replaced with '0' for calculation purposes.

11 - Projects that disturb >1000 tonnes of soil, the ≥0.03% S classification guideline would apply (refer to acid sulfate management guidelines).

12 - Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.

NATA Lab Accred No: 14960 This Document is issued in accordance with NATA's accreditation requirements. Accredited for compliance with ISO/IEC 17025

(Classification of potential acid sulfate material if: coarse Scr≥0.03%S or 19mole H^+/t; medium Scr≥0.06%S or 37mole H^+/t; fine Scr≥0.1%S or 62mole H^+/t) - as per QUASSIT Guidelines

checked: ....

Graham Lancaster

Laboratory Manager

Environmental Analysis Laboratory, Southern Cross University,
Tel. 02 6620 3678, website: scu.edu.au/eal

Report Date/Time: 9 August 2011 11:50:22AM

Sample Receipt Notification (SRN)

Project:	EAL/B5348
Customer:	**Geolink - Coffs Harbour**
Contact:	Ali McCallum
Client Job ID:	GEO01679 6x Soil Samples
No. of Samples:	6 samples
Date Received:	9/08/2011
Comments:	Standard Request
Biller:	**Geolink - Coffs Harbour** - Ali McCallum - 02 6651 7666

Environmental Analysis Laboratory
PO Box 157
Lismore NSW 2480
ABN: 41 995 651 524
Tel: (02) 6620 3678 Fax (02) 6620 3957
Email: eal@scu.edu.au

Test Request

Sample Text ID	Client Sample ID	SS-PACK-04 Metals Scan	SS-PACK-17 Petroleum Compounds Assessment 1a
B5348/001	A	1	1
B5348/002	B	1	1
B5348/003	C	1	1
B5348/004	D	1	1
B5348/005	E	1	1
B5348/006	F	1	1
Total		**6**	**6**

Appendix C

Identifying Acid Sulfate Soil

C1 Potential Acid Sulfate Soil (PASS)

C1.1 PASS Characteristics

- waterlogged soils – unripe muds (soft, sticky and can be squeezed between fingers, blue grey or dark greenish grey mud with a high water content), silty sands or sands (mid to dark grey) or bottom sediments (dark grey to black e.g. iron monosulfides "black oozes") possibly exposed at sides and bottom of drains or cuttings, or in boreholes;
- peat or peaty soils;
- coffee rock horizons; or
- a sulfurous smell e.g. hydrogen sulfide or 'rotten egg' gas.

Plate C1 Potential ASS Soil Profile

Plate C2 Potential ASS Soil Profile

Source: http://www.ccma.vic.gov.au/soilhealth/photos.htm

C1.2 Water Characteristics

- Waterlogged soils;
- water pH usually neutral but may be acidic; or
- oily looking iron bacterial surface scum (the similar appearances of iron bacterial scum and a hydrocarbon slick can be differentiated by disturbing the surface with a stick: bacterial scum will separate if agitated whereas a hydrocarbon slick will adhere to the stick upon removal).

NB: Caution should be taken when inspecting highly altered landscapes in the field (e.g. where inert fill has been placed over ASS material, dredge spoil, etc). Soil, water and landscape indicators may be masked by past landscape and drainage modifications and this should be taken into consideration when determining borehole locations.

C1.3 Vegetation Characteristics

- Dominant vegetation is tolerant of salt, acid and/or water logging conditions e.g. mangroves, salt couch, *Phragmites* (a tall acid tolerant reed), swamp-tolerant reeds, rushes, paperbarks (*Melaleuca spp.*) and swamp oak (*Casuarina spp.*).

C1.4 Field Indicators for PASS Characteristics

- Typically waterlogged, unripe muds (soft, buttery texture, blue grey or dark greenish grey) or estuarine silty sands or sands (mid to dark grey) or bottom sediments of estuaries and tidal lakes (dark grey to black);

- offensive odour, predominantly due to 'rotten egg gas' (hydrogen sulfide H2S).

C2 Actual Acid Sulfate Soil (AASS)

C2.1 AASS Characteristics

- Presence of corroded shell;
- sulfurous smell e.g. hydrogen sulfide or 'rotten egg' gas; and any jarositic horizons or substantial iron oxide mottling in surface encrustations or in any material dredged or excavated and left exposed.

Plate C3 Potential ASS Soil Profile

Plate C4 Potential ASS Soil Profile

Source: http://www.ccma.vic.gov.au/soilhealth/photos.htm

C2.2 Water Characteristics

- water of pH <5.5 (and particularly below 4.5) in surface water bodies, drains or groundwater (this is not a definitive indicator as organic acids may contribute to low pH in some environments such as *Melaleuca* swamps);
- unusually clear or milky blue-green water flowing from or within the area (aluminium released by ASS acts as a flocculating agent);
- extensive iron stains on any drain or pond surfaces, or iron-stained water and ochre deposits; and
- oily looking bacterial surface scum (differentiated from a hydrocarbon slick of similar appearance as described for PASS).

C2.3 Vegetation Characteristics

- dead, dying, stunted vegetation;
- scalded or bare low-lying areas; and
- poor vegetation regrowth in previously disturbed areas.

C2.4 Infrastructure

- corrosion of concrete and/or steel structures (including foundations, fences, masonry/brick walls, pipes).

NB: May also be due to excessive salinity or to salinity in combination with AASS.

C2.5 Field Indicators for AASS Characteristics

- Unusually clear or milky blue-green drainage water within or flowing from the area (Aluminium released by the ASS acts as a flocculating agent);
- extensive iron stains on any drain or pond surfaces, or iron-stained water and ochre deposits;
- Jarosite containing horizons or iron oxide mottling in auger holes or recently dug surfaces;
- Jarosite present in surface encrustations or in any material dredged or excavated and left exposed;
- corrosion of concrete and/or steel structures;
- dominance of mangroves, reeds, rushes and other swamp-tolerant vegetation; and
- sulphurous (H_2S) smell after rain following a dry spell, or when the soils are oxidised or disturbed.

The straw-coloured material in the black clay in Plate C5 is the mineral Jarosite appearing along the root channels. Jarosite is evidence that there is oxidised ASS. It is found in places where the ASS has been disturbed (excavated or drained) so that the previously inundated ASS layers have been exposed to air.

Plate C5 Jarosite along root channels

Source: http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil_acid_sulfate_soils

Plate C6 Sulfidic material in Acid Sulfate Soil formed in the River Murray under permanently waterlogged or saturated conditions under 75 to 100 cm of water

Source: Government of South Australia Information Sheet: Acid Sulfate Soils along the Lower Murray River

Plate C7 White and yellow salt efflorescence on soil surface and with bright yellow mottles in cracks

Source: Government of South Australia Information Sheet: Acid Sulfate Soils along the Lower Murray River

Plate C8 Monosulfidic black ooze

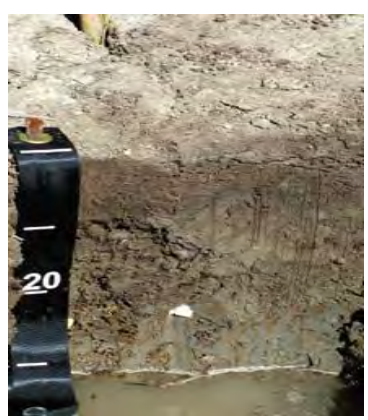

Plate C9 Soil profile showing white and

(MBO) material exposed in shallow backswamp wetlands	yellow salt efflorescence on the surface with sulfuric material. Soil becomes acidic (pH <4) after drainage. Sulfidic material Dark grey to black; grey matrix with light brown mottles in heavy clay. Only if disturbed will this layer become acidic (pH >4).

Source: Government of South Australia Information Sheet: Acid Sulfate Soils along the Lower Murray River

References

South Australia EPA (2007), *Contamination Site Guidelines for Acid Sulfate Soil Material.* South Australia, November 2007

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Appendix D

Acid sulfate soil management summary

Consultation strategy

Soil sampling and analysis indicates there is a high risk that excavation may disturb AASS within the study area. There is also a high risk associated with dewatering, if required for culvert extension works. Containment and treatment is therefore required to reduce the risk of harm these materials may cause to the surrounding environment.

Acid sulfate soil management principles

The following principles of Acid Sulfate Soil Management are in accordance with the Acid Sulfate 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:
  - where possible, the proposed works will involve removal of topsoil only and placement of fill to attain a similar carriageway elevation to the existing road.
  - excavation of topsoil and placement of fill will occur within a 24 hour period, minimising exposure and oxidation of any ASS materials;
- neutralisation:
  - AASS materials occur within the soil profile to a depth of 2 m, therefore all excavation works that disturb the natural soil profile will require neutralisation with lime as outlined in Section 4.3.2 below; and
  - stockpile leachate and/or water extracted during dewatering must be in accordance water quality objectives listed in the RMS document *Technical Guideline: Environmental Management of Construction Site Dewatering* (EMCSD) and in accordance with the *Protection of the Environment Operations Act* 1997 (POEO Act).

Management

Mitigation measures

The following mitigation measures are to be implemented where excavation occurs within ASS treatment areas identified on Illustration 3.2 or if ASS soils are identified during excavation works in other areas:

- soils identified as PASS and/or AASS shall be disturbed to a minimum;
- the time 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 to recommended liming rate and 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 300 mm clean fill within 24 hours. This could be achieved by:
  - excavating 300 mm greater than the finished level then backfilling with 300 mm 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.

Should temporary stockpiling of soils be required for longer than 24 hours the following additional mitigation measures are to be implemented:

- excavated 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 m away from waterways; and waterbodies including wetlands;
- the stockpiles are to be bunded, and soils covered to slow oxidation and prevent ingress of rainfall;
- treatment using the liming procedure (outlined below) should immediately follow excavation;
- upstream flow diversion and downstream leachate collection measures should be installed around the stockpiles;
- any stockpile leachate and/or sediment basin dewatering is to be undertaken in accordance with 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) and the EMCSD. Section 4.6 of the EMCSD requires water quality objectives criteria as follows:
  - 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.

Liming and treatment procedure for ASS

1. Lime the base of the stockpile pad with a 5 mm thick layer of fine grade-1 agricultural lime;
2. Spread excavated ASS onto the pad in layers 10 – 30 cm thick;
3. Apply lime at a standard rate of 10 kg of lime per tonne of soil excavated.
4. Note: windy conditions should be avoided for safety and efficiency;
5. Cultivate lime into the ASS layer well, preferably using a rotary hoe. Ensure an even homogenous mix of soil and lime is created before spreading the next soil layer;
6. Repeat steps 2 – 5 as required.

Sedimentation Basins: Soil Sample Analysis

Sedimentation basins are proposed for the works. Additional soil sampling and analysis to a depth of 4 m (being 1 m beyond the maximum excavation depth) is required prior to following determination of the preferred route during REF preparation with the report to be updated to reflect sampling results. Laboratory analysis will provide liming rates required to neutralise excavated soil for these sites and excavation depths. Additional soil sampling and analysis is to comply with ASSMAC guidelines.

Sedimentation Basins: Potential Dewatering

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

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

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 EMSCD water quality objectives criteria as follows:

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

This ASSMP 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.

General Water Quality Issues

Soils on site have been categorised as Type D Dispersible soils. These soils contain 10 per cent or more dispersible material and require a flocculation agent, such as gypsum, to assist with settling when captured in a sediment basin. Dosing should occur within 24 hours once the storm event generating runoff has concluded. When the total suspended solids levels have dropped below 50 milligrams per litre, the basin may be dewatered. This usually takes between 36 and 48 hours if gypsum has been used. Note that the design calls for each sediment basin to be settled and drained within five days of the conclusion of each storm event.

To protect downstream water quality, all pollutants, sediment and/or waste removed from sediment basins, sediment fencing and gross pollutant traps will be disposed in stabilised dumps where soil and water measures have been implemented to stop offsite movement of these pollutants. All rubbish and wastes will be collected and disposed of at an approved disposal depot or recycled during and upon completion of the works. Work will cease if any pollution problems are suspected or detected. This will be detected through visually monitoring the work site, keeping a fuel and chemical inventory which will be reconciled on a monthly basis, monitoring discharge waters and the downstream water bodies for sediment entrainment and physical changes.

Additionally, to prevent adverse impacts in relation to surface and ground water, the following mitigation measures will be *considered for inclusion in Review of Environmental Factors for the preferred route option:*

- erosion and sediment control measures will be fully implemented, managed and maintained for the duration of the construction activities;
- vegetated areas will only be cleared and stripped of topsoil immediately prior to excavations;

- works are to be carried out wherever possible during the cooler months, when rainfall events occur less frequently;
- the weather is to be monitored during the proposed period of works. Works (particularly pavement formations and excavations) are to be scheduled outside of forecasted significant rain events and postponed during unforeseen rain events;
- works will cease and all sediment control measures checked and repaired or reinstalled (if required) if heavy rainfall was forecast;
- all surface water runoff will be directed to a sediment retention basin prior to discharge from the site;
- sediment control features will be checked as soon as practical (within 24 hours) after significant rainfall events;
- disturbed areas will be stabilised and/or revegetated as soon as practicable;
- surface water runoff from rehabilitated areas will be directed around the works areas, keeping 'clean' runoff separate from 'dirty' runoff;
- all fuels and chemicals will be stored in a bunded area sufficient to hold 1.5 times the quantity of volume stored;
- a spill containment kit, including equipment to address both terrestrial and aquatic spills, would be available at all times. Staff would be trained in the effective deployment of the spill containment kit.
- refuelling of equipment and vehicles will only occur in an appropriately bunded area or offsite (e.g. at a depot);
- all equipment will be maintained and operated according to manufacturer's specifications; and

Potential for localised ground water displacement

Placing fill over soft soils causes settlement. Acid sulfate soils are known to have a low strength, thus any significant load placed over such soils will cause consolidation of the underlying material. Consolidation results in water being expelled from pores within the soil matrix over a period of time. In the case of acid sulfate soils, this water could be acidic and movement of this water could contaminate the surrounding environment and corrode susceptible buried infrastructure. The proposed upgrade works will require substantial volumes of fill placed over areas classified as ASS and PASS.

In order to minimise the risk posed by filling over underlying ASS, lime-rich sand can be placed as a filter layer along the downstream perimeter of these fill sites to neutralise the buried ASS. The amount of lime within the sand is to be determined by the acidity of affected groundwater and designed to include a factor of safety between 1.5 and 2.0.

Monitoring

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. EMSCD and ANZECC Water Quality Criteria require that pH of water discharged into the environment must be between 6.5 and 8.5.

Training

All construction staff and site personnel must be made aware of their environmental responsibilities and safeguard measures from the ASSMP to minimise environmental impacts.

An onsite meeting must be held with each relevant contractor, construction staff, site personnel, RTA Project staff and the RTA's Northern Environmental Officer before the commencement of works/activities, including site establishment. 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 sulfate 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. Environmental awareness/toolbox talks must commence early in the program and continue as new personnel/contractors are engaged.

A field guide for the identification of ASS materials is attached at Appendix C.

Appendix E

NSW RTA Laboratory Results

RESULTS OF ACID SULPHATE SOIL ANALYSIS (Page 1 of 1)

7 samples supplied by RTA-Grafton on 7th April, 2004 - Lab. Job No. E1929

Analysis requested by David Groth. - **Your Project: Cameron's Corner - Reissued 26/5/04 with corrections to comments for CC4-SS2**

Sample Site	Depth (m)	Texture (note 9)	Reduced Inorganic Sulphur (% chromium reducible S) (%Scr) (note 2)	% ANC %$CaCO_3$ (note 11)	NAGP Kg H_2SO_4/ Tonne soil (note 12)	TAA pH	Total Actual Acidity (TAA) mole / Kg	Lab. Bulk Density tonne DW/m³	Potential Acidity Neutralising Calculation Kg Lime/m³ (based on %Scr)	Potential Acidity Neutralising Calculation Kg Lime/m³ (based on NAGP)	Actual Acidity Neutralising Calculation Kg Lime/m³ (based on TAA)	COMMENTS RE: Classification as actual or potential acid sulphate soil (ASS) (based on %Scr results)
CC3- ASS1	0.15-0.35	Fine	0.016	..	..	4.04	0.136	1.03	0.5	..	6.8	**YES Actual** / NOT Potential ASS
CC3- ASS2	0.35-0.8	Fine	0.016	..	..	3.67	0.106	1.21	0.6	..	6.3	**YES Actual** / NOT Potential ASS
CC3- ASS3	1.0-1.3	Fine	0.019	..	..	3.68	0.085	1.35	0.8	..	5.6	**YES Actual** / NOT Potential ASS
CC3- ASS4	1.5-1.8	Medium	0.005	..	..	4.78	0.006	1.16	0.2	..	0.3	NOT Actual or Potential ASS
CC4- ASS1	0.25-0.55	Fine	0.035	..	..	3.90	0.120	1.11	1.2	..	6.5	**YES Actual** / NOT Potential ASS
CC4- ASS2	1.1-1.5	Fine	**0.106**	0.00	3.3	4.13	0.078	1.28	4.2	4.2	4.8	**YES Actual / YES Potential ASS**
CC4- ASS3	1.5-1.7	Fine	0.004	..	..	3.70	0.112	1.77	0.2	..	9.7	**YES Actual** / NOT Potential ASS
									Refer Note 6 & 7	Refer Note 6 & 7	Refer Note 6 & 7	

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)

2 - Samples analysed by **POCAS method** (ie Peroxide Oxidation - Combined Acidity and Sulphate - Version 3 updated published method) and **'Chromium Reducible Sulphur' technique** (Scr - Method 22B)

3 - Methods from Stone, Y. Ahern CR, and Blunden B (1998). **Acid Sulphate Soil Manual 1998.** ASSMAC, Wollongbar, NSW.

4 - Total carbon and total sulphur determined using a LECO CNS 2000 analyser

5 - Bulk density was determined immediately on arrival to laboratory (insitu bulk density is preferred)

6 - Neutralising Requirement (based on NAGP, chromium reducible sulphur or total sulphur) = Kg H_2SO_4/tonne x bulk density

7 - The neutralising requirement does not include a safety margin for complete neutralisation (a factor of 1.5 is often recommended)

8 - Conductivity 1 dS/m = 1 mS/cm = 1000 μS/cm

9 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays

10 - Neutralisation Calculation for neutralisation of actual and potential acidity (ie. sum of calculation based on Crs and TAA)

11 - ANC= Acid Neutralising Capacity of the Soil (Detection limit of 0.05% $CaCO_3$ Equivalent)- (this procedure is currently NOT NATA registered)

12 - NAGP= Net Acid Generating Potential= $(31.3*\%S_{ox})-(10*\%ANC)$ (From Mulvey, 1993)

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Number:

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(Classification of potential acid sulphate material if: coarse Scr≥0.03%S; medium Scr≥0.06%S; fine Scr≥0.1%S)

(equivalent conversions - 0.03%S = 0.019 mole/ Kg; 0.06%S = 0.037 mole/ Kg; 0.1%S = 0.062 mole/ Kg)

* Projects that disturb >1000 tonnes of ASS soils with ≥0.03% S, a detailed management plan may be required.

checked: ....