Z Railway Corridor – Acid Sulfate Soils Framework

CLIENTS | PEOPLE | PERFORMANCE

Hancock Prospecting Pty Ltd

Alpha Coal Project (Rail) Supplementary Environmental Impact Statement

Acid Sulfate Soil Management Framework

March 2011

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Contents

Table Index

Appendices

1. Introduction

1.1 Purpose and Objectives of the Framework

This framework for acid sulfate soil (ASS) management has been developed to outline the key working principles for managing the ASS component of drilling/excavation of sediments for the proposed rail line and loop within low-lying areas. This framework will form the basis for an ASS Management Plan (ASSMP), to be agreed with Department of Environment and Resource Management (DERM) and put in place prior to the start of construction.

The objectives of this framework are to:

- Outline the principles of ASS management for drilling/excavating soil
- Outline the principles of ASS management for any reclaimed areas
- Outline validation testing and monitoring for each of the above

This management framework is based on the information presented in the preceding chapters of this Environmental Impact Statement (EIS). This framework is not intended to be a detailed management plan for the project but rather an outline of the management principles. It is intended that, as the project progresses and more data is gathered, a more detailed investigation and management plans will be developed to incorporate all aspects of the project including earthworks, construction of the embankments, the rail infrastructure and disposal of sediments.

1.2 What are Acid Sulfate Soils?

ASS are soils that contain iron sulfides; which, when exposed to atmospheric oxygen in the presence of water, form sulfuric acid. ASS generally forms in protected low-energy environments such as barrier estuaries and coastal lakes, and commonly occurs in low-lying coastal lands such as Holocene-aged marine muds and sands. When disturbed, these soils are prone to producing sulfuric acid and mobilising heavy metals into groundwater. The release of these reaction products can be detrimental to biota, human health and built infrastructure.

The Queensland Acid Sulfate Soils Investigation Team (QASSIT) have released guidance notes on ASS, covering the requirement for assessing sites and the management of sites where ASS are identified. Consideration of ASS is required as part of a construction management plan, development conditions or as a requirement for a dewatering license application.

Proponents of developments that involve the disturbance of soil or the change of groundwater levels in areas susceptible to ASS, are required to conduct desktop and field based investigations to determine the extent and magnitude of ASS at the site to ascertain the potential risks and, if necessary, formulate appropriate management strategies.

1.3 Guiding Principles

The guiding principles of this ASS Framework are to set out the management objectives, measurable targets and key performance indicators, as determined by the State Planning Policy (SPP2/02) *Planning and Managing Development Involving Acid Sulfate Soils* and the QASSIT *Technical Manual - Soil Management Guidelines* (2002). The guiding principles are presented below. The preferred strategy is to

avoid disturbing potential acid sulfate soils (PASS), however, if suitable design and management programs are implemented, limited environmental impacts should occur. Therefore, where there is a potential for PASS to be present, consideration will be given to possible approaches to minimise disturbance of these soils and groundwater, and to evaluate the mitigation of any potential impacts.

The main objective of managing ASS is to prevent or minimise oxidation of PASS and any on and off-site impacts in a responsible and cost-effective way. The selection of appropriate strategies and management will depend on a number of site-specific characteristics, including:

- Type of excavation or development proposed
- Site history, including the presence of fill material
- Type of soil present (e.g. sand, clay, etc) including its buffering capacity
- Variability of soils on the site
- Surface hydrology and groundwater occurrence
- The receiving environment for waste soils and any discharge water

1.4 Overview of ASS within the Proposed Rail Route Footprint

ASS are generally confined to low-lying coastal areas of Holocene- to Quaternary-aged marine and estuarine sediments. The Geological Survey of Queensland 1:250,000 scale Digital Geological Mapping indicates that the low-lying coastal study area comprises of Quaternary-aged sediments and Carboniferous- to Permian-aged intrusive volcanics. The majority of the rail loop area (Abbot Point) consists of Quaternary-aged alluvium, coastal mud flats, minor evaporates, colluvium and soil. This particular geological unit (Qa) generally corresponds to areas that are below 5 m AHD (refer to Figure 1 in Appendix A). Further details regarding the geology of the study are can be found in Section 5 (Soils, Topography and Land Disturbance) of the Alpha Coal Project EIS (Hancock Prospecting, 2010).

With respect to local planning policies, developments that have the potential to disturb in-situ ASS fall under the assessment of the SPP 2/02, which requires an ASS investigation if the Project:

- Falls in an area mapped as containing ASS
- Fill greater than or equal to 500 m^3 is being filled at or above 0.5 m height, on land below 5 m Australian Height Datum (AHD)
- At or within 5 m AHD, excavations exceeding 100 m^3
- At or within 20 m AHD, excavation exceeding 100 m^3 at or below 5 m AHD

Two sections of the proposed rail route fall at or below 20 m AHD, between chainage 482.5 km and 487.0 km, and between chainage 492.5 km and 510.0 km (rail loop area). The first section, chainage 482.5km to 487.0 km, ranges in elevation from approximately 15 m AHD to 25 m AHD, and should not require excavation to or below 5 m AHD. The second section, chainage 492.5 km to 510.0 km, traverses low lying areas with a ground surface elevation ranging from less than 1 m to 5 m AHD. Previous investigations, further outlined in Section 5.2.1 of the EIS (Hancock Prospecting, 2010), indicate the presence of ASS and PASS around Abbot Point. Construction in these areas will involve the use of in-fill, as well as potential excavation of piers for three bridge structures – over Splitters Creek at chainage 484.85, a bridge over the Bruce Hwy and North Coast rail line between 492.6 and 492.8 and over Saltwater Creek at 498.25; and minor excavation to bed culverts at various locations including within the

rail loop section that intersects the Caley Valley wetlands. Under the SPP 2/02, the proposed development will require an ASS assessment, and if required, preparation of an ASS Management Plan.

1.5 Key ASS Management Principles for Construction of the Rail Loop

The key ASS management principles for construction of the Rail Loop are:

- Confirmation of the delineation and quantity of PASS sediments within the footprint, prior to drilling/excavation/dewatering
- Confirmation of the delineation of non-ASS sediments within the footprint, prior to drilling/excavation/dewatering
- Minimisation of rehandling of sediments identified as containing oxidisable sulfur above the action criteria, in order to reduce the potential of dispersion of sulfidic fines
- Appropriately test, handle, treat (neutralise) and manage disposal of any excavated material that exceeds a volume of 100m^3 (if located at or below 5 m AHD)

2. Initial ASS Assessment and Screening Process

Suitably qualified personnel will be required to evaluate the possible presence of ASS within the subsurface.

The possible occurrence of ASS needs to be established on a site by site basis. A preliminary screening process should be undertaken, which would normally utilise published DERM risk maps and CSIRO data where available. Given that there are no DERM ASS risk maps available for the northern section of the proposed rail alignment, including Abbott Point, the following sources are reviewed in relation to the site:

- Generic soil maps
- Environmental geological maps
- Topographic maps
- Other local investigations/environmental reports from previous studies

The information will be used to classify the individual sites into the following acid sulfate soil risk categories:

- No Known ASS Risk
- Low to Moderate ASS Risk
- Moderate to High ASS Risk

The risk categories are further described in the following Sections 2.1 to 2.2.

2.1 No Known and Low/Moderate ASS Risk.

If the available information indicates **No known** or **Low/Moderate** ASS risk, which is identified through the initial screening process, the degree of potential risks should be confirmed through an ASS assessment. This will be undertaken during a site visit and will entail the completion of a site reconnaissance form for each site. A generic copy of the form is included in Appendix C.

If the initial screening process indicates the potential presence of ASS, there will be a requirement to manage the area consistent with the approach for **Moderate/High** ASS Risk sites.

For **No Known** and **Low/Moderate** ASS Risk sites, the following will be recorded during construction phase of the Project:

- A map indicating dimensions and excavated soil volumes
- Geological/lithological observations
- Photographic records

2.2 Moderate/High ASS Risk

2.2.1 Avoidance of ASS

The primary aim of the ASS management plan is for minimisation of disturbance to ASS. As specified in the QASSIT Sampling Guidelines (QASSIT, 1998) and the Soil Management Guidelines (QASSIT, 2002), avoidance and/or minimised disturbance of ASS is the preferred option.

Where there is a moderate or high risk of ASS, it is considered that excavation and dewatering of ASS should be minimised or engineered cut-off solutions employed if the disturbance will be significant (e.g. sheet piling of excavations prior to dewatering).

2.2.2 Exceptions to Risk Status

Although a preliminary screening process and site observations may indicate site classification as **Moderate/ High** ASS Risk a number of exclusions will likely result in the management approach more consistent with that of the **No Known** ASS Risk, or **Low/Moderate** ASS Risk**.** These exceptions include the following:

- Excavation volumes less than 100 m^3
- Return of unsaturated excavated material from above the watertable back to the excavation site, within 18 hours of excavation

It should be noted that excavated saturated materials from below the watertable at **Moderate/ High** ASS Risk sites will require treatment as outlined in Section 4. Maximum short-term stockpiling for untreated soils is generally 18-hours for a conservative approach, but this is subject to weather conditions, and timeframes should be adjusted accordingly.

2.2.3 Management of Moderate/High ASS Risk

Where disturbances of ASS cannot be avoided, **Moderate/High** ASS Risk sites should be managed with reference to the following QASSIT guidelines;

- Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland (QASSIT Guideline, 1998)
- Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines (QASSIT Guideline, 2002)

There will be a requirement to undertake the following:

- Completion of intrusive ground investigations, including sampling and laboratory testing, in order to characterise the ASS profile and develop treatment/management requirements
- Documentation of Treatment/Management procedures (i.e. ASS Management Plan) to be adopted for the Site
- Implementation of ASS management/treatment procedures

Where dewatering and lowering of the water table is necessary in (**Moderate/High** ASS Risk areas) a groundwater investigation will be required and an ASS dewatering management procedure developed as part of the CEMP, and will be used in support of the development application.

The above ASS management requirements for areas of **Moderate/High** ASS Risk are further detailed in the following sections:

- Section 3 Preliminary Investigation of Acid Sulfate Soils;
- Section 4 Acid Sulfate Soil Management Strategy; and
- Section 5 Groundwater Investigation in Moderate to High Risk Areas.

3. Preliminary Investigation of Acid Sulfate Soils

3.1 Introduction

Preliminary ASS site investigations are intended to delineate the extent of naturally occurring soil layers containing sulfide bearing minerals. ASS materials are identified as either Actual Acid Sulfate Soils (AASS) or Potential Acid Sulfate Soils (PASS). AASS contain inorganic sulfides that have undergone oxidation, are generally in aerobic conditions and are already acidic. PASS contain un-oxidised sulfides under anaerobic conditions which become acidic when disturbed and exposed to oxygen. Laboratory analyses of soil samples enable the identification of ASS as either PASS or AASS. If it is anticipated that dewatering will be required, the ASS site investigation will need to incorporate a groundwater component as described in Section 5 of this framework.

Excavation of **Moderate/High** ASS Risk site soils can be managed by either;

- Treatment of soils on site
- Removal of soils from site (with subsequent off-site treatment/disposal) as dictated by constraints on time, costs and space requirements

If **Moderate/High** ASS Risk soils are to be excavated, the following approach will be undertaken.

3.2 Sampling Frequency

Site investigations will be conducted in accordance with the QASSIT Sampling Guidelines (QASSIT, 1998), in order to identify potential impacts on soil, surface and groundwater. Soil sample intensity is somewhat dependent on the nature, depth and size of the disturbance proposed, and the sensitivity of the surrounding environment. Most ASS investigations will require sufficient sampling to create three-dimensional maps and cross sectional diagrams of oxidisable sulfur content by depth for presentation in the ASS management plan.

The Sampling Guidelines stipulate for linear disturbances, a sampling intensity of one borehole/test pit per 50 m should be progressed along the proposed alignment. The area of potential ASS or PASS runs from chainage 492.5 km to 510.0 km, covering a linear area of approximately 17.5 km, and requiring 350 sampling locations. There is scope for a reduction in the number of sampling locations, by taking a staged approach to the sampling program. A Sampling and Analysis Plan (SAP) should be developed for this scale of project field investigations.

Sampling will be undertaken to a depth of 1 m below the proposed maximum depth of disturbance or dewatering on site. Soil cores should be logged in accordance with Australian Standards (*AS1726-1993 Geotechnical Site Investigations*), and sampled at 0.25 m depth intervals and placed in zip lock bags with the air excluded. The samples will be stored on ice in an esky, delivered to a National Association Testing Authority (NATA) accredited laboratory for analysis within 24 hours. If samples cannot be delivered within 24 hours, they will be frozen, pending transfer to the laboratory.

Soil sample analysis should comprise of both 'field testing' and ASS specific laboratory analyses as outlined in the Sampling Guideline (QASSIT, 1998).

3.3 Field Testing

3.3.1 Preliminary Screening Analysis

Preliminary screening is comprised of pH (pH_f) and oxidised pH (pH_{fox}) testing. The pH_{fox} test mimics what would occur naturally if the soil were exposed to air. This may be completed in the field, or dispatched to a laboratory for pH_f and pH_{fox} testing.

3.3.2 Preliminary Screening Assessment Criteria

Following the receipt of preliminary screening test results, the criteria, given in Table 1, should be considered prior to the re-batch for quantitative laboratory analysis.

Table 1 Preliminary ASS Screening Criteria

Criteria Levels	Potential Soil Types
<5.5 (pH_f)	Acidic Soil
<4.0 (pH_f)	AASS
<3.0 (pH_{fox})	PASS
pH_f minus pH_{fox} >2	PASS

3.4 Laboratory Testing

Utilising the pH_f and the pH_{fox} screening results, selected samples will be analysed by either the Suspension Peroxide Oxidation Combined Acidity and Sulfate (SPOCAS) or the Chromium Reducible Sulfer (S_{CR}) Suite analysis method, allowing the accurate assessment of ASS occurrence.

3.4.1 Test Methods

Samples assessed using the SPOCAS method give an indication as to the net acidity of all acid-producing sources including organic matter, whereas the S_{CR} method indicates the inorganic sulphur content of soil. The preferred method is SPOCAS, as this method provides a greater understanding of acidity and neutralising capacity in the soil profile. Therefore, the SPOCAS method should be the primary identifier for potential and actual acidity.

The samples requiring further laboratory analysis should be selected on the following basis:

- To ensure every major soil type is analysed
- To ensure the boundary between each soil horizons' acidic characteristics can be defined
- Where the difference between pH_f and pH_{fox} is 2 or greater
- Where the pH_{fox} values are <4

It is recommended that a minimum of 30% of the total samples collected be analysed for SPOCAS/ S_{CR}.

3.4.2 Assessment Criteria

Results of net acidity are compared to an action trigger criteria set by the QASSIT Soil Management Guidelines to assess whether management of soils will be required. The action criteria are summarised in Table 2.

Table 2 Action Limits for Treatment of AASS and PASS

Soil Texture	Clay Content (%)	Acid Trail (mol/tonne) for <1000 Tonnes Disturbed	Acid Trail (mol/tonne) for >1000 Tonnes Disturbed
Course textured soils sands to loamy sands	<5	18 mol H^+/tonne (0.03% S)	18 mol H^+/tonne
Medium textured soils sandy loams to light clays	5 - 40	36 mol H^+/tonne (0.06% S)	
Fine textured soils medium to heavy clays and silty clays.	>40	62 mol H^+/tonne (0.1% S)	

It should be noted that if excavation works will result in a disturbance of more than 1000 tonnes (t) of soil, a comprehensive management plan will be required.

3.5 Reporting Requirements

The following information should be provided in all ASS investigation reports:

- A completed Site Reconnaissance Form (refer to Appendix C)
- The exact location of each test location shown on an appropriately scaled map, with cross-sections indicating AASS/PASS
- A brief description of the equipment and/or methods used to retrieve the samples
- A summary table with observations and data
- NATA endorsed laboratory certificates of analysis

The report will conclude if ASS conditions exist onsite and the extent to which management actions are required. Section 4 of this plan details requirements for ASS management and treatment.

4. Acid Sulfate Soil Management Strategy

On the basis of the investigation results, where actual and/or potential ASS have been identified, ASS management procedures in accordance with the QASSIT Soil Management Guidelines (QASSIT, 2002) will be prepared.

Acidic soils may be managed by either, excavation and off-site transport to a licensed ASS treatment facility, or by on-site treatment and neutralisation. When on-site treatment and neutralisation is elected, a management plan will need to address the following elements:

- Neutralisation Methodologies
- Mixing of Neutralisation Agent
- In-Situ Treatment/Lime Dusting of Exposed Surfaces
- Stockpile Management
- Off-Site Treatment
- Verification of Treated Material
- Leachate and Surface Water Sampling

4.1 Neutralisation Methodologies

If analysis indicates net acidity values above the action criteria of 0.03%S (18 mol H^+/tonne), excavated materials will require treatment by application of a suitable neutralisation agent, (commercially available Aglime is recommended) at a rate consistent to neutralise the indicated soil acidity. Based on the laboratory results, the liming rate for the excavated sediment is based upon the following information:

a) Max net acidity as determined by laboratory analysis

b) Estimated density of the soil material

c) The calcium carbonate ($CaCO_3$) content of the neutralising material (aglime) as indicated by the Product Information Sheet provided by the supplier (i.e. the effective neutralisation factor)

d) The particle size distribution of the neutralising material as indicated by the Product Information Sheet provided by the supplier

e) Utilisation of a safety factor of 1.5

f) Application of neutralising agent will be undertaken on specially constructed treatment pads and stockpiled as described in Section 4.4

If a variation from the calculated liming rates is proposed, further field investigations will be required. If sub-surface conditions vary significantly from those observed during the ASS investigation, including any indication of contamination, excavation activities should stop and qualified personnel engaged to assess the site conditions. Changes in site conditions may require additional laboratory testing to confirm the concentrations of the potential contaminants observed.

4.2 Mixing of Neutralising Agent

The materials to be treated will be placed on the liming pad, in a layer no greater than 300 mm thick. Ideally, the soils/sediments should be allowed to partially dry prior to application of the neutralising agent. If the soils are too moist, the neutralising agent will not distribute evenly throughout the soils forming pockets of Aglime, increasing the potential for leaving untreated sediment in the stockpile. If this occurs, the Aglime may not be able to neutralise all of the acidic leachate that develops.

The stockpiles will be mixed immediately after top dressing using agricultural cultivators, disc harrows or similar machinery.

4.3 In-Situ Treatment/Lime Dusting of Exposed Surfaces

Where in-situ PASS material is to be exposed for longer than the short-term exposure times given in Section 4.5, Aglime will be applied to excavation walls and base, at a rate equivalent to that required to neutralise 0.5 m thickness of material for clays, or up to 1 m of material for sand or gravels.

4.4 Stockpile Management

The Contractor will be responsible for ensuring that all management measures outlined in the following management strategy (or as agreed otherwise) are adhered to for the duration of the contract.

The following operations/tasks are required for the treatment of excavated **Moderate/High** ASS Risk soils:

- Specific areas of the site will be set aside for stockpile storage and neutralisation activities
- A soil neutralisation containment treatment pad, underlain by a compacted guard layer of non-ASS, clayey material and lime, at a rate determined from the results of the laboratory testing of ASS material, using the following equation:

  Guard layer (kg/m^2) = 0.2 x thickness of layer to be treated (m) x maximum or 95% upper confidence limit liming rate (kg/tonne).

  The treatment pad and guard layer will be constructed at the neutralisation area upon which AASS and PASS materials will be treated. The purpose of the guard layer will be to neutralise any acidic leachate produced from the stockpile, and prevent acidic runoff entering the underlying ground surface and the surrounding environment.
- The guard layer for the treatment pad should be constructed from compacted non-ASS, clayey material, with a minimum thickness of 300 mm, plus or minus 25 mm of “pit-face” limestone material (i.e. material not crushed or screened), and overlain by a thickness of 150 mm agricultural lime (particle size <0.3 mm)
- A crushed limestone bund with a minimum height of 300 mm will be constructed around the perimeter of the treatment pad, to contain any leachate and divert potential stormwater around the treatment area
- Drainage from the bund will be collected in one or more collection basins with an impermeable (plastic) lining and a layer of lime, with an appropriate capacity;
- Any leachate will be monitored for pH and total titratable acidity (by field measurements)

- All components of the limestone containment area and leachate pond will be inspected daily and repairs will be made accordingly to maintain the integrity of the infrastructure
- Excavated acidic soils will be carted directly to the treatment area for neutralisation
- Potential acidic soils will be stockpiled the maximum height of the stockpiles will be 2 m. The sides of the stockpiles pile will be battered to prevent excess runoff and scouring
- The stockpiles should be covered to limit rainfall infiltration and potential leachate production
- The stockpile area should contain bunding, to prevent acidic leachate from running into the environment

4.5 Off-Site Treatment

If it is decided to excavate and transport soils off-site to a licensed treatment facility, it is recommended that the soils are immediately dispatched to the facility after excavation. Where the contractor cannot immediately dispatch samples to the facility, it will be necessary to stockpile soils on site. The duration of stockpiling of excavated soils is subject to the criteria given in Table 3.

Table 3 Short term stockpilling

Type of Material		Duration of stockpiling	
Texture Range	Approx. clay content	Days	Hours
Coarse texture	<5	Overnight	18 hours
Medium Texture	5-40	2.5 days	70 hours
Fine Texture	>40	5 days	140 hours

It is proposed that stockpile management methodologies in Section 4.4 are followed.

4.6 Verification of Treated Material

Where ASS are identified and treated by the Contractor, post-treatment verification sampling is required. All treated soils will be validated by collecting soil samples at a rate of 1 per 250 m^3 throughout the stockpile and submitting the samples for laboratory analysis to confirm neutralisation has been successful.

If validation testing indicates incomplete neutralisation, the contractor will apply and mix additional lime, as per the laboratory liming rate given in the verification test.

4.6.1 Sampling Density

To produce a representative sample for verification testing, the sample locations will be evenly distributed throughout the stockpile. A sufficient number of verification samples will be collected and analysed to demonstrate that neutralisation has taken place. The density of verification sampling should be sufficient to provide a high level of confidence in the verification of the treated material, and will depend on the volume of spoil and the level of treatment undertaken. For this project, a sampling density

of one sample per 250 m^3 of treated material should be sufficient for verification that the soil has been completely neutralised.

4.6.2 Sampling Technique

A person experienced in ASS sampling shall collect a composite sample, composed of 10 representative aliquots (sub-samples) from each volume (to be specified in the project ASSMP) of stockpiled material, for submission for analysis. The sub-samples will be selected using the following criteria;

- Approximately 250 g of soil will be collected from 10 locations evenly distributed through the stockpile
- Where the soil is non-cohesive (i.e. granular) the sample will be homogenised in a splitter box, the 2.5 kg composite sample will be split three times to produce a representative sample
- The splitter box will be decontaminated by removing any visible signs of previous sediment samples
- Where using a splitter box is impractical because the soil is cohesive (i.e. clayey soils), the sample will be homogenised in a large stainless steel bowl, or equivalent, and a representative sample taken from the homogenised material

4.6.3 Analysis

The Contractor will submit the composite samples for Total Potential Acidity (TPA) testing to a laboratory with NATA accreditation. If laboratory analyses indicate the material has not been adequately neutralised and has a TPA above QASSIT (1998) Action Criteria, additional liming requirements will be calculated from the TPA results and the material re-treated and re-verified.

4.6.4 Verification Reporting

A Soil Neutralisation Verification Report (SNVR) will be prepared by the Contractor. The SNVR will document that the soil has been neutralised and is suitable for final placement or disposal. The SNVR will include, but not be limited to, the following information:

- A table summarising the analytical results from the soil stockpile and verification sampling
- A plan showing earthwork and stockpile locations, which includes sample identification numbers and location of verification sampling

4.7 Leachate and Surface Water Sampling

Within the ASS Management Plan, individual water guideline levels will be established with consideration of the individual ecological value of potentially affected areas. Where applicable, guideline levels will meet the minimum guideline levels detailed in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, 2000) guidelines for Freshwater Aquatic Ecosystems or Marine Aquatic Ecosystems within the Bowen region. Prior to works commencing, sufficient surface-water sampling will be required to show seasonal natural background variations. Background surface-water data will then be used to establish trigger levels, which will be used to compare results from samples taken throughout the construction phase.

5. Groundwater Investigation in Moderate to High Risk Areas

In **Moderate/High** ASS Risk areas, where excavations are required to extend below the watertable, appropriate groundwater management measures should be identified and implemented.

It is recommended that a groundwater investigation and management program be developed prior to construction and implemented where dewatering is undertaken in an area underlain by ASS and one of the following is applicable;

- Dewatering will be undertaken for a period of greater than 4 weeks
- The scale of the dewatering or drainage should be defined by the size of the cone of depression
- Near wetlands or in any other environmentally sensitive area

The proposed rail loop intersects with the Caley Valley wetlands, therefore a groundwater investigation is recommended for this region, with the groundwater programme consisting of the following.

- Groundwater Investigation prior to commencement of works
- Groundwater Investigation during construction operations
- Post-dewatering operations

5.1 Groundwater Investigation Prior to Commencement of Works

In addition to the soil investigation works outlined in Section 3, groundwater monitoring bores are recommended to be installed to collect baseline groundwater quality data prior to the commencement of construction and/or dewatering operations (this may involve more than one monitoring event to ensure that data obtained is representative and to capture temporal variations).

The construction of the monitoring bores may be combined with the collection of soil samples as required in Section 3. It should be noted that a licensed driller is generally required for construction of monitoring wells. Following construction, all monitoring bores should be sampled, with the samples submitted to a NATA certified laboratory for analysis. The laboratory groundwater quality analytical suite should include:

- Total acidity
- Total alkalinity
- pH
- Major ions (i.e. sulfate, chloride)
- Dissolved metals (filtered) (i.e. Al, As, Cr, Cd, Fe, Mn, Ni, Zn, Se)
- Ammoniacal nitrogen
- Electrical conductivity (EC)
- Total dissolved solids (TDS),
- Dissolved oxygen (DO)
- Redox potential

- Total nitrogen
- Total phosphorus
- Filterable reactive phosphorus (FRP)

Following the preliminary investigation, involving establishment of bores, sampling and analysis, site specific ASS groundwater management procedures should be prepared.

5.2 Groundwater Investigation during Construction Operations

The required activities and methodologies are outlined in Section 5. In summary, the following is required:

- Daily field monitoring for pH, standing water levels, EC during the dewatering operation and continued until it can be shown that groundwater levels have returned to normal elevations
- Samples to be collected for laboratory analysis at fortnightly intervals during the dewatering operations
- Laboratory analysis of groundwater samples to include: total acidity, total alkalinity, pH, major ions, dissolved aluminium (filtered), dissolved arsenic (filtered), dissolved chromium (filtered), dissolved cadmium (filtered), dissolved iron (filtered), dissolved manganese (filtered), dissolved nickel (filtered), dissolved zinc (filtered), dissolved selenium (filtered), ammoniacal nitrogen, EC, TDS, DO, redox potential, total nitrogen, total phosphorus, FRP.

5.3 Post Dewatering Operations

Following cessation of dewatering, the following should be completed to ensure minimal short-term and no long-term impacts have occurred:

- Laboratory analysis of groundwater samples from monitoring bores should be collected after completion of dewatering operations
- Groundwater samples to be collected from all groundwater monitoring bores for laboratory analysis at intervals of one month to two months for a period of at least six months. This must include at least one groundwater monitoring event taken at the time of seasonal groundwater high, following completion of the dewatering operation.
- Report on results of the groundwater and effluent water quality and on results from the water level monitoring program

6. Groundwater Monitoring Program

6.1 General

Groundwater monitoring is an integral part of the management of ASS and groundwater as it allows for any changes in land and water quality to be monitored pre, during and post construction, giving an indication as to the success of the management strategies implemented. As a result, and as part of the initial groundwater investigation at the site (if required), groundwater monitoring bores should be installed in proximity to the proposed works. These bores should be utilised pre, during and post construction to determine groundwater quality and quantity. Groundwater results will be used and compared to baseline data to monitor any significant changes in water quality and to confirm that minimal short-term and no long-term negative impacts have occurred.

6.2 Assessment Criteria

Chemical indicators that may indicate that groundwater is being affected by the oxidation of sulfides include the following:

- A sulfate/chloride ratio of greater than 0.5
- An alkalinity/sulfate ratio of less than 5
- A pH of less than 5.5
- A soluble aluminium concentration of greater than 1 mg/L

The Swedish Environmental Protection Agency developed a risk-ranking scheme to estimate the vulnerability of groundwater to acidification based on alkalinity and pH, as shown in Table 4.

Table 4 Vulnerability of Groundwater to Acidification Risk Ranking Scheme

Risk Ranking	Alkalinity (mg/L)	pH Range	Description
Low	> 60	> 6.0	Adequate to maintain pH in most circumstances.
Moderate	30-60	5.5-7.5	Unlikely to maintain a stable pH in areas with significant acid leaching.
High	10-30	5.0-6.0	Unlikely to maintain a stable pH in acid sulfate soil areas.
Very high	< 10	< 5.0	May be unsuitable for use because of high metal and arsenic concentrations.

6.3 ANZECC Guidelines

Considered on a site by site basis, it will be necessary to compare groundwater data to either the Fresh or Marine water assessment criteria specified in the ANZECC/ARMCANZ (2000) guidelines.

6.4 Assessment Criteria

The laboratory results of the groundwater and dewatering effluent monitoring programs should be compared with assigned assessment criteria and/or ANZECC/ARMCANZ Guideline levels.

6.5 Decommissioning of Treatment Facilities

At the completion of the works, the Contractor will be responsible to collect samples of the accumulated sediments at the base of each stockpile site to determine the appropriate decommissioning requirements.

Sample analyses will include, but not be limited to:

- SPOCAS or S_{cr}
- Metals (Al, As, Cr, Cu, Se, Zn)

Sediments will be classed based laboratory analysis results, and disposed of accordingly.

6.6 Groundwater Contingency Plan

In the event that groundwater monitoring results indicate the oxidation of sulfide bearing minerals has occurred through site works, based either on daily field measurements taken by the Contractor or from laboratory results collated by the Contractor, dewatering shall be stopped immediately and the Superintendent's Representative informed. No further effluent should be allowed to infiltrate until the issue is addressed by an appropriate groundwater contingency plan.

6.7 Reporting

The reporting requirements outlined in Table 5 shall be followed. It should be noted that due to the low amounts of dewatering anticipated, it is considered that exception monitoring be undertaken. That is, reporting to the Superintendent or the Superintendent's Representative will only be required in the event of an exceedance over the nominated criteria.

Table 5 Dewatering Management Plan Reporting

Responsibility	Item	Reporting To Whom	Timing
Contractor	Results of the water monitoring programs along with actions taken to achieve water quality targets including quality of the dewatering effluent.	Superintendent	Within 24 hours of water quality falling outside the assigned trigger level.
Contractor	Initial Closure Report (detailing all elements and results pertaining to both ASS management, groundwater management and dewatering management, where conducted.	Superintendent for onward transmission to DERM	On completion of earthworks and management.
Contractor	Post-Dewatering Monitoring Closure Report (required only when groundwater monitoring is undertaken after completion of works as part of the groundwater monitoring program)	Superintendent for onward transmission to DERM	On completion of post-construction groundwater monitoring program.

7. Summary

To mitigate the potential environmental impacts, a detailed ASS Management Plan (MP) will be developed and implemented prior to the start of the earthworks and/or dewatering activities. The ASS MP will be prepared in accordance with the Soil Management Guidelines (QASSIT, 2002) and include a description of the following activities in detail:

- Conduct a risk assessment, identify objectives and set targets and key performance indicators. Detailed records should be kept during actual works to demonstrate control measures and modified, if required, as work progresses
- Delineate AASS, PASS and non-ASS sediments within the disturbance footprint, including preparation of a series of plans and cross-sections. Figure 1 in Appendix A shows the areas that have been classified as potential 'hot spots'.
- Prepare a comprehensive sediment tracking plan that details the numbered packages of sediment, soil characteristics, source, volume, stockpile location, time and date of treatment, disposal and other special comments
- Any dewatering and lowering of the natural water table as part of constructions activities should be avoided where possible and is to be monitored prior to, during and after project completion
- Prepare a water management strategy for the project area, to mitigate the potential impacts of contaminated leachate and runoff entering the receiving environment. The strategy should include:
  - Collection of any runoff and any water pumped from excavations
  - Testing and treatment (if treatment is required) of any contained water prior to release into waterways. All water should be validated to ensure it is at a similar or better quality than that of the receiving environment and consistent with appropriate guidelines and any release requirements.
- Conduct verification testing of the sediments to ensure that the sediments have no net acidity
- Provide contingency for lime treatment of excavated sediments if PASS is identified in the sediment for reclamation
- Contain, manage and monitor any potential seepage from the settlement ponds including any reaction products that may be present
- Establish a monitoring network to allow early detection of any contamination plumes, fluctuations in groundwater levels and degradation of groundwater quality as a result of oxidation of PASS
- Develop a groundwater management plan should be developed to provide a framework for routine monitoring and data analysis, special event monitoring, due diligence auditing and corrective actions to be taken in the event of a non-compliance
- Develop an ASS Management Plan for post placement of material to manage the dewatering area including any future disturbances, incidences or remedial actions that may be required

A full ASS assessment is required to be undertaken for Alpha Coal Project proposed rail loop area, and any other proposed excavation or in-fill areas that fall below 20 m AHD, and disturbed sediment below 5 m AHD.

8. References

ANZECC/ARMCANZ. 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy*, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Ahern C.R., Ahern M.R., Powell B., (QASSIT), 1998, *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland – Version 4.0,* October 1998, Department of Environment and Resource Management, Brisbane.

Dear S.E., Moore N.G., Dobos S.K., Watling K.M., and Ahern C.R. (QASSIT), 2002, *Soil Management Guidelines Version 3.8,* November 2002 in *Queensland Acid Sulfate Soil Technical Manual,* Queensland Department of Environment and Resource Management, Queensland Acid Sulfate Soils Management Committee (QASSMAC).

Hancock Prospecting, 2010, *Alpha Coal Project Environmental Impact Statement, Volume 3*, Australia.

Queensland Government, 1997, *Environmental Protection (Water) Policy (EPP Water).*

Queensland Government, 1994, *Environmental Protection Act (EP Act).*

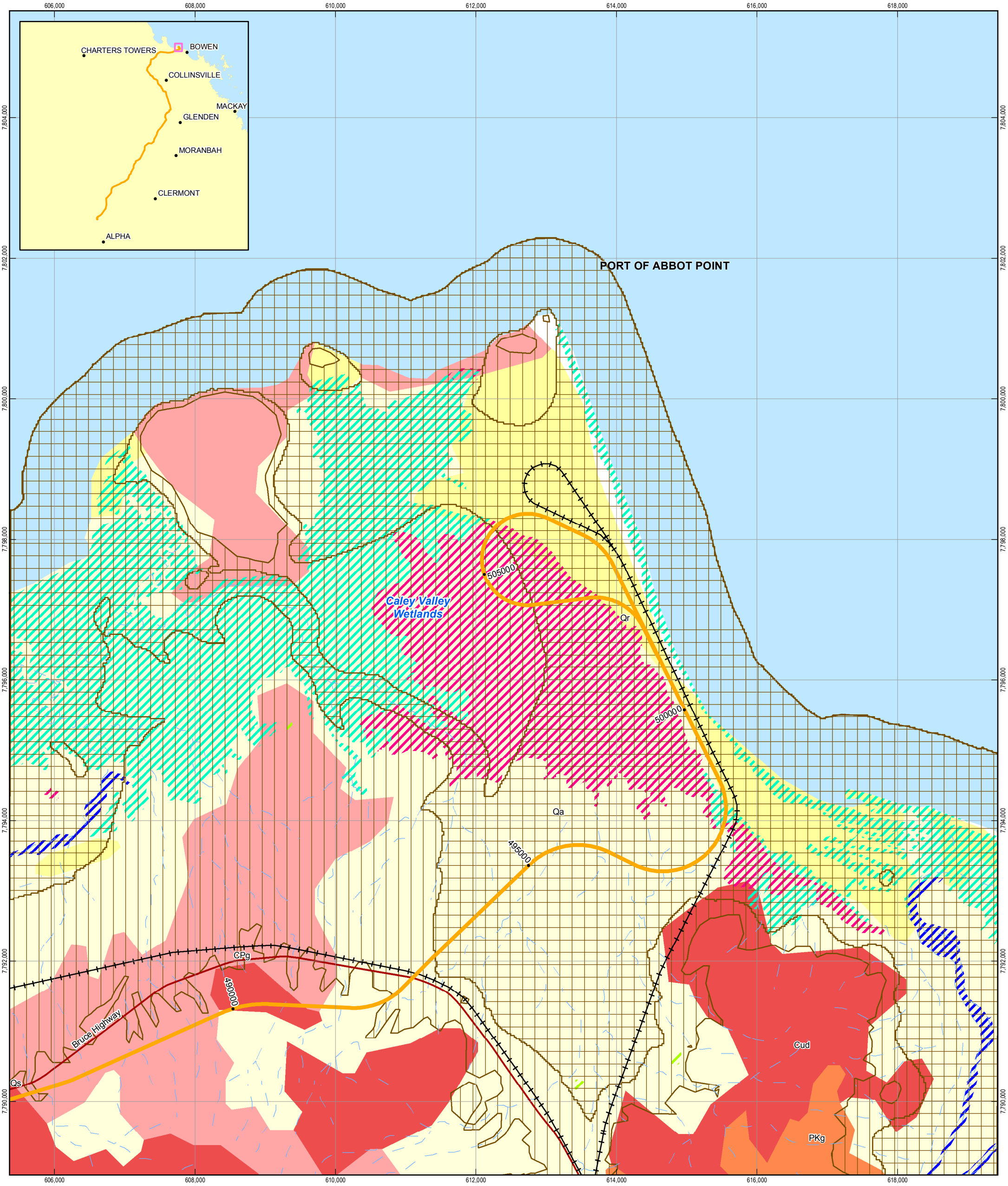
Queensland Government, 1997, *Integrated Planning Act (IPA).*

Queensland Government SPP 2/02, 2002, *Planning and Managing Development Involving Acid Sulfate Soils*. State Planning Policy, November 2002, Integrated Planning Act 1997.

Swedish EPA, 2010, *Environmental Quality Criteria for Groundwater,* Swedish EPA Report 5051, available online at www.swedishepa.com/en/In-English/Menu/State-of-the-environment/Environmental-quality-criteria/Environmental-quality-criteria-for-groundwater/

Appendix A

Potential ASS Risk Map



LEGEND

- Proposed Alignment
- State Road
- Existing Railway
- Watercourse
- Area Below 5m (AHD)
- Area Below 20m (AHD)

Wetland Area
- Estuarine Waterbody
- Lacustrine Waterbody
- Palustine Waterbody
- Riverine Waterbody

Geology
- Quarternary Alluvium (Qa)
- Quarternary Sand (Qr)
- Quarternary Colluvium (Qs)
- Carboniferous - Permian Grandiorite (CPg)
- Permian - Cretaceous Granite (PKg)
- Carboniferous Bulgonunna Volcanic (Cud)

Source: See Copyright Details below and for full disclosure please refer to the SEIS ***Volume 2, Appendix B***

1:50,000 (at A3)

0 0.25 0.5 1 1.5 2

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 55

N

HANCOCK PROSPECTING PTY LTD

Alpha Coal Project
Supplementary Environmental Impact Statement

POTENTIAL ACID SULFATE SOILS

Job Number	41-23742
Revision	A
Date	09-03-2011

Figure: 1

G:\41\23742\GIS\Maps\MXD\200_Geology_Groundwater\41-23742_206_rev_a.mxd

Appendix B

SPP 2/02 – Checklist Form for ASS

SPP 2/02 Checklist Form for Acid Sulfate Soils (Version 1, June 2004)

Within the local governments listed in Annex 1 of SPP 2/02, the policy applies to all land, soil and sediment at or below 5 m AHD where the natural ground level is less than 20 m AHD. Within these areas, the SPP applies to development involving any of the following activities (as per diagram overleaf):

- excavating or otherwise removing 100 m^3 or more of soil or sediment; or
- filling of land involving 500 m^3 or more of material with an average depth of 0.5 m or greater.

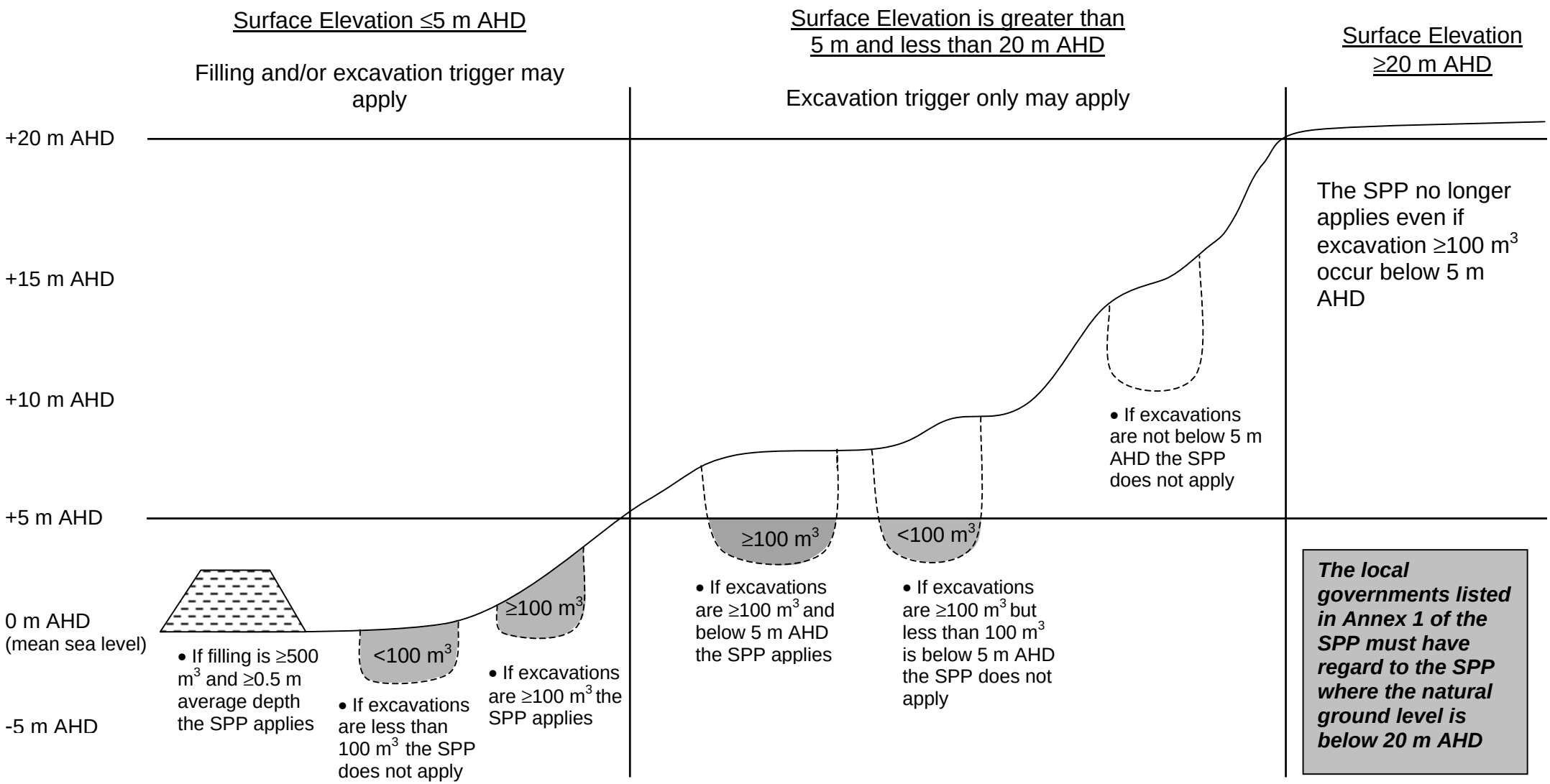
A completed checklist form should accompany all development applications referred to the Department of Natural Resources, Mines and Energy where State Planning Policy 2/02 is applicable and where the Department is an Advice Agency.

1.	What is the lowest elevation of the natural ground surface on site? (SPP 2/02 may apply to development where any part of the site is below 20 m AHD. If all parts of the site are above 20 m AHD no further questions apply)	☐ m AHD	
2.	What is the total volume of material being excavated below 5 m AHD on site where the natural ground surface is below 20 m AHD?	☐ m^3	
3.	What is the maximum volume and average depth of fill being placed on site where the natural ground surface is below 5 m AHD?	☐ m^3 ☐ m	
4.	Is State Planning Policy 2/02 applicable to this development application? (Use the above figures from Q1–Q3 together with the diagram on the next page)	☐ Yes*	☐ No
5.	Is the Department of Natural Resources, Mines and Energy identified as an 'Advice Agency' for this development application? (Excavation of ≥1000 m^3 of soil or sediment from at or below 5 m AHD, and/or; filling with ≥1000 m^3 of material at or below 5 m AHD is referred to NRM&E for advice. The local authority assesses excavations and/or filling below these limits in accordance with the SPP and Guideline)	☐ Yes*	☐ No
6.	Is an acid sulfate soils investigation report attached to this development application?	☐ Yes	☐ No
7.	Are acid sulfate soils present at the site?	☐ Yes*	☐ No
8.	Are acid sulfate soils being disturbed[1] at the site?	☐ Yes*	☐ No
9.	Is a groundwater investigation report attached to this development application?	☐ Yes	☐ No
10.	Is groundwater on and/or off site potentially being interfered with due to this development application?	☐ Yes*	☐ No
11.	Is an acid sulfate soils management plan attached to this development application?	☐ Yes	☐ No

*If the answer is "yes" to questions 4, 5, 7, 8 or 10 an ASS investigation should be undertaken and submitted to the assessment manager to enable the application to be properly assessed and determined. Reference material is available from the following sources: www.nrme.qld.gov.au/land/ass; State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils; State Planning Policy 2/02 Guideline; Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland (Ahern *et al*. 1998); Soil Management Guidelines (Dear *et al*. 2002); Acid Sulfate Soils Laboratory Methods Guidelines (Ahern *et al*. 2004); The Instructions for the Treatment and Management of Acid Sulfate Soils (Qld Govt 2001). Note: Information on the location of ASS is available on NRM&E Special ASS Maps; consult NRM&E for coverage and availability.

[1] In this context, 'disturbance' refers to any activity or action that will or is likely to expose ASS to oxidising conditions eg. movement, excavation or drainage of ASS.

Areas and Development to which SPP 2/02 Applies



Appendix C

Site Reconnaissance Form

Acid Sulfate Soil – Site Reconnaissance Form

The following form is to be completed during the initial site inspection. This form will aid in determining the risk of acid sulfate soils at the site. If upon completion, any of the listed indicators are present on site, the contractor will advise the Superintendent and seek advice from a suitably experienced advisor on the need for and scope of a site specific acid sulfate soil investigation.

Contractor Name:		**Date:**	
Site ID:			

Visual

- □ Peaty or black soils (or other organic materials)
- □ Waterlogged soils
- □ Coffee rock present
- □ Yellow / red staining (Jarosite /iron oxides) in soil
- □ Sulfurous gas (‘rotten egg’ smell)
- □ Rust / orange staining evident on infrastructure as a result of groundwater
- □ Wetland dependent vegetation – (e.g. mangroves, paperbarks and reeds)
- □ Scums and slimes from iron precipitates on waters (if present)

Location

- □ Low-lying coastal areas, particularly with elevations below 5m AHD;
- □ Caley Valley Wetland area.

Pre-disposing Factors

- Permanently inundated wetlands
- Seasonally or occasionally saturated or inundated floodplains and swamplands
- Shallow estuarine areas, tidal swamps and/or wetlands
- Mangrove areas
- Sites known or believed to contain carbonaceous or pyritic materials such as:
  - Site containing fill;
  - Former municipal waste disposal sites;
  - Industrial areas.

Additional Notes

Appendix D

DERM – Identifying ASS Fact Sheet

Identifying acid sulfate soils

Acid sulfate soils are soils and sediments that contain iron sulfides, commonly pyrite. When exposed to air due to drainage or disturbance these soils produce sulfuric acid (battery acid), often releasing toxic quantities of iron, aluminium, and other heavy metals.

Release of acid and metals can cause significant harm to the environment, engineering structures and even human health. Areas of acid sulfate soils should be identified before disturbance to ensure that appropriate measures can be taken to minimise potential problems.

Identifying acid sulfate soils

Acid sulfate soil maps for some areas are available from the Department of Environment and Resource Management (DERM). These maps cover areas from the Queensland New South Wales border to Noosa, Maryborough, Gladstone, Rockhampton, Yeppoon, Sarina, Mackay and Bowen.

A number of landscape features can indicate the presence of acid sulfate soils and highlight areas that may require further investigation. Laboratory analysis of soil samples is necessary to confirm the presence of acid sulfate soils.

Elevation

Acid sulfate soils are commonly found less than five metres (AHD) above sea level, particularly in low-lying coastal areas such as mangroves, floodplains, wetlands, estuaries, and brackish or tidal lakes. Acid sulfate soils can also be found at higher elevations associated with areas that experience large tidal variations.

Figure 1: Coastal floodplain—typical acid sulfate soil environment

Vegetation

Species that commonly indicate acid sulfate soil areas include mangroves, marine couch, tea-trees (*Melaleuca* spp.), *Phragmites australis* (a tall, acid-tolerant grass species), and she-oaks (*Casuarina* spp.).

Soils

In their undisturbed, waterlogged state, acid sulfate soils may range from dark grey muds to grey sands, gravels or peats. Initially, they have a pH close to neutral (6.5–7.5), but may become very acidic (pH <4) when exposed to air. When disturbed, the soils may smell of rotten eggs (hydrogen sulfide gas).

Acid sulfate soil symptoms

A number of indicators provide evidence of previous disturbance of acid sulfate soils.

Vegetation

Stunted or dead vegetation, acid scalds and poor vegetation regrowth in previously disturbed areas are indicative of the impacts of acid sulfate soil exposure. (Salinity may cause similar symptoms.)

Figure 2: Death of vegetation due to the oxidation and subsequent acidification of acid sulfate soils

Water bodies affected by acid sulfate soil runoff favour plants that are more acid tolerant. Water lilies, rushes and sedges can dominate water bodies preventing light penetration, eventually killing bottom-dwelling vegetation, which then decays and reduces dissolved oxygen in the water.

Jarosite

Jarosite is a yellow mineral and is the most conclusive field indicator that iron sulfides in acid sulfate soils are oxidising and forming sulfuric acid. Jarosite requires very acidic conditions (pH <3.7) to form.

Monosulfides

Monosulfides are unstable iron sulfides (FeS and related compounds) that can form at the bottom of slow-moving or still waters in ASS-prone areas, appearing as a black ooze. When disturbed, they are capable of releasing iron and acid, and can rapidly deoxygenate the surrounding water.

9 311662 171023

Figure 3: Jarosite is found in acid sulfate soils where oxygen is available e.g. old root channels and on exposed surfaces

Water quality

When sulfuric acid reaches a water body, the water can become highly acidic (pH <4).

Clear blue-green water indicates the presence of soluble aluminium and iron. Soluble iron has a greenish colour. When aluminium from the soil moves into the water, it can cause suspended particles to clump together and drop to the bottom of the water body. This results in clear blue-green water with a deceptively healthy-looking appearance.

Figure 4: Clear blue-green water with acid conditions and high aluminium content

Fish kills

Fish kills may be associated with acid sulfate soil or monosulfide exposure. Sudden changes in acid, aluminium, iron or oxygen levels in the aquatic environment can kill fish and may also kill less obvious aquatic organisms, including crustaceans and oysters. Diseases such as red spot may also be triggered.

Damage to infrastructure

Sulfuric acid attacks concrete, weakening bridge pylons, canal walls, pipes, culverts and foundations. The acid 'eats' away the alkaline material in the concrete and exposes the aggregate, causing instability, cracking, pitting, and ultimate failure.

Iron staining

A by-product of the oxidation of acid sulfate soils is the production of rust-coloured iron stains and oily-looking bacterial scums. When acid water mixes with water of a higher pH, the dissolved iron in the water precipitates as a rust-red scum, which can smother and kill vegetation and aquatic organisms. During iron scum formation, oxygen is removed from the water, resulting in low dissolved oxygen levels. This can be a potential cause of fish kills.

Figure 5: Rust-red iron staining

Field tests and acidity

Field pH tests can be a useful indicator and screening tool for acid sulfate soils and should be supported by laboratory analysis. The acidity of the soil can be measured using a pH electrode. Guidelines (available from DERM) outline the method for conducting these field pH tests.

Further information

For more information about acid sulfate soils, refer to the following DERM fact sheets:

- L60—*Acid sulfate soils in Queensland*
- L62—*Managing acid sulfate soils*
- L64—*Using acid sulfate soils maps.*

Further information is also available on the website: <www.derm.qld.gov.au> or from DERM's Queensland Acid Sulfate Soils Investigation Team (QASSIT) on (07) 3896 9819.

This fact sheet was produced with funding assistance from the Natural Heritage Trust.

May 2009
L61
For further information phone 13 13 04

GHD

201 Charlotte Street Brisbane QLD 4000
GPO Box 668 Brisbane QLD 4001
T: (07) 3316 3000 F: (07) 3316 3333 E: bnemail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Draft	C.Johnsen	M.Prskalo				
A	M.Prskalo	D.Allayialis		P Bradley		08/04/11