Ardill Payne & PARTNERS

ENGINEERS PLANNERS SURVEYORS ENVIRONMENTAL PROJECT MANAGEMENT

ACID SULFATE SOIL ASSESSMENT & MANAGEMENT PLAN

Proposed Rezoning for Future Residential Subdivision and Development

Lot 100 DP 1201719
Hills Road, Rileys Hill

For:
Monal Pty Ltd

October 2020

BALLINA
45 River Street
PO Box 20
BALLINA NSW 2478
02 6686 3280

GUNNEDAH
Germane House
285 Conadilly Street
GUNNEDAH NSW 2380
02 6742 9955

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Table of Contents

1. Introduction

1.1. Introduction and Executive Summary

Ardill Payne & Partners (APP) has been commissioned by Monal Pty Ltd to complete an Acid Sulfate Soil Assessment and Management Plan for Lot 100 DP 1201719, Hills Road, Rileys Hill.

The Department of Planning issued a conditional Gateway Determination (dated 16th February 2018) in respect of the subject land as follows:

"Planning Proposal (Department Ref: PP_2018_RICHM_001_00): to rezone part of Lot 100 DP 1201719 at Hills Road, Rileys Hill from RU1 Primary Production to RU5 Village and change the minimum lot size from 40 hectares to 600m^2 to enable the land to be developed for low density residential purposes."

An Acid Sulfate Soil Assessment and Management Plan was prepared to address part of Condition 1 (dated 17th July 2018), viz:

1. Prior to community consultation the following site investigations are to be undertaken and the planning proposal amended if necessary to reflect the outcomes of the site investigations. The site investigations are to be included in the material used for community consultation:
    a. an ecological assessment,
    b. a preliminary site contamination assessment including soil sampling as appropriate and to the satisfaction of Council;
    c. an Aboriginal cultural heritage assessment;
    d. an assessment of the potential impacts of the Rileys Hill Quarry operations, including a land use conflict risk assessment for potential blasting, noise, traffic and vibration impacts, should the operation of the quarry be resumed;
    e. a traffic impact assessment;
    f. a flood study;
    g. a bushfire hazard risk assessment;
    h. an infrastructure servicing plan; and
    i. an acid sulfate soils assessment.

2. Prior to community consultation the planning proposal is to be amended as follows:
    a. the content of the planning proposal is to be amended in accordance with the results of the site investigations require by Condition 1 of this Gateway determination;
    b. maps which show the current and proposed zone and minimum lot size for the land are to be included within the planning proposal; and
    c. a project time line is to be included in the planning proposal;

3. Once the site investigations required by Condition 1 have been undertaken and the planning proposal has been amended in accordance with Condition 2 the planning proposal is to be forwarded to the Department for approval of the form

Richmond Valley PP_2018_RICHM_001_00 (EF18/275)

of the proposal for community consultation in accordance with section 57(2) of the Act.

As per Condition 2 above, and as a consequence of on-going detailed communications with Council in complying with Condition 1 above, the Planning Proposal has been modified such that there has been:

- a significant reduction in the proposed footprint/area of the RU5 zone
- an increase in the mapped minimum lot size to 800m^2 for the RU5 zoned land
- the inclusion of an E2 – Environmental Conservation Zone over part of the land with a 2ha minimum lot size

As a consequence of the above, there has been a significant reduction in the potential lot yield as originally proposed, from 70 x residential lots down to 35 x residential lots (which will be zoned RU5) and 1 x single dwelling opportunity lot (which will be zoned part RU1 and part E2).

This amended Acid Sulfate Soil Assessment and Management Plan has been prepared to support/inform the community consultation process for the Planning Proposal as per Condition 3 above.

Laboratory testing has shown that soils in the investigation area are acidic but do not have potential for further generation (i.e. no PASS detected). Due to the acidic nature of surface and sub-surface soils around one of the boreholes (BH4) liming is proposed, although, the liming rates are relatively low (all below 10kg $CaCO_3$ / tonne excavated material dry weight).

1.2. Acid Sulfate Soils

Acid sulfate soil (ASS) is the common name given to soils containing iron sulphides. When exposed to oxygen, through lowering of surrounding groundwater or excavation, air drawn into the soils can cause oxidation of the iron sulphides, producing sulphuric acid.

ASS typically occurs in low-lying estuarine coastal areas. Run-off from exposed ASS areas may find its way to stormwater, groundwater or natural aquatic environments. The acidic run-off may lower the pH of receiving waters, increase the concentration of metals and reduce the natural buffering capacity of the receiving waters. This can have significant impacts on aquatic life in those receiving waters.

There are two basic types of ASS: Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS). AASS are soils that have already been oxidised. Hence AASS environments are already acidic in nature. PASS are soils that have not yet been oxidized (ie they still contain oxidisable sulphur). AASS and PASS can co-exist.

In anaerobic conditions (such as below the water table), PASS do not pose an environmental threat, however if conditions change (such as during de-watering, excavation or drought), the sulphides can oxidise and form sulphuric acid. Developments involving excavation or de-watering must establish the presence and extent of ASS down the soil profile, as works may intercept ASS horizons and pose risks to both human and ecological health.

This assessment has been conducted and prepared in accordance with the NSW Acid Sulfate Soils Manual (Acid Sulfate Soils Management Advisory Committee, 1998) referred to here as ASSMAC.

1.3. Scope

The scope of work for the Acid Sulfate Soil Assessment of the site included:

- The site is being investigated for the purposes of a proposed residential subdivision (post rezoning);
- This study shall be used to assist the excavation and potential soil treatment process with regard to the presence of acid sulfate soils;
- To ascertain the presence and distribution of acid sulfate soils, 4 boreholes to a depth of 4.0m were undertaken;
- Soil samples were collected from boreholes at 0.5m intervals between depth of 0-4.0m;
- Analysis of all samples for field pH (pH_F) and field peroxide pH (pH_{fox}) to provide initial indication of PASS/AASS;
- Laboratory analysis of selected samples (minimum 25% of samples collected) to determine Total Actual Acidity (TAA) and % Chromium Reducible Sulphur ($\%S_{CR}$); and
- Summary of ASS assessment results with calculated liming rates.

1.4. Soil Landscape

The site soil variants are mapped by Morand 2001[1] as developed terrain from the Olive Gap (olb) soil landscape grouping, viz:

- Olive Gap (olb)
  - Landscape – rolling rises and low hills on Gatton Sandstone (quartz-lithic and feldspathic sandstones), Ripley Road Sandstone (quartz sandstone and conglomerate). Slopes 10 – 15%; relief 70 – 100m; elevation 20-150m. Rock outcrop common. Two conspicuous faults are present. Partially cleared, tall open-forest, previously logged.
  - Soils – shallow to moderately deep (50-100cm), poorly/imperfectly drained Grey and Brown Kurosols (Gleyed Podzolic soils; Yellow Podzolic Soils) throughout slopes and crests, with localised, moderately deep (>100cm), moderately well drained Red Dermosols and Red Kandosols (Red Pedzolic Soils/Red Earths) on ferruginised sandstone.
  - Limitations – Steep slopes; rock outcrop; high foundation hazard. Highly erodible, strongly acidic, stoney and infertile soils with low permeability.

During large rainfall events, based on the topography of the site, surface water sheet-flows to the centre of the site and is ultimately directed east towards the Broadwater National Park.

[1] *Morand, D.T. (2001)*, "Soil Landscapes of the Woodburn1:100 000 Sheet Map", *Soil Conservation service of NSW, Sydney.*

1.5. Site ASS Classification

The majority of the site is mapped as Class 5 – Acid Sulfate Soil (ASS) on the Richmond Valley Local Environmental Plan 2012 *Acid Sulfate Soil Map – Sheet ASS_009* (Figure 1). A thin strip along the south-eastern boundary, adjacent to Hills Road is mapped as Class 3 – ASS.

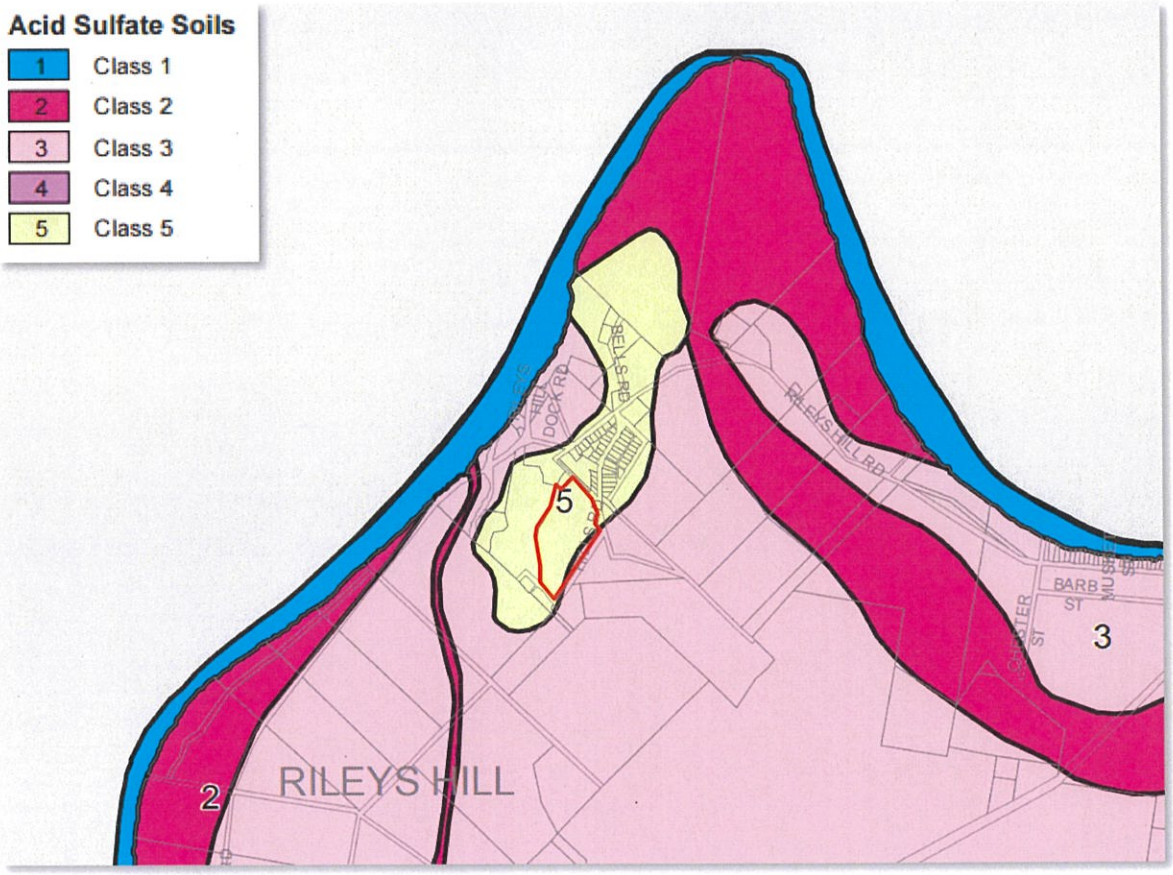


Figure 1: Acid Sulfate Soils Map – Sheet_009 (RVLEP 2012)

Development consent and an *Acid Sulfate Soils Management Plan* is required for carrying out certain works in different ASS classified soils. The works requiring development consent are described in Table 1 below.

Table 1: Works Requiring Development Consent

Class	Works
3	Works more than 1m below the natural ground surface. Works by which the watertable is likely to be lowered more than 1m below the natural ground surface.
5	Works within 500m of adjacent Class 1, 2, 3 or 4 land that is below 5m AHD and by which the watertable is likely to be lowered below 1m AHD on adjacent Class 1, 2, 3 or 4 land.

The watertable on the site or the surrounding land is not proposed to be lowered below 1m AHD and therefore no further action is required for soils classified as Class 5 ASS. However, some works which extend beyond 1m below the natural ground surface may occur in the south-eastern portion of the lot, which is classified as Class 3 ASS. No lowering of the watertable is proposed on any Class 3 ASS on site.

2. Field Investigation and Sampling

Fieldwork was carried out on the 17th May 2018 by Australian Soil and Concrete Testing (ASCT). Four boreholes were drilled to a depth of 2.5m.

Samples for acid sulfate testing were recovered at the surface and 0.5m intervals until 2.5m bgl at each borehole location. Soil samples were placed in plastic zip-lock bags and placed under cold storage conditions to minimise oxidation. All samples were submitted to the NATA Accredited Environmental Analysis Laboratory at Southern Cross University (Lismore Campus) for field pH and field peroxide pH tests. Based on the field sampling results, selected samples were analysed via the Chromium Reducible Sulphur technique. Sample results are discussed in Section 4.

The borehole locations are included in Attachment 1.

3. Site Conditions

3.1. Surface

The site is largely cleared and contains no improvements apart from boundary fencing. A set of above ground power lines runs through the site north-north-east and south-south-west. The site has a healthy vegetative cover in addition to some scattered established trees and established vegetation along the majority of the boundaries.

3.2. Sub-surface

Sub-surface conditions within the investigation area were found to be generally uniform. The lower portion is characterised by silty sand underlain by fine to medium grained grey sand. The higher portions of the site to the north-west are characterised by silty sand underlain by silty clay and silty sand to 2m bgl where weathered sandstone was discovered. Engineering logs provided by ASCT are included in Attachment 1.

3.3. Watertable

The watertable was encountered at approx. 1.3m below the natural ground surface during the drilling of the boreholes.

4. Laboratory Testing

4.1. Techniques and Criteria

Twenty (24) soil samples were obtained from the site investigation. Field pH and peroxide tests were carried out on all 24 samples. These are simple qualitative techniques used to gauge the likely presence and severity of AASS and PASS.

4.2. pH_F Results

pH_F records the pH of a 1:5 soil - water suspension. The following indications can be drawn from the pH_F measurements:

- pH_F readings of pH <4, indicate that actual acid sulfate soils are present with the sulfides having been oxidised in the past, resulting in acid soil (and soil pore water) conditions.
- pH_F values >4 and <5.5 are acid and may be the result of some previous or limited oxidation of sulfides, but is not confirmatory of actual ASS. Substantial exchangeable/soluble aluminium and hydrogen ions usually exist at these pH values.
- Other factors such as excessive fertiliser use, organic acids or strong leaching can cause $4< pH_F <5.5$. Field pH alone cannot indicate potential ASS as they may be neutral to slightly alkaline when unoxidised.

All samples were generally slightly acidic (pH_F 4.40 – 5.95). No samples had pH_F <4.0.

These results indicate that Actual Acid Sulfate Soils (AASS) are not present on the site.

4.3. pH_{FOX} Results

pH_{FOX} are measured by oxidising a small sample of soil with hydrogen peroxide. Results can be interpreted in the following way:

- If the pH_{FOX} <3 and there was a strong reaction to the peroxide, there is a high level of certainty of potential acid sulfate soils. The more the pH_{FOX} drops below 3, the more positive the presence of sulfides.
- A pH_{FOX} 3-4 is less positive and laboratory analyses are needed to confirm if sulfides are present. Sands particularly may give confusing field test results and must be confirmed by laboratory analysis.
- For pH_{FOX} 4-5 the test is neither positive nor negative. Sulfides may be present either in small quantities and be poorly reactive under quick test field conditions. In some cases,

the sample may contain shell/carbonate that neutralises some or all acid produced by oxidation. In other cases, the pH_{FOX} value may be due to the production of organic acids and there may be no sulfides present. In these cases, analysis for sulfur using the POCAS method would be the best to check for the presence of oxidisable sulfides.

- For pH >5 and little or no drop in pH from the field value, little net acid generating ability is indicated. Again, the sulfur trail of the POCAS method should be used to check some samples to confirm the absence of oxidisable sulfides.

Three of the four surface samples had a pH_{FOX} of less than 3 however, this is most likely due to the higher concentration of organic matter in the soil reacting with the peroxide rather than a presence of potential acid sulfate soils. Furthermore, if the samples were PASS, they would have already oxidised as they are at the surface and therefore would be identified in the AASS test.

4.4. Field Results Summary

The field results suggest that no AASS and no significant PASS exist on the site.

Laboratory methods have then been used to confirm these field test findings. Nine samples were analysed using the chromium reducible sulfur technique. Nine samples were considered to be adequate due to the uniform nature of the soil profile across the boreholes (with the exception of BH4, which accounted for four of the nine samples).

4.5. Action Criteria for Acid Sulphate Soils

The ASSMAC action criteria (threshold values) for AASS and PASS soils are presented in Table 2 below.

Table 2: Acid Sulphate Soil Action Criteria

Soil Category (Texture)	Action Criteria (<1000 tonnes to be disturbed)		Action Criteria (>1000 tonnes to be disturbed)	
	Oxidisable Sulphur (% S_{cr}) (Strong indicator of PASS/AASS)	**Titratable Actual Acidity (mol H^+/tonne)** (Indicator of AASS)	**Oxidisable Sulphur (% S_{cr})** (Strong indicator of PASS/AASS)	**Titratable Actual Acidity (mol H^+/tonne)** (Indicator of AASS)
Coarse – sands to loamy sands	0.03	18	0.03	18
Medium – sandy loams to light clays	0.06	36	0.03	18
Fine – medium to heavy clays and silty clays	0.1	62	0.03	18

Given the size and scope of the proposed development, it is expected that <1000 tonnes may be disturbed at the site, hence the *<1000 tonnes disturbed* action criteria is relevant for this assessment. However, the action criteria is the same regardless of the amount of soil that is disturbed as the soil at the subject site is sand.

4.6. Laboratory Results

Nine samples were analysed using the Chromium Reducible Sulphur (S_{CR}) technique. Results indicated that all $\%S_{CR}$ values were below the ASSMAC action criteria. This suggests that soils within the investigation area have a low potential for further acid generation.

Titratable Actual Acidity (TAA) exceeded ASSMAC action criteria in 7 of the 9 samples analysed (including all four of the samples from BH4). This is actual acidity, or existing acidity, and is presumed to be present across the entire soil profile.

The laboratory certificate is included in Attachment 2.

5. Management

5.1. Acid Sulfate Soil Identification

The field pH of ASS in their undisturbed state is pH 4 or more and may be neutral or alkaline. They pose a considerable environmental risk when disturbed, as they will become severely acidic when exposed to air and oxidised.

Any lowering of the watertable or excavation that removes the watertable that protects potential acid sulfate soils will result in their aeration and the exposure of iron sulfide sediments by drainage or excavation to oxygen will generate sulfuric acid.

Actual acid sulfate soil has been identified at BH4 for the extent of the borehole, from the natural ground level to 2.5m bgl. Based on these results, it is likely that acid sulfate soil is located beyond 2.5m bgl.

5.2. Soil Treatment Measures

Good quality, fine agricultural lime, with a neutralising value of 100, will be used as a neutralising agent on excavated material. Lime will be applied at various rates depending on the subsoil.

Liming rates, as calculated by the laboratory, are relatively very low in the vicinity of BH1, BH2 and BH3. Furthermore, the lime calculation includes a safety factor of 1.5 as a safety margin for acid neutralisation. Therefore, even with the safety factor in place, the lime that is to be applied to the soil is almost negligible. It should also be noted that there is no proposed development in the vicinity of BH1 and BH2 and the 10m APZ along the boundary would most likely cover the strip of Class 3 ASS in the vicinity of BH3. Additionally, the one sample that was analysed with the S_{CR} technique for BH3 was only one mol above the adopted TAA action criteria. It is therefore recommended that liming in this area is not warranted or proposed.

Liming rates calculated for sandy soils (in the vicinity of BH 1, 2 and 3) which are included for reference only:

Table 3: Liming Rate of Sandy Soils

Depth of material (m bgl)	Liming rate (kg $CaCO_3$ / tonne excavated material DW)
0m – 0.75m	2.0
0.75m – 1.75m	0.5
1.75m – 2.5m	3.4

Liming of soils in the vicinity of BH1, BH2 and BH3 are not proposed.

Liming of silty clay/sandstone (in the vicinity of BH 4) will be at a rate of:

Table 4: Liming Rate of Silty Clay/Sandstone Soils

Depth of material (m bgl)	Liming rate (kg $CaCO_3$ / tonne excavated material DW)
0m – 0.75m	5
0.75m – 1.75m	8.3
1.75m – 2.5m	6.9

Soils will be extracted and treated in situ. Liming will occur via the following procedure:

For ASS, the following procedure is to be employed:

- Excavated material spread within a designated bunded area in layers of workable depth (typically not more than 0.3m loose thickness);
- Lime applied to the excavated AASS/PASS material as well as around the base of the excavation, at a rate in accordance with Table 4 to neutralise potential acidity;
- Lime thoroughly mixed with soil materials through the use of a rotary hoe, pulvi-mixer or some similar mechanical process as nominated by the contractor to achieve a thorough mix. The liming should be confined to areas of manageable size and an apron of fine lime shall be provided when stockpiling for any length of time;
- Validation soil samples collected at a rate of one sample per 250m^3 of excavated soil and submitted for laboratory analysis using the SPOCAS method. Testing will be required to produce Total Potential Acidity (TPA) results of less than the action criteria in Table 4.4 of the ASSMAC guidelines;
- Should the tests show that the soil acidity has not achieved the above standard, then the material must be re-worked and more lime added until it is verified that the soil meets the required standard;
- If the soil results show great variability, then the treatment rates should be re-assessed and higher frequency verification tests adopted (eg 1 in 150m^3); and
- Once adequate neutralisation is achieved, the soil will be suitable for replacement as back-fill. Excess soil shall be treated as specified above and disposed of on-site.

Results from monitoring shall be kept on-site during construction and be available for inspection by the engineer, Council or State Government officers. Details of the treatment and monitoring activities should be provided to the site Engineer on a monthly basis, until the completion of the works.

No soil shall be disposed of off-site. Delivery dockets for the agricultural lime should be kept with other site records to demonstrate that adequate neutralising agent was used on site.

5.3. Groundwater Treatment Measures

Groundwater will likely be intercepted during future site works, however no de-watering is proposed and therefore no treatment of groundwater is proposed.

Surface water shall be directed away from the excavations.

5.4. Contingency Measures

The following contingency measures are for any of the works that are below the existing ground surface in the vicinity of BH4.

If soil from an excavation is not expected to be stockpiled out of the excavation for greater than 24 hours, no analysis is required for this material. If material is stockpiled out of an excavation for longer than 24 hours, soil acidity in disturbed materials should be monitored. Should the field pH tests show that the soil acidity has not been neutralised, then the material must be re-worked and additional lime treatment carried out until it is verified that the soil meets the required standard.

No groundwater is proposed to be discharged off site. However, in the event that groundwater is required to be discharged off site, if monitoring of collected water at the point of discharge indicates the pH is below acceptable discharge limits, then discharge must immediately cease and further treatment be carried out. Agricultural lime may only be applied following directions by the ASS Consultant who shall direct the Contractor in mixing procedures such that lime is added in small increments so as not to cause unduly high water pH levels (i.e. above 8.5). The agricultural lime shall be stored in a covered and bunded area to prevent accidental release to the surrounding environment.

In the event that pH measurement of exposed soils in excavations does not meet required levels, lime shall be spread over the affected area and the pH levels further monitored.

Sufficient lime is to be stored in a dry location on-site to permit the immediate implementation of the above contingency measures.

6. Conclusion

Ardill Payne & Partners (APP) has been commissioned by Monal Pty Ltd to complete an Acid Sulphate Soil Assessment and Management Plan for Lot 100 DP 1201719, Hills Road, Rileys Hill, which was required to satisfy the conditions of the Department of Planning's Gateway Determination (dated 16th February 2018).

Laboratory testing has shown that soils in the investigation area are acidic but do not have potential for further generation (i.e. no PASS detected). As actual acid sulfate soil was detected a management plan was prepared and development consent is required.

The management plan contained within this report will ensure that any ASS material is treated, managed and re-used appropriately as to prevent any detrimental effects on the environment. It is assumed that all excavated material will be re-used on site.

This assessment has been conducted in accordance with the *NSW Acid Sulfate Soils Manual* (Acid Sulfate Soils Management Advisory Committee, 1998).

7. General Notes

General

Geotechnical and environmental reports present the results of investigations carried out for a specific project and usually for a specific phase of the project (e.g. preliminary design). The report is based specific criteria, such as the nature of the project, underground utilities or scope of service limitations imposed by the Client. The report may not be relevant for other phases of the project (e.g. construction), after some time or where project details and clients change.

Soil and Rock Description

Soil and rock descriptions are based on AS1726-1993 using visual and tactile assessment except at discrete locations where field and/or laboratory tests have been carried out. Refer to the terms and symbols sheet for definitions.

Groundwater

The water levels indicated are taken at the time of measurement and depending on material permeability may not reflect the actual groundwater level at those specified locations. Also groundwater levels can vary with time due to seasonal or tidal fluctuation, construction activities and other external factors.

Interpretation of Results

The discussion and recommendations in the accompanying report are based on extrapolation/interpolation from data obtained at discrete locations and other external sources and guidelines. The actual interface between the materials may be far more gradual or abrupt than indicated. Also actual conditions in areas not sampled may differ from those predicted.

The report is based on significant background details that only the authors can be aware off, and therefore implementation of the recommendations by others may lead to misinterpretation and complications. Therefore this company should be consulted to explain the reports implications to other involved parties.

Reporting relies on interpretation of often limited factual information based on judgement and opinion which has a level of uncertainty and ambiguity attached to it, and is far less exact than other design disciplines. This should be considered by users of the report when assessing the implications of the recommendations.

Change in Conditions

Subsurface conditions can change with time and can vary between test locations. Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations can also affect subsurface conditions.

8. Scope of Engagement

This report has been prepared by Ardill Payne & Partners (APP) at the request of Monal Pty Ltd for the purpose of an Acid Sulfate Soils Assessment and Management Plan and is not to be used for any other purpose or by any other person or corporation.

This report has been prepared from the information provided to us and from other information obtained as a result of enquiries made by us. APP accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

APP declares that it does not have, nor expects to have, a beneficial interest in the subject project.

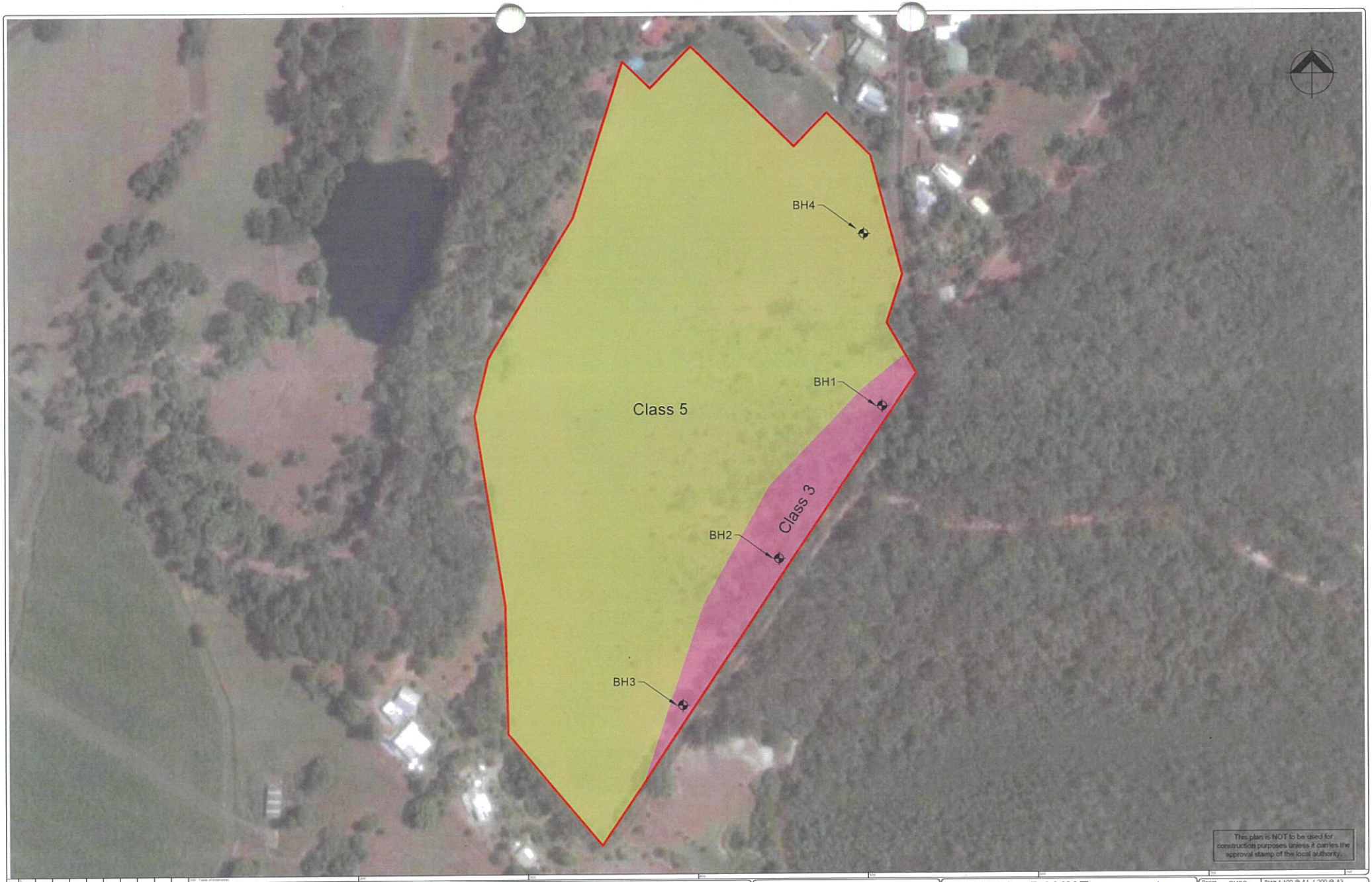
To avoid this advice being used inappropriately it is recommended that you consult with APP before conveying the information to another who may not fully understand the objectives of the report. This report is meant only for the subject site/project and should not be applied to any other.

9. Attachments

Attachment 1	Sampling Map
Attachment 2	Borehole Logs
Attachment 3	Laboratory Results

ATTACHMENT 1

Attachment 1: Sampling Map



Issue	Date	Description	App'd

Client:
Monal Pty Ltd
(c/- Alan Cardy)

Project:
Proposed Residential Subdivision
Lot 100 DP 1201719
Hills Road, Rileys Hill

Title:
Indicative Acid Sulfate Soils Sampling Map

ARDILL PAYNE
& Partners
ENGINEERS PLANNERS SURVEYORS
ENVIRONMENTAL PROJECT MANAGEMENT
BALLINA 45 River Street Ph. 02 6686 3280
GUNNEDAH 285 Conadilly Street Ph. 02 6742 9955
A.B.N. 51 808 558 977 e-mail: info@ardillpayne.com.au

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Datum	AHD
Drafting File	8174 ASS.dwg
Design File	
Dwg No.	ASS.1
Issue	A

Ardill Payne & PARTNERS

ATTACHMENT 2

Attachment 2: Borehole Logs

SITE PLAN & TEST LOCATIONS

Client:	Ardill Payne & Partners	**ASCT Ref No:**	H18-581
Project:	- Hill Street, Rileys Hill	**Client Ref No:**	NA
Borehole Position:	See Site Sketch	**Drilling Method:**	Power Auger
Surface Elevation:	Exisiting Surface Level	**Drill Bit:**	100mm Ø TC

1 Borehole Location

1 Test Pit Location

BOREHOLE LOG SHEET - 1

Client:	Ardill Payne & Partners	**ASCT Ref No:**	H18-581
Project:	- Hill Street, Rileys Hill	**Client Ref No:**	NA
Borehole Position:	See Site Sketch	**Drilling Method:**	Power Auger
Surface Elevation:	Exisiting Surface Level	**Drill Bit:**	100mm Ø TC

Depth (m)	Graphic Symbol	Group Symbol	Soil Description (AS 1726)	Consistency / Relative Density / Rock Strength	DCP Blows/300mm *Cone Tip*	Test Sample
0.0		SM	**SILTY SAND, NATURAL:** black, non plastic, fine to medium grained sand, moist.			Disturbed
0.1						
0.2						
0.3		SP	**SAND, NATURAL:** grey and brown, non plastic, fine to medium grained sand, moist.			
0.4						
0.5						Disturbed
0.6						
0.7						
0.8						
0.9		SP	**SAND, NATURAL:** grey, non plastic, fine to medium grained sand, moist.			
1.0						Disturbed
1.1						
1.2						
1.3		SP	**SAND, NATURAL:** grey, non plastic, fine to medium grained sand, wet.			
1.4						
1.5						Disturbed
1.6						
1.7						
1.8						
1.9						
2.0		SP	**SAND, NATURAL:** brown, non plastic, fine to medium medium grained sand, wet.			Disturbed
2.1						
2.2						
2.3						
2.4						
2.5			**DRILLING TERMINATED:** target depth reached.			Disturbed
2.6						
2.7						
2.8						
2.9						
3.0						
3.1						
3.2						
3.3						
3.4						
3.5						
3.6						
3.7						
3.8						
3.9						
4.0						
4.1						
4.2						
4.3						
4.4						
4.5						
4.6						
4.7						
4.8						
4.9						
5.0						

BOREHOLE LOG SHEET - 2

Client:	Ardill Payne & Partners	**ASCT Ref No:**	H18-581
Project:	- Hill Street, Rileys Hill	**Client Ref No:**	NA
Borehole Position:	See Site Sketch	**Drilling Method:**	Power Auger
Surface Elevation:	Exisiting Surface Level	**Drill Bit:**	100mm Ø TC

Depth (m)	Graphic Symbol	Group Symbol	Soil Description (AS 1726)	Consistency / Relative Density / Rock Strength	DCP Blows/300mm *Cone Tip*	Test Sample
0.0		SM	**SILTY SAND, NATURAL:** black, non plastic, fine to medium grained sand, moist.			Disturbed
0.1						
0.2						
0.3						
0.4		SP	**SAND, NATURAL:** dark grey and grey, non plastic, fine to medium grained sand, moist.			
0.5						Disturbed
0.6						
0.7						
0.8						
0.9						
1.0						Disturbed
1.1						
1.2						
1.3						
1.4						
1.5		SP	**SAND, NATURAL:** dark grey and grey, non plastic, fine to medium grained sand, wet.			Disturbed
1.6						
1.7						
1.8						
1.9						
2.0						Disturbed
2.1						
2.2						
2.3						
2.4						
2.5			**DRILLING TERMINATED:** target depth reached.			Disturbed
2.6						
2.7						
2.8						
2.9						
3.0						
3.1						
3.2						
3.3						
3.4						
3.5						
3.6						
3.7						
3.8						
3.9						
4.0						
4.1						
4.2						
4.3						
4.4						
4.5						
4.6						
4.7						
4.8						
4.9						
5.0						

BOREHOLE LOG SHEET - 3

Client:	Ardill Payne & Partners	**ASCT Ref No:**	H18-581
Project:	- Hill Street, Rileys Hill	**Client Ref No:**	NA
Borehole Position:	See Site Sketch	**Drilling Method:**	Power Auger
Surface Elevation:	Exisiting Surface Level	**Drill Bit:**	100mm Ø TC

Depth (m)	Graphic Symbol	Group Symbol	Soil Description (AS 1726)	Consistency / Relative Density / Rock Strength	DCP Blows/300mm *Cone Tip*	Test Sample
0.0		SP	**SAND, NATURAL:** dark grey, non plastic, fine to medium grained sand, moist.			Disturbed
0.1						
0.2						
0.3						
0.4						
0.5						Disturbed
0.6						
0.7						
0.8		SP	**SAND, NATURAL:** grey, non plastic, fine to medium grained sand, moist.			
0.9						
1.0						Disturbed
1.1						
1.2						
1.3						
1.4						
1.5						Disturbed
1.6			**SAND, NATURAL:** grey, non plastic, fine to medium grained sand, wet.			
1.7						
1.8						
1.9						
2.0						Disturbed
2.1						
2.2						
2.3						
2.4						
2.5			**DRILLING TERMINATED:** target depth reached.			Disturbed
2.6						
2.7						
2.8						
2.9						
3.0						
3.1						
3.2						
3.3						
3.4						
3.5						
3.6						
3.7						
3.8						
3.9						
4.0						
4.1						
4.2						
4.3						
4.4						
4.5						
4.6						
4.7						
4.8						
4.9						
5.0						

BOREHOLE LOG SHEET - 4

Client:	Ardill Payne & Partners	**ASCT Ref No:**	H18-581
Project:	- Hill Street, Rileys Hill	**Client Ref No:**	NA
Borehole Position:	See Site Sketch	**Drilling Method:**	Power Auger
Surface Elevation:	Exisiting Surface Level	**Drill Bit:**	100mm Ø TC

Depth (m)	Graphic Symbol	Group Symbol	Soil Description (AS 1726)	Consistency / Relative Density / Rock Strength	DCP Blows/300mm *Cone Tip*	Test Sample
0.0		SM	**SILTY SAND, NATURAL:** black, non plastic, fine to medium grained sand, moist.			Disturbed
0.1						
0.2		CH	**SILTY CLAY, NATURAL:** orange, high plastic, high dry strength, moist.			
0.3						
0.4						
0.5						Disturbed
0.6						
0.7						
0.8						
0.9						
1.0						Disturbed
1.1						
1.2		XW	**SILTY SAND/EXTREMELY WEATHERED SANDSTONE, NATURAL:** orange/white, dry.			
1.3						
1.4						
1.5						Disturbed
1.6						
1.7						
1.8						
1.9						
2.0		DW	**WEATHERED SANDSTONE, NATURAL:** grey, dry.			Disturbed
2.1						
2.2						
2.3						
2.4						
2.5			**DRILLING TERMINATED:** target depth reached.			Disturbed
2.6						
2.7						
2.8						
2.9						
3.0						
3.1						
3.2						
3.3						
3.4						
3.5						
3.6						
3.7						
3.8						
3.9						
4.0						
4.1						
4.2						
4.3						
4.4						
4.5						
4.6						
4.7						
4.8						
4.9						
5.0						

ATTACHMENT 3

Attachment 3: Laboratory Results

Environmental Analysis Laboratory

PO Box 157 (Military Road)
LISMORE NSW 2480
T: 02 6620 3678 E: eal@scu.edu.au W: www.scu.edu.au

Submitting Client Details

Quote Id:
Job Ref: 8174
Company: ARDILL PAYNE
Contact: ROWENA MCLEARY
Phone:
Mobile:
Email: rowenam@ardillpayne.com
Postal address: 45 RIVER ST BALLINA 2478

Billing Client Details

☐ Tick if same as submitting details
ABN:
Company: APP
Contact: GAYLE EVTUSHENKO
Phone:
Mobile:
Email: gaylee@ardillpayne.com.au
Postal address:

Payment Method:

☐ Purchase Order
☐ Cheque
☐ Credit/Debit Card (EAL staff will phone for details)
☑ Invoice (prior approval)

Relinquished: R. MCLEARY Date: 22/5/18
Received: Date: 22.5.18

Preservation: none - (freezer bricks) - ice - acidified - filtered - other
Condition on receipt: ambient - (cool) - frozen - other

Comments: AS-PACK-007 for all samples
AS-PACK-001 if required
0, 0.5, 1.0, 1.5, 2.0, 2.5

Thank you!

Likelihood and nature of Hazardous material:

Lab ID	Sample ID	Sample Depth	Sampling Date	Sampler	Your Client	Crop ID	Sample Type (e.g. water, leaf, soil)	Total number of samples	Sample Analysis Request: Price list code (e.g. SW-PACK-06) AS-PACK-007					
1-6	BH1 0→2.5	0→2.5	17/5/18	ASLT	8174	–	soil		X					
7-12	BH2 0→2.5	↓	↓	↓	↓	↓	↓		X					
13-18	BH3 0→2.5	↓	↓	↓	↓	↓	↓		X					
19-24	BH4 0→2.5	↓	↓	↓	↓	↓	↓		X					

RESULTS OF ACID SULFATE SOIL ANALYSIS

24 samples supplied by Ardill Payne & Partners on 22/05/18. Lab Job No.H0595
Analysis requested by Rowena McGeary. Your Job: 8174

PO Box 20 BALLINA NSW 2478

Sample Identification	Depth	EAL Lab Code	Texture	Moisture Content		pH_F and pH_{FOX}				Potential Sulfidic Acidity (Chromium Reducible Sulfur - CRS)		Actual Acidity (Titratable Actual Acidity - TAA)		Retained Acidity ($\%S_{KCl} - \%S_{CRS}$)		Acid Neutralising Capacity (ANC_{BT})		Net Acidity (based on S_{CR})	Lime Calculation
	(m)			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH_F	pH_{FOX}	pH change	Reaction	(% S_{CR})	(mol H^+/t)	pH_{KCl}	(mol H^+/t)	($\%S_{NAS}$)	(mol H^+/t)	(% $CaCO_3$)	(mol H^+/t)	(mol H^+/t)	(kg $CaCO_3$/t DW)
Abs/sol. info.	--		--	--	--	(in-house method S21)				(in-house method S20)		(in-house method T6b)		--		(in-house method S14)		--	--
BH1	0.0	H0595/1	Coarse	9.1	0.10	4.40	3.22	-1.18	Low	..	..	..	..	..	..	..	..	..	..
BH1	0.5	H0595/2	Coarse	5.9	0.06	5.42	3.26	-2.16	Low	<0.005	0	5.01	13	..	..	..	..	13	0.9
BH1	1.0	H0595/3	Coarse	20.0	0.25	5.57	4.42	-1.15	Low	..	..	..	..	..	..	..	..	..	..
BH1	1.5	H0595/4	Coarse	22.9	0.30	5.95	3.88	-2.07	Low	..	..	..	..	..	..	..	..	..	..
BH1	2.0	H0595/5	Coarse	19.2	0.24	5.28	3.90	-1.38	Low	..	..	..	..	..	..	..	..	..	..
BH1	2.5	H0595/6	Coarse	23.2	0.30	4.56	2.91	-1.65	Low	<0.005	0	3.95	45	0.000	0	..	..	45	3.4
BH2	0.0	H0595/7	Coarse	15.1	0.18	5.09	1.63	-3.46	Medium	<0.005	0	4.41	41	0.000	0	..	..	41	3.1
BH2	0.5	H0595/8	Coarse	6.8	0.07	5.71	2.58	-3.13	Low	..	..	..	..	..	..	..	..	..	..
BH2	1.0	H0595/9	Coarse	21.7	0.28	5.40	2.92	-2.48	Low	<0.005	0	5.39	6	..	..	..	..	6	0.5
BH2	1.5	H0595/10	Coarse	22.4	0.29	5.53	3.13	-2.40	Low	..	..	..	..	..	..	..	..	..	..
BH2	2.0	H0595/11	Coarse	19.1	0.24	5.69	3.06	-2.63	Medium	..	..	..	..	..	..	..	..	..	..
BH2	2.5	H0595/12	Coarse	25.0	0.33	5.60	3.42	-2.18	Medium	..	..	..	..	..	..	..	..	..	..
BH3	0.0	H0595/13	Coarse	6.9	0.07	5.66	2.47	-3.19	Medium	0.005	3	4.74	19	..	..	..	..	22	1.7
BH3	0.5	H0595/14	Coarse	4.7	0.05	5.57	3.54	-2.03	Low	..	..	..	..	..	..	..	..	..	..
BH3	1.0	H0595/15	Coarse	4.9	0.05	5.80	3.57	-2.23	Low	..	..	..	..	..	..	..	..	..	..
BH3	1.5	H0595/16	Coarse	17.6	0.21	5.74	4.14	-1.60	Low	..	..	..	..	..	..	..	..	..	..
BH3	2.0	H0595/17	Coarse	21.5	0.27	5.69	3.87	-1.82	Low	..	..	..	..	..	..	..	..	..	..
BH3	2.5	H0595/18	Coarse	21.7	0.28	5.82	4.28	-1.54	Low	..	..	..	..	..	..	..	..	..	..
BH4	0.0	H0595/19	Medium	15.1	0.18	5.58	2.64	-2.94	Medium	<0.005	0	4.72	34	..	..	..	..	34	2.5
BH4	0.5	H0595/20	Fine	14.9	0.18	5.24	2.99	-2.25	Medium	<0.005	0	3.92	93	0.000	0	..	..	93	6.9
BH4	1.0	H0595/21	Fine	19.0	0.23	4.91	2.94	-1.97	Medium	..	..	..	..	..	..	..	..	..	..
BH4	1.5	H0595/22	Medium	10.9	0.12	5.42	3.53	-1.89	Medium	0.010	6	3.90	104	0.002	1	..	..	111	8.3
BH4	2.0	H0595/23	Medium	8.0	0.09	5.50	3.82	-1.68	Medium	..	..	..	..	..	..	..	..	..	..
BH4	2.5	H0595/24	Medium	12.2	0.14	5.54	3.41	-2.13	Medium	0.007	4	3.94	88	0.000	0	..	..	93	6.9

NOTES:

1. All analysis is reported on a dry weight (DW) basis, unless wet weight (WW) is specified.
2. Samples are dried and ground immediately upon arrival (unless supplied dried and ground).
3. Analytical procedures are sourced from Ahern CR, McElnea AE and Sullivan LA (2004). *Acid sulfate soil laboratory method guidelines*. Queensland Department of Natural Resources, Mines and Energy: Indooroopilly, Qld, Australia.
4. The Acid Base Accounting Equation is **Net Acidity = Actual Acidity + Retained Acidity + Potential Sulfidic Acidity (S_{CR} or S_{Cr}) – Acid Neutralising Capacity/Fineness Factor** (Ahern et al. 2004 - full reference above).
5. Retained Acidity is required when the pH_{KCl} < 4.5 or where jarosite has been visually observed. Acid Neutralising Capacity is required when the Potential Sulfidic Acidity is greater than the texture dependent trigger and the pH_{KCl} is ≥ 6.5.
6. **An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ≥ 0.03% S or 19 mol H^+/t; medium texture ≥ 0.06% S or 37 mol H^+/t; fine texture ≥ 0.1% S or 62 mol H^+/t)** (Ahern *et al.* 2004 - full reference above)
7. For projects that disturb > 1000 tonnes of soil, the coarse trigger of ≥ 0.03% S must be applied in accordance with Ahern CR, Stone Y and Blunden B (1998). *Acid sulfate soils assessment guidelines*. Acid Sulfate Soil Management Advisory Committee: Wollongbar, NSW, Australia.
8. Acid sulfate soil texture triggers can be related to standard soil textures: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays (Ahern et al. 1998 - full reference above).
9. Bulk density is required to convert liming rates to soil volume based results. Field bulk density rings can be submitted to EAL for bulk density determination.
10. **The lime calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Ahern et al. 2004). This is only applied to positive values. An increased Safety Factor may be required in some cases.**
11. A negative Net Acidity result indicates an excess acid neutralising capacity.
12. '..' is reported where a test is either not requested or not required. Where pH_{KCl} is < 4.5 or > 6.5, zero is reported for S_{NAS} and ANC in Net Acidity calculations, respectively.
13. Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
14. ** NATA accreditation does not cover the performance of this service.

NATA

checked: .....
Graham Lancaster
Laboratory Manager