Aargus

Environmental - Remediation - Engineering - Laboratories - Drilling

ACID SULPHATE SOILS ASSESSMENT

182, 184, 188, 190 & 190A Victoria Road & 18-26 & 28 Faversham Street, Marrickville NSW

Prepared for

E & D Danias Pty Ltd

8th May 2014

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REFERENCES

- Acid Sulphate Soils Management Advisory Committee (ASSMAC) (1998) – *Acid Sulphate Soils Assessment Guidelines*.

ABBREVIATIONS

AASS	Actual Acid Sulphate Soils
AHD	Above Height Datum
ANC	Acid Neutralising Capacity
ASS	Acid Sulphate Soils
ASSMAC	Acid Sulphate Soils Management Advisory Committee
ASSMP	Acid Sulphate Soils Management Plan
BGL	Below Ground Level
DNR&M	Department of Natural resources and Mines
DO	Dissolved Oxygen
EC	Electric Conductivity
EIL	Ecological Investigation Level
EPA	Environmental Protection Authority
HIL	Health-based Investigation Level
LOR	Limit of reporting
NV	Neutralising Value
PASS	Potential Acid Sulphate Soils
POCAS	Peroxide Oxidation Combined Acidity and Sulphate
PSI	Preliminary Site Investigation
QA/QC	Quality Assurance/Quality Control
QASSIT	Queensland Acid Sulphate Soils Investigation Team
SPOCAS	Suspended Peroxide Oxidation Combined Acidity and Sulphate
Spos	Peroxide Oxidisable
TAA	Total Actual Acidity
TCLP	Toxicity Characteristic Leaching Procedure
TPA	Total Potential Acidity
TSA	Total Sulfidic Acidity
TSS	Total Suspended Solids
VENM	Virgin Excavated Natural Material

1.0 INTRODUCTION

Aargus Pty Ltd was commissioned by E & D Danias Pty Ltd to conduct an Acid Sulphate Soils Assessment within the property located at 182,184,188,190A & 190 Victoria Road and 18-26 & 28 Faversham Street, Marrickville NSW ("the site"). The site is located in the Marrickville Council local government area.

The ASS is required as disturbances to Potential Acid Sulphate Soil (PASS) or Actual Acid Sulphate Soils, which may occur during construction and excavation works, can result in the formation of acid. The acid, once formed, could then damage infrastructure or harm ecological systems.

The results of the field parameters from this assessment should only be used as a preliminary study to determine if further investigations are required. If results meet the criteria no further work, including an ASS Management Plan, will be required.

2.0 OBJECTIVES

The purpose of the ASS Assessment is to determine the presence or absence of ASS at the site. In the absence of ASS it is essential to assess for the presence of Potential Acid Sulphate Soils (PASS). If the results do not meet criteria an Acid Sulphate Soil Management Plan will be required.

This Preliminary Assessment reviewed the presence of ASS / PASS in the portion of the site that may require excavation.

3.0 SCOPE OF WORKS

The scope of works of the Preliminary ASS Assessment included:

- Review of previous environmental assessments;
- Site walkover;
- Targeted soil boring, sampling and testing for potential ASS at the site;
- Interpretation of field test and laboratory analysis and findings; and
- Reporting in accordance with relevant assessment guidelines / regulations.

4.0 ASSESSMENT CRITERIA

When assessing ASS at sites in NSW Acid Sulphate Soils Management Advisory Committee (ASSMAC) (1998) Acid Sulphate Soils Assessment Guidelines apply.

The purpose of this report is to determine whether there is a probable risk associated with ASS or PASS and to determine whether these types of soils actually exist on the site.

These maps do not detail the severity of the ASS, but only provide an indication that they may be present. The decision to classify certain areas as ASS is based on a number of geomorphic conditions and site criteria. The following points are used to determine if ASS are likely to exist (extracted from ASSMAC (1998) Acid Sulphate Soils Assessment Guidelines):

- Sediments of recent geological age (Holocene) ~ 10 000 y.o.
- Soil horizons less than 5m AHD (Australian Height Datum).
- Marine or estuarine sediments and tidal lakes.

- In coastal wetlands or back swamp areas; waterlogged or scalded areas; interdune swales or coastal sand dunes.
- In areas where the dominant vegetation is mangroves, reeds, rushes and other swamp tolerant and marine vegetation.
- In areas identified in geological descriptions or in maps bearing sulphide minerals, coal deposits or former marine shales/sediments.
- Deeper older estuarine sediments >10m below the ground surface, Holocene or Pleistocene age.

The following soil indicators are used to determine if ASS are actually present on a site:

- field pH ≤4 in soils
- presence of shell
- any jarosite horizons or substantial iron oxide mottling in auger holes, in surface encrustations or in any material dredged or excavated and left exposed. Jarosite is not always found, however, in actual acid sulphate soils.

The following soil indicators are used to determine if PASS are actually present on a site:

- waterlogged soils, unripe muds (soft, buttery, blue grey or dark greenish grey) or estuarine silty sands or sands (mid to dark grey) or bottom sediments of estuaries or tidal lakes (dark grey to black)
- presence of shell
- soil pH usually neutral but may be acid -positive Peroxide Test (see section 7.2 Field pH results).

5.0 SITE INFORMATION

5.1 Site Identification

The site property is located at 182, 184, 188, 190A & 190 Victoria Road and 18-26 & 28 Faversham Street, Marrickville NSW (refer to Figure 1 – Locality Map in Appendix A). The site is located in the Marrickville Council local government area.

The surrounding land uses identified are described in the table below:

Orientation	Description
North	Commercial Business Park – multiple tenants
East	Faversham Street, then commercial properties
South	Substation, tennis courts &dry cleaning warehouse
West	Victoria Road, then commercial properties including timber yard

5.2 Site Description

A site visit was carried out on 15th and 17th October 2013 by an Aargus field scientist. At the time of the site inspection, the following observations were made:

- The site was rectangular in shape and used for commercial and residential purposes;
- The site was occupied by a large warehouse with attached office building in the southern western portion of the site, a residential property & small warehouse in the north western portion of the site, three warehouse buildings & awning in the central northern portion of the site, three warehouse & office building along the eastern boundary of the site, concrete access ways, two concrete sealed car park areas in the western & eastern portion of the site, unsealed access ways in the north of the site and garden beds located throughout the site;
- The main access to the site was along Victoria Road& Faversham Street, on the western & eastern boundaries, respectively;

- The large warehouse on the site was constructed of bricks with a metal roof. It was occupied by Rosa Stone and had a small mechanical area in the central portion of the site. The attached office building had a showroom and was also used by Rosa Stone. This office building had a second level which was used for office space;
- The residential property was made from bricks and appeared to have a metal roof. The small warehouse to the north of the residential property was made from bricks. This was occupied by Prestige Smash Repairs and contained a spray booth;
- The three warehouse and office buildings in the central northern portion of the site were constructed of brick and metal and were occupied by Gorilla Constructions for metal work, office work & other commercial purposes;
- The three warehouse and office buildings along the eastern boundary of the site were constructed of brick and metal and were occupied by SoundWorks Studios & office tenants;
- The car park areas were located in the western & eastern halves of the site and were sealed with concrete & were in average condition. Cracks were visible on the surface;
- Unsealed access ways and car park area were observed along the northern site perimeter and in the central northern part of the site;
- Some waste material, including office furniture, empty oil drums, disposable coffee cups, broken plastic signs, cardboard boxes and green waste, was observed in the car park of the property at 190 & 190A Victoria Road, Marrickville NSW;
- A stormwater drain manhole was observed in the car park area of 18-26 Faversham Street, in the east of the site;
- The site boundaries were defined by Victoria Road in the west, Faversham Street in the east, the outline of the adjacent buildings to the north & south;
- No surface standing water was noticed at the site;
- There was evidence of chemical storage at the site. Spray painting chemicals & oil was located at 182, 188 & 190 Victoria Road, Marrickville NSW;

- A spray booth was located at 184 Victoria Road;
- There were no indicators of underground storage tanks within the site; and
- Hazardous material was observed and included fibro cement sheeting.

5.3 Topography

The site slopes towards the south east at a gradient of approximately 3-5°. The regional topography appears undulating and generally sloping towards the south-east.

Stormwater runoff from the site is expected to flow in a southerly direction and discharge into the stormwater drain located along the site boundaries in the southern part of the site.

5.4 Local geology, hydrogeology, surface waters

Reference to the Sydney 1:100,000 Geological Series Sheet 9130 Edition 1, dated 1983, by the Geological Survey of New South Wales, Department of Mineral Resources, indicates the following:

- The site is located within an area underlain by alluvial deposits consisting of "peat, sandy peat and mud" and denoted as (Qhs); and
- The site is at approximately 60m to the south of the geological boundary with Ashfield Shale, which is denoted as (Rwa) and at approximately 250m to the east of the geological boundary with the Hawkesbury Sandstone, which is denoted as (Rh).

A search of the Department of Natural Resources (DNR) borehole database information revealed five (5) groundwater bores within a 1km radius of the site, with final drilling depths of 1.30m to 4.25m BGL, and used for monitoring purposes.

The nearest surface water body from the site is Alexandra Canal located approximately 1.8 km south-east of the site, which runs south westerly towards Wolli Creek. Water from the local and surrounding areas is likely to flow towards Wolli Creek and thence into Botany Bay.

5.5 Proposed development

The report has been prepared as part of a due diligence process for investigation purposes.

6.0 SOIL BORING AND SAMPLING

A soil sampling and analysis program was used to consolidate the nature and degree of Acid Sulphate Soils present in the surface and subsurface geology. Samples were collected from three (3) boreholes (BH1 to BH3) drilled within the site. The boreholes were drilled to depths between 4.3m & 8.0m below ground level (BGL), that being refusal in bedrock, with samples collected at varying depths depending on the soil profile (the borehole locations are presented in Figure 2 – Site Plan in Appendix A).

Field analysis was performed on the collected samples for pH_f and pH_{fox} in accordance with the required sampling techniques of the *ASSMAC (1998) Assessment Guidelines* (see Appendix D – ASSMAC (1998) Field pH and peroxide test protocol).

6.1 Health & Safety

Standard Health and Safety procedures were observed. Rubber gloves were worn to minimise exposure to any potential contaminants. Breathing apparatus and PPE suits were supplied but not worn.

6.2 Quality Assurance/Quality Control (QA/QC)

Standard QA/QC procedures were followed. The decontamination of sampling equipment and the hand auger was achieved by washing with phosphate-free detergent and tap water, followed by final rinsing with distilled water. This was conducted after the collection of samples.

Standard sampling and analysing procedures are in accordance with and set out in the *NSW ASSMAC (1998) "Acid Sulphate Soils Assessment Guidelines"*.

7.0 FIELD RESULTS

7.1 Soil observations

Based on information from all boreholes, the surface and sub-surface profile across the site is generalised as follows:

- REWORKED INSITU SOILS – Silty Clay, medium plasticity, dark grey, moist, soft to firm.
- NATURAL – Silty CLAY, medium plasticity to high plasticity, grey with red mottling, with some fine to medium iron-stained gravel, moist, firm to stiff.
- NATURAL – Sandy CLAY, medium plasticity, grey with red mottling, fine to medium sand, with some fine to medium iron-stained gravel, moist to stiff
- NATURAL – SANDSTONE, fine to medium grained, grey and dark brown with red mottling, very low strength, extremely weathered, with silty clay bands.

No unusual colouring was detected in the soil suggesting the presence of pyrite (iron sulphide) or Jarosite was unlikely. Unripe muds or mid to dark-grey estuarine sands were not detected. Sulphurous odours were not detected in any of the recovered samples.

For full details of the soil profile refer to the borehole logs in Appendix C.

7.2 Field pH results

The results of field pH tests are presented in Table 1 below.

Table 1: Summary of field analysis results

Sample	Depth (m)	Soil Type	pH		pH	
			H_2O	Soil pH_f	H_2O_2	Soil pH_{fox}
BH1	0.5 – 1.0	FILL	7.0	8.5	5.0	5.9
BH1	1.0 – 1.45	Silty CLAY	7.0	8.3	5.0	5.7
BH1	3.5 – 4.0	Sandy CLAY	7.0	7.5	5.0	5.4
BH2	0.5 – 1.0	FILL	7.0	8.4	5.0	5.9
BH2	2.0 – 2.5	Silty CLAY	7.0	8.0	5.0	5.7
BH2	4.0 – 4.5	Sandy CLAY	7.0	7.5	5.0	5.2
BH2	7.0 – 7.5	Gravelly Sandy CLAY	7.0	7.6	5.0	5.1
BH3	0.5 – 1.0	Reworked Silty Clay	7.0	8.4	5.0	6.1
BH3	1.5 – 2.0	Silty CLAY	7.0	7.9	5.0	5.8
BH3	3.0 – 3.5	Sandy CLAY	7.0	7.6	5.0	5.4

Notes:

- pH_f refers to pH field (soil and distilled H_2O).
- pH_{fox} refers to pH field oxidised (soil and peroxide).

To investigate the presence of Actual ASS (acid sulfate soils) of the soils water was added to the soil samples. The pH_f of the investigated samples was well above 4. This indicates the soils from which the samples were collected did not contain Actual Acid Sulfate Soil (ASS).

To investigate the presence of PASS (potential acid sulphate soils), 30% peroxide (H_2O_2) was added to soil samples and the resulting pH of the mixture was measured (field test protocols are presented in Appendix B – ASSMAC (1998) Field pH and peroxide test protocol). The pH of the soil peroxide solution (pH_{fox}) did not decrease below 3 pH units in any of the samples which would indicate if PASS was present. The values for pH_{fox} of greater than 5 indicate no net acid generating ability, and the soils down to 7.5m BGL are not considered to contain Potential Acid Sulphate Soils.

The addition of peroxide to the soil did not change colour and did not release sulphurous odours.

8.0 CONCLUSIONS AND RECOMMENDATIONS

This report has been prepared as part of a due diligence process for investigation purposes. Field pH tests indicated that soil samples collected at depth from the site were not acidic and well above the ASSMAC (1998) guideline of pH≤4. Also, pyrite or jarosite was not observed during the investigation and only slight sulphurous odours were recorded within the borehole at shallow depths. During field investigations no unripe muds were observed, mid to dark grey estuarine sands were not observed and field tests confirmed no Actual Acid Sulphate Soils. The soils at the site, therefore, did not contain *Actual Acid Sulphate Soils*.

To investigate the presence of PASS, 30% peroxide was added to soil samples and the resulting pH of the mixture was measured. The pH of the soil peroxide solution $pH_{f(ox)}$ did not decrease below 3 pH units in any of the samples, which would indicate if PASS was present. The values for $pH_{f(ox)}$ of greater than 5 indicate no net acid generating ability, as was the case in all samples recovered across the site. The pH_{fox} values were above the ASSMAC (1998) guidelines that suggests a lack of unoxidised sulphides.

The purpose of this assessment was to investigate the soil on the site and test for the potential presence of ASS and PASS. PASS soils were ***not detected*** at any depth up to 7.5m BGL. We would be pleased to provide further information or discuss any aspect of our report. Please do not hesitate to contact the undersigned should you have any queries.

For and on behalf of
Aargus Pty Ltd

Joseph McDermott
Environmental Scientist

Reviewed By

Mark Kelly
Environmental Manager

9.0 LIMITATIONS

Whilst to the best of our knowledge, information contained in this report is accurate at the date of issue, although subsurface conditions, including groundwater levels and contaminant concentrations, can change in a limited time. This should be borne in mind if the report is used after a protracted delay.

There is always some disparity in subsurface conditions across a site that cannot be fully defined by investigation. Hence it is unlikely that measurements and values obtained from sampling and testing during environmental works carried out at a site will characterise the extremes of conditions that exist within the site.

There is no investigation that is thorough enough to preclude the presence of material that presently or in the future, may be considered hazardous at the site. Since regulatory criteria are constantly changing, concentrations of contaminants presently considered low may, in the future, fall under different regulatory standards that require remediation.

Opinions are judgements that are based on our understanding and interpretation of current regulatory standards, and should not be construed as legal opinions.

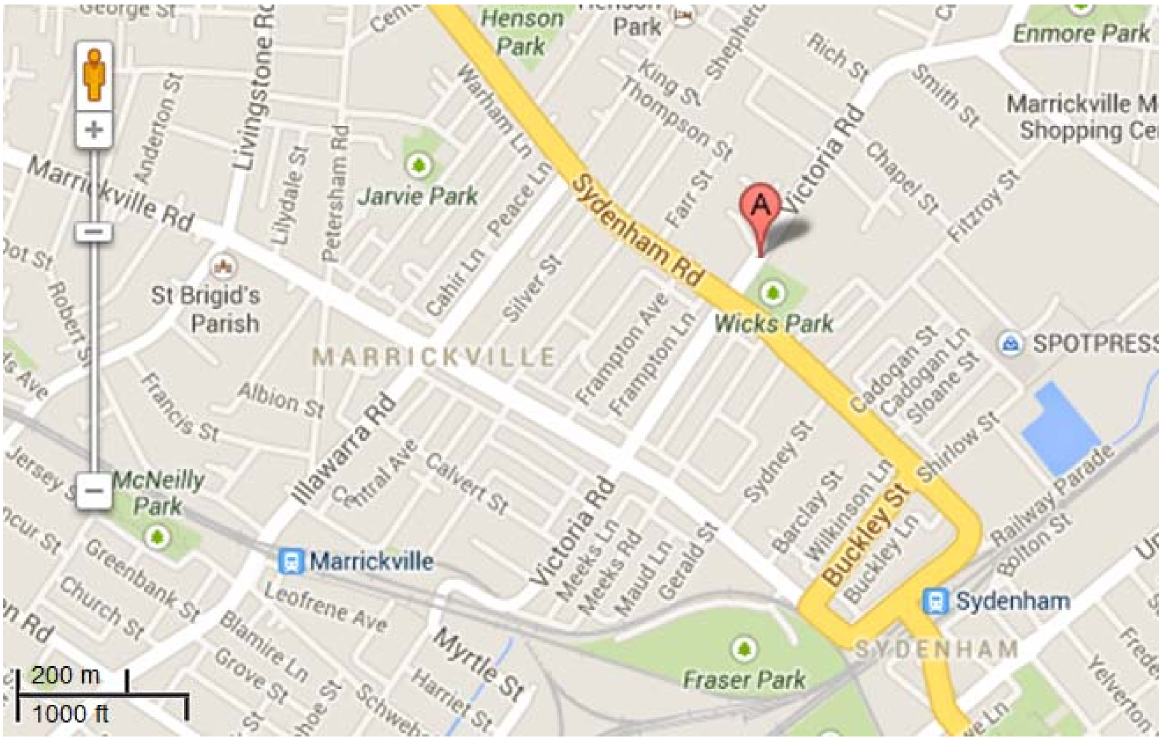
Although the information provided by an Acid Sulphate Soils Assessment and Management Plan can reduce exposure to risks, no assessment, however diligently carried out, can eliminate them. It must be noted that these findings are professional findings and have limitations. Even a rigorous professional assessment may fail to detect all ASS and/or PASS on a site. Sulphates may be present in areas that were not surveyed or sampled.

Appendix B – Important information about your environmental report should also be read in conjunction with this report.

APPENDIX A

LOCALITY MAP & SITE PLAN

SITE LOCALITY MAP



PROJECT DETAILS	
Project Title	Acid Sulphate Soils Assessment
Project No.	ES5611/3
Client	E & D Danias Pty Ltd
Site Address	Victoria Road, Marrickville NSW

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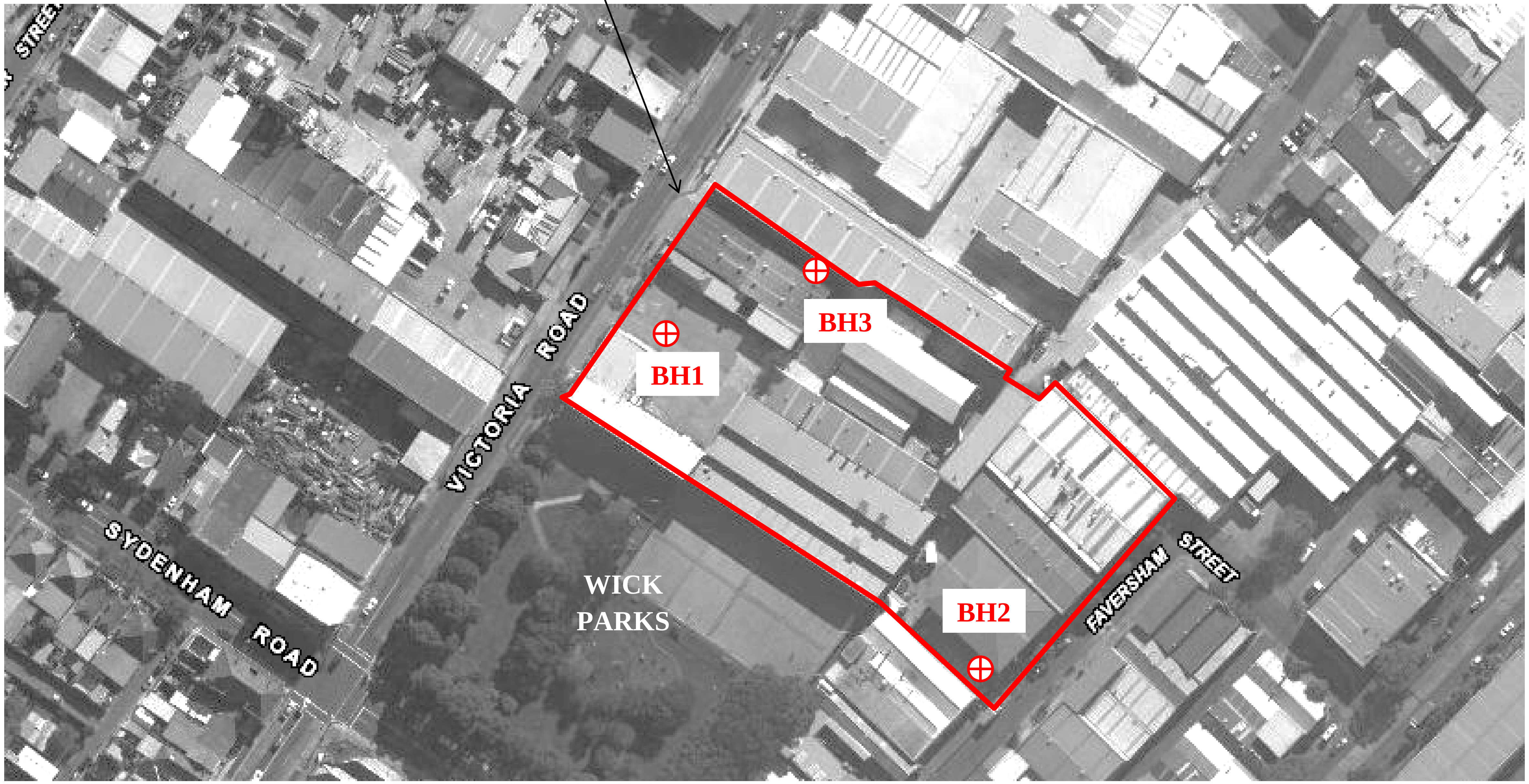
DRAWING DETAILS			
Figure No.	1	**Rev No.**	0
Scale	50m & 200m	**Size**	A4
Drawn by	MS	**Date**	9.12.13
Approved by	MK	**Date**	9.12.13

Approximate Site Boundary

North



Legend: ⊕ Approximate locations of boreholes drilled on 15th and 17th October 2013 by Aargus

Image Source: www.maps.six.nsw.gov.au

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Drawn	MM	**E & D Danias Pty Ltd** **Acid Sulphate Soils Assessment** **Victoria Road, Marrickville NSW**	Figure 2
Checked	HN		Title: Site Plan
Date	22/01/2014		Job No: Job No: ES5611/3
Scale	NTS		

APPENDIX B

IMPORTANT INFORMATION ABOUT YOUR ENVIRONMENTAL REPORT

IMPORTANT INFORMATION ABOUT YOUR ENVIRONMENTAL SITE ASSESSMENT

These notes have been prepared by Aargus (Australia) Pty Ltd and its associated companies using guidelines prepared by ASFE (The Association) of Engineering Firms Practising in the Geo-sciences. They are offered to help you in the interpretation of your Environmental Site Assessment (ESA) reports.

REASONS FOR CONDUCTING AN ESA

ESA's are typically, though not exclusively, carried out in the following circumstances:

- as pre-acquisition assessments, on behalf of either purchaser or vender, when a property is to be sold;
- as pre-development assessments, when a property or area of land is to be redeveloped or have its use changed for example, from a factory to a residential subdivision;
- as pre-development assessments of greenfield sites, to establish "baseline" conditions and assess environmental, geological and hydrological constraints to the development of, for example, a landfill; and
- as audits of the environmental effects of an ongoing operation.

Each of these circumstances requires a specific approach to the assessment of soil and groundwater contamination. In all cases however, the objective is to identify and if possible quantify the risks that unrecognised contamination poses to the proposed activity. Such risks may be both financial, for example, cleanup costs or limitations on site use, and physical, for example, health risks to site users or the public.

THE LIMITATIONS OF AN ESA

Although the information provided by an ESA could reduce exposure to such risks, no ESA, however, diligently carried out can eliminate them. Even a rigorous professional assessment may fail to detect all contamination on a site. Contaminants may be present in areas that were not surveyed or sampled, or may migrate to areas which showed no signs of contamination when sampled.

AN ESA REPORT IS BASED ON A UNIQUE SET OF PROJECT SPECIFIC FACTORS

Your environmental report should not be used:

- when the nature of the proposed development is changed, for example, if a residential development is proposed instead of a commercial one;
- when the size or configuration of the proposed development is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership
- or for application to an adjacent site.

To help avoid costly problems, refer to your consultant to determine how any factors, which have changed subsequent to the date of the report, may affect its recommendations.

ESA "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site assessment identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists who then render an opinion about overall subsurface conditions, the nature and extent of contamination, its likely impact on the proposed development and appropriate remediation measures. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. Nothing can be done to help minimise its impact. For this reason owners should retain the services of their consultants through the development stage, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Natural processes and the activity of man change subsurface conditions. As an ESA report is based on conditions, which existed at the time of subsurface exploration, decisions should not be based on an ESA report whose adequacy may have been affected by time. Speak with the consultant to learn if additional tests are advisable.

ESA SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Every study and ESA report is prepared in response to a specific brief to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Other persons should not use a report for any purpose, or by the client for a different purpose. No individual other than the client should apply a report even apparently for its intended purpose without first conferring with the consultant. No person should apply a report for any purpose other than that originally contemplated without first conferring with the consultant.

AN ESA REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when design professionals develop their plans based on misinterpretations of an ESA. To help avoid these problems, the environmental consultant should be retained to work with appropriate design professionals to explain relevant findings and to review the adequacy of their plans and specifications relative to contamination issues.

LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final borehole or test pit logs are developed by environmental scientists, engineers or geologists based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final logs customarily included in our reports. These logs should not under any circumstances be redrawn for inclusion in site remediation or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimise the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To reduce the likelihood of boring log misinterpretation, the complete report must be available to persons or organisations involved in the project, such as contractors, for their use. Those who o not provide such access may proceed under the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing all the available information to persons and organisations such as contractors helps prevent costly construction problems and the adversarial attitudes that may aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because an ESA is based extensively on judgement and opinion, it is necessarily less exact than other disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, model clauses have been developed for use in transmittals. These are not exculpatory clauses designed to foist liabilities onto some other party. Rather, they are definitive clauses that identify where your consultant's responsibilities begin and end. Their use helps all parties involved recognise their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your ESA report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

APPENDIX C

BOREHOLE LOGS

Aargus

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Telephone: (61) 1300137038
Fax: (61) 1300136038

BOREHOLE NUMBER BH1

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5611/1A
PROJECT LOCATION Victoria Road Corridor - Site 2, Marrickville, NSW

DATE STARTED 15/10/13 **COMPLETED** 15/10/13
R.L. SURFACE
DATUM
DRILLING CONTRACTOR Aargus Pty Ltd
SLOPE 90°
BEARING ---
EQUIPMENT Aargus Drilling Rig
HOLE LOCATION Refer to Site Plan Figure 1
HOLE SIZE 100mm diameter
LOGGED BY MM
CHECKED BY HN
NOTES RL top of borehole is approximate

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV			0–0.15			Concrete 150mm thick.		PAVEMENT
						FILL, silty sandy clay, low plasticity, dark grey, moist, soft.	ES	FILL
						REWORKED INSITU SOILS, silty clay, medium plasticity, greenish grey with red mottling, with some fine to medium ironstained gravel, moist, firm.	DS, ES	REWORKED INSITU SOILS
			1		CH	Silty CLAY, medium to high plasticity, dark grey and grey with red mottling, with some fine to medium ironstained gravel, moist, firm to stiff.	SPT 2, 3, 5 N=8; ES	ALLUVIUM SOILS
			2		CH	Silty CLAY, medium to high plasticity, grey with reddish brown mottling, with some fine to medium ironstained gravel, moist, stiff.	DS, ES; SPT 4, 6, 7 N=13	RESIDUAL SOILS
	Seepage		3		CI	Sandy CLAY, medium plasticity, grey with red mottling, fine to medium sand, with some ironstained gravel, moist, stiff.	ES; DS, ES; SPT 10, 8/20mm Bouncing	
ADT			4.5			SANDSTONE, fine to medium grained, grey with red and dark brown mottling, extremely low strength, extremely weathered, with silty clay bands. becoming very low strength from 4.5m bgl.	ES	BEDROCK 'V' bit refusal at 4.5m bgl. 'TC' bit refusal at 4.9m bgl.
			4.9			Borehole BH1 terminated at 4.9m		

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BOREHOLE NUMBER BH2

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5611/1A
PROJECT LOCATION Victoria Road Corridor - Site 2, Marrickville, NSW

DATE STARTED 15/10/13 **COMPLETED** 15/10/13 **R.L. SURFACE** **DATUM**
DRILLING CONTRACTOR Aargus Pty Ltd **SLOPE** 90° **BEARING** ---
EQUIPMENT Aargus Drilling Rig **HOLE LOCATION** Refer to Site Plan Figure 1
HOLE SIZE 100mm diameter **LOGGED BY** MM **CHECKED BY** HN
NOTES RL top of borehole is approximate

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV						Concrete 150mm thick.		PAVEMENT
						FILL, silty gravelly sand, fine to coarse, grey and brown, fine to coarse gravel, moist, loose.	ES	FILL
			1			REWORKED INSITU SOILS, silty clay, medium plasticity, dark grey, moist, soft to firm.	ES SPT 2, 2, 4 N=6	REWORKED INSITU SOILS
			2		CH	Silty CLAY, medium to high plasticity, grey with red mottling, with some fine to medium ironstained gravel, moist, firm.	ES DS, ES	ALLUVIUM SOILS
	Seepage ▶		3		CH	Silty CLAY, medium to high plasticity, grey with reddish brown mottling, with some fine to medium ironstained gravel, moist, firm.	SPT 2, 2, 5 N=7 ES	RESIDUAL SOILS
			4, 5		CI	Sandy CLAY, medium plasticity, grey with red mottling, fine to medium sand, with some fine to medium ironstained gravel, moist, very stiff.	DS, ES SPT 7, 9, 14 N=23 ES	
			6, 7		CH	Gravelly Sandy CLAY, medium to high plasticity, grey with reddish yellow mottling, fine to coarse sand, with some fine to medium ironstained gravel, moist, very stiff to hard.	ES DS, ES	'V' bit refusal at 7.6m bgl.
ADT			8			SANDSTONE, fine to medium grained, grey and dark brown with red mottling, very low strength, extremely weathered, with silty clay bands.		BEDROCK high 'TC' bit resistance.
			9			Borehole BH2 terminated at 8m		

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BOREHOLE NUMBER BH3

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5611/1A
PROJECT LOCATION Victoria Road Corridor - Site 2, Marrickville, NSW

DATE STARTED 17/10/13 **COMPLETED** 17/10/13
R.L. SURFACE **DATUM**
DRILLING CONTRACTOR Aargus Pty Ltd
SLOPE 90° **BEARING** ---
EQUIPMENT Aargus Drilling Rig
HOLE LOCATION Refer to Site Plan Figure 1
HOLE SIZE 100mm diameter
LOGGED BY MM **CHECKED BY** HN
NOTES RL top of borehole is approximate

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV						FILL, silty gravel, fine to medium, grey and brown, dry to moist, loose.		FILL
						REWORKED INSITU SOILS, silty clay, medium plasticity, greenish grey with red mottling, with some fine to medium ironstained gravel, moist, soft.	ES	REWORKED INSITU SOILS
			1				ES	
					CH	Silty CLAY, medium to high plasticity, grey with red mottling, with some fine to medium ironstained gravel, moist, firm to stiff.	SPT 2, 3, 5 N=8	ALLUVIUM SOILS
			2				ES	
					CH	Silty CLAY, medium to high plasticity, grey with reddish brown mottling, with some fine to medium ironstained gravel, moist, stiff.	DS	RESIDUAL SOILS
			3		CI	Sandy CLAY, medium plasticity, grey with red and brown mottling, fine to medium sand, with some fine to medium ironstained gravel, moist, stiff to very stiff.	SPT 3, 7, 9 N=16	
							DS	'V' bit refusal at 3.8m bgl.
ADT	Seepage ▶		4			SANDSTONE, fine to medium grained, grey and dark brown with red mottling, very low strength, extremely weathered, with silty clay bands.	DS	BEDROCK high 'TC' bit resistance.
						Borehole BH3 terminated at 4.3m		
			5					
			6					
			7					
			8					
			9					

APPENDIX D

ASSMAC (1998) FIELD pH AND PEROXIDE TEST PROTOCOL

Aargus

APPENDIX 1. Field pH and the Peroxide Test

1. Field pH Test

The field pH (pH_F) of actual acid sulfate soils tends to be ≤ 4 while the field pH of potential acid sulfate soils tends to be neutral. Field pH provides a useful quick indication of the likely presence and severity of "actual" acid sulfate soils. The field pH is a qualitative method only that cannot be used as a substitute for laboratory analysis in the identification of acid sulfate soils for assessment purposes.

Field pH readings should be taken at regular intervals down the soil profile. It is recommended this test be done every 0.25 m down the profile but at least every 0.5 m interval or horizon whichever is the lesser.

- pH readings of pH ≤4, indicates that actual acid sulfate soil are present with the sulfides having been oxidised in the past, resulting in acid soil (and soil pore water) conditions.
- pH 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 pH >4 - <5.5. Field pH alone cannot indicate potential ASS as they may be neutral to slightly alkaline when unoxidised.

In order to test for potential acid sulfate soils that contain unoxidised sulfides, peroxide is used to rapidly oxidise the iron sulfides (usually pyrite), resulting in the production of acid with a corresponding drop in pH.

Notes on pH equipment

Preferably a battery powered, field pH meter with a robust, spear point, double reference pH electrode should be used. The probe can be inserted directly into soft wet soils or soil mixed up into a paste with deionised water. Care must be exercised not to scratch the electrode on sandy or gravely soils. The probe should be standardised prior to use and regularly during use against standard solutions according to the manufacturers instructions.

Alternatively, an approximate 1:5 soil:deionised water suspension can be made up in small tubes, hand shaken and pH of the solution measured. pH test strips can be used to give an approximate value (pH +/- 0.25). Raupach soil pH test kits should be used with caution as they can give erroneous results. Both these latter methods are based on mixed indicator solutions that give a pH dependant colour and are subject to interferences .

2. Field Peroxide pH Test

To test for the presence of unoxidised sulfides and therefore potential acid sulfate soils, the oxidation of the soil with 30% (100 volume) hydrogen peroxide can be performed in the field. The most common method is:

- a small sample of soil is placed in a small glass container (eg short clear centrifuge tubes or clear tissue culture clusters) and a small volume of peroxide is dropped onto the soil.

Note: Allow the digested solution to cool after the reaction.
A pH probe will only measure to 60°C.

The reaction should be observed and rated. In some cases, the reaction may be instantaneous; in others, it may take 10 minutes or more. Heating over hot water or in the sun may be necessary to start the reaction on cool days, particularly if the peroxide is cold.

Potentially positive reactions includes one or more of the following:

- change in colour of the soil from grey tones to brown tones
- effervescence
- the release of sulfurous odours
- a substantial depression in pH below pH_F
- pH < 3

The strength of the reaction is a useful indicator. The peroxide test is most useful and reliable with clays and loams containing low levels of organic matter. It is least useful on coffee rock, sands or gravels, particularly dredged sands with low levels of sulfidic material (eg <0.05 % S). With soils containing high organic matter (such as surface soils, peats, mangrove/estuarine muds and marine clays), care must be exercised when interpreting the reaction as high levels of organic matter and other soil constituents particularly manganese oxides can also cause a reaction.

Note of caution with the use of peroxide

30 % hydrogen peroxide is a strong oxidising agent and should be handled carefully with appropriate eye and skin protection. This test should be only undertaken by trained operators.

The pH of analytical grade peroxide may be as low as 3 as manufacturers stabilise technical grade peroxide with acid, The peroxide pH should be checked on every new container and regularly before taking to the field and adjusted to 4.5 - 5.5 with a few drops of 0.1M NaOH if necessary. False field pH_{FOX} readings could result if this step is not undertaken.

3. pH after oxidation

The measurement of the change in the pH $_{FOX}$ following oxidation can give a useful indication of the presence of sulfidic material and can give an early indication of the distribution of sulfide down a core/ profile or across the site. The pH after oxidation test is not a substitute for analytical test results.

If the pH $_{FOX}$ value is at least one unit below field pH $_{F}$, it may indicate potential acid sulfate soils. The greater the difference between the two measurements, the more indicative the value is of a potential acid sulfate soils. The lower the final pH $_{FOX}$ value is, the better the indication of a positive result.

- If the pH $_{FOX}$ < 3 and there was a strong reaction to the peroxide, there is a high level of certainty of a 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 $_{FOX}$ >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.

Care is needed with interpretation of the result on highly reactive soils. Some soil minerals other than pyrite react vigorously with peroxide, particularly manganese but may only show small pH changes. When selecting soil for testing it is advisable to avoid material high in organic matter as the oxidation of organic matter can lead to the generation of acid. However, pH of soils containing organic matter and no pyrite do not generally stay below 4 on extended oxidation. In general, positive tests on 'apparently well drained' surface soils should always be treated with caution and followed up with laboratory confirmation.

The field peroxide tests can be made more consistent if a fixed volume of soil (using a small scoop) is used, a consistent volume of peroxide is added and left to react for an hour, and the sample is made up to a fixed volume with deionised water before reading. However, such procedures take time in the field and are more suited to a 'field shed' situation. When effervescence (sometimes violent) has ceased, a few additional mL of peroxide should be added until the reaction appears complete. If the reaction is violent, it is recommended that deionised water be added to cool and dilute the reaction. The test may have to be repeated with a small amount of water added to the soil prior to peroxide addition. The
pH ^{FOX} of the resultant mixture is then measured.

4. Reporting the results

All pH $_{F}$ and pH$_{FOX}$ results along with the strength of reaction should be tabulated by site and depth and reported in the ASS report. An example of a recording sheet is attached.