Twynam Property Group

Preliminary Acid Sulfate Soils Assessment: Lot 30 DP1198692, Mundamia, NSW.

P0802193JR05V02
January 2015

martens consulting engineers

ENVIRONMENTAL

WATER

WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

Limitations Statement

The sole purpose of this report and the associated services performed by Martens & Associates Pty Ltd is to complete a preliminary acid sulfate soils assessment for a proposed development, in accordance with the scope of services set out in the contract / quotation between Martens & Associates Pty Ltd and Twynam Property Group (hereafter known as the Client). That scope of works and services were defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

Martens & Associates Pty Ltd derived the data in this report primarily from a number of sources which may include for example site inspections, correspondence regarding the proposal, examination of records in the public domain, interviews with individuals with information about the site or the project, and field explorations conducted on the dates indicated. The passage of time, manifestation of latent conditions or impacts of future events may require further examination / exploration of the site and subsequent data analyses, together with a re-evaluation of the findings, observations and conclusions expressed in this report.

In preparing this report, Martens & Associates Pty Ltd may have relied upon and presumed accurate certain information (or absence thereof) relative to the site. Except as otherwise stated in the report, Martens & Associates Pty Ltd has not attempted to verify the accuracy of completeness of any such information (including for example survey data supplied by others).

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This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between Martens & Associates Pty Ltd and the Client. Martens & Associates Pty Ltd accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

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Document and Distribution Status

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Revision No.	Description	Status	Release Date	Document Location			
				File Copy	Twynam Property Group	Allen Price & Associates	
1	Preliminary ASS report	Draft	16.04.2014	1P, 1H	1P		
1	Preliminary ASS report	Final	12.08.2014	1E, 1P, 1H	1P		
2	Lot reference	Final	21.01.2015	1E, 1P, 1H	-	1P	

Distribution Types: F = Fax, H = hard copy, P = PDF document, E = Other electronic format. Digits indicate number of document copies.

All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Scope of Work

1.1 Overview

This report documents the findings of a preliminary acid sulfate soils (ASS) assessment undertaken at Lot 30 DP1198692, Jonsson Rd, Mundamia ('the site'). The assessment was commissioned by the Client, Twynam Property Group, to address a request from NSW Department of Planning.

The assessment has been undertaken with reference to NSW Acid Sulfate Soil Management Advisory Committee (ASSMAC, 1998) guidelines.

1.2 Proposed Development

At the time of reporting, the following details regarding components of the development proposal were available:

- Proposed sub-division into approximately 360 residential allotments.
- Internal road network with associated stormwater drainage.
- Sewerage, water, power and gas infrastructure to service the development.

1.3 Objectives

The study objective was to undertake a preliminary ASS assessment of the site.

1.4 Scope of Work

Scope of work included:

- Site walkover.
- Drilling of 11 boreholes (BH301 – BH311) with representative soil sample collection.
- Laboratory analysis of 16 soil samples.
- Preparation of a report in general accordance with ASSMAC (1998).

2 Site Location and Setting

Site background information is summarised in Table 1 with site location shown in Attachment A.

Table 1: Site background information

Site address	George Evans Rd, Mundamia, NSW and 58 Jonnson Rd, Mundamia.
Lot and DP (Title Information)	Lot 30 DP1198692.
Zoning	1(d) 'General Rural'.
Local government area (LGA)	Shoalhaven City Council.
Current land use	Rural residential / agricultural / livestock grazing.
Proposed land use	Residential.
Surrounding land uses	Predominantly rural with some rural residential allotments to the west and north, residential developments to the south east.
Geology and soil landscapes	Nowra Sandstone, a subgroup of the Megalong Conglomerate Group geology. Nowra Soil Landscape consisting of moderately deep (50 – 100cm) brown podzolic soils on crests/upper slopes, with yellow earths or yellow podzolic soils on mid slopes, lower slopes and drainage depressions.
Topography and drainage	Elevations across the site range from 36 – 70 mAHD with a general fall to the east/north east.
Groundwater	No free groundwater was observed during excavation of boreholes 301 to 311 completed for the ASS assessment. However, certain soil layers from BHs 305 and 309 were noted as being moist enough to be indicative of potentially holding groundwater. MA's Hydrogeological Assessment (2011) for the site found ephemeral water tables in areas of shallow soil and less ephemeral water tables in areas of deeper soil. In both cases the water table was perched within soil above the underlying sandstone rock.

3 Preliminary Acid Sulfate Soils Assessment

3.1 Desktop Review

3.1.1 Acid Sulfate Soils Mapping

Review of Shoalhaven City Council's ASS mapping indicates that the site is classified as 'no known occurrence' of ASS.

3.1.2 Geomorphic Setting

The likelihood of ASS occurrence at a site is a function of various geomorphic parameters, in particular those listed in Table 2 (ASSMAC, 1998). Each is an indicator that ASS is likely to be present on-site. Two of the seven geomorphic features listed are present or possibly present on the site. Therefore, the geomorphic setting of the site indicates that actual or potential ASS may be present.

Table 2: Geomorphic features indicative of acid sulfate soils.

Geomorphic Feature	Present on site?
Holocene sediments	No
Soil horizons less than 5 m AHD	No
Marine / estuarine sediments or tidal lakes	No
Coastal wetland; backwater swamps; waterlogged or scaled areas; interdune swales or coastal sand dunes.	Yes – waterlogged soils
Dominant vegetation is mangroves, reeds, rushes and other swamp or marine tolerant species.	No
Geologies containing sulphide bearing material / coal deposits or former marine shales/sediments	Possible
Deep older (Pleistocene) estuarine sediments	No

3.2 Soil Sampling and Laboratory Analysis

3.2.1 Soil Sampling Regime

Based on a total developable site area of approximately 30.6 ha, ASSMAC (1998) guidelines recommend 62 boreholes as an appropriate number of sampling boreholes for the site. A total of 11 boreholes were excavated for the preliminary ASS assessment which was considered appropriate for preliminary screening purposes given the site's

elevation is well above 5 mAHD (36 – 70 mAHD), the majority of geomorphic features indicated that ASS is unlikely to be present on the site, the site is not mapped to contain ASS soils and the site contains residual soils overlying sandstone bedrock.

A total of 16 soil samples from the 11 boreholes were selected to cover a range of locations and depths and submitted to laboratory for Peroxide Oxidation Combined Acidity and Sulfate (sPOCUS) analysis.

3.2.2 *Results*

Laboratory results/ASSMAC (1998) action criteria interpretation are summarised in Attachment C with the complete laboratory report provided in Attachment D. Results are summarised as follows:

- Actual Acid Sulfate Soil (AASS) was found for two samples (BH301, depth 2.50 m and BH309, depth 1.75 m).
- Potential ASS (PASS) found for 11 samples.
- Neither PASS or ASS found for three samples.

Results exceeded the action criteria for 13 of the 16 samples and therefore in accordance with ASSMAC (1998), a detailed management plan should be prepared. The shallowest sample depth which exceeded action criteria was 0.1 m.

We note that ASSMAC (1998) action criteria interpretation assumed less than 1,000 tonnes of soil will be disturbed.

3.2.3 *Conclusion*

Soils meeting the ASSMAC (1998) tests for AASS and PASS are present on the site. If it is accepted ASSMAC (1998) applies, then a detailed management plan is required. Importantly, the site soils are residual and overly sandstone, therefore the origin of soil acidity is likely the underlying geology. Consultation with NSW OEH's ASS expert Dr Mitch Tulau (per communication, 24.03.2014) suggests that ASSMAC (1998) guidelines do not apply to this site with residual soil landscapes. Given the fact that soils are presently in the aerobic zone of the soil profile, it is unlikely that disturbance of those soils will result in any environmental impacts. Given these considerations it is not reasonable to assume disturbance of the soils on the site will result in any impacts. It is therefore recommended that, while application of ASSMAC (1998) may conclude a management plan is required, further to recent consultation with NSW OEH ASS expert, the site context of a residual soil leads to the conclusion that excavation of the material will not lead to adverse impacts and therefore a management plan is not essential to ensure protection.

4 Limitations

Occasionally sub-surface soil conditions in areas of the site not investigated may be found to be different from those expected. This can also occur with groundwater conditions, especially after climatic changes. Should, during site works, soil or water conditions be found to be significantly different to those detailed in this report, works shall cease immediately and the new conditions should be addressed by Martens & Associates to determine ASS implications before recommencement.

5 References

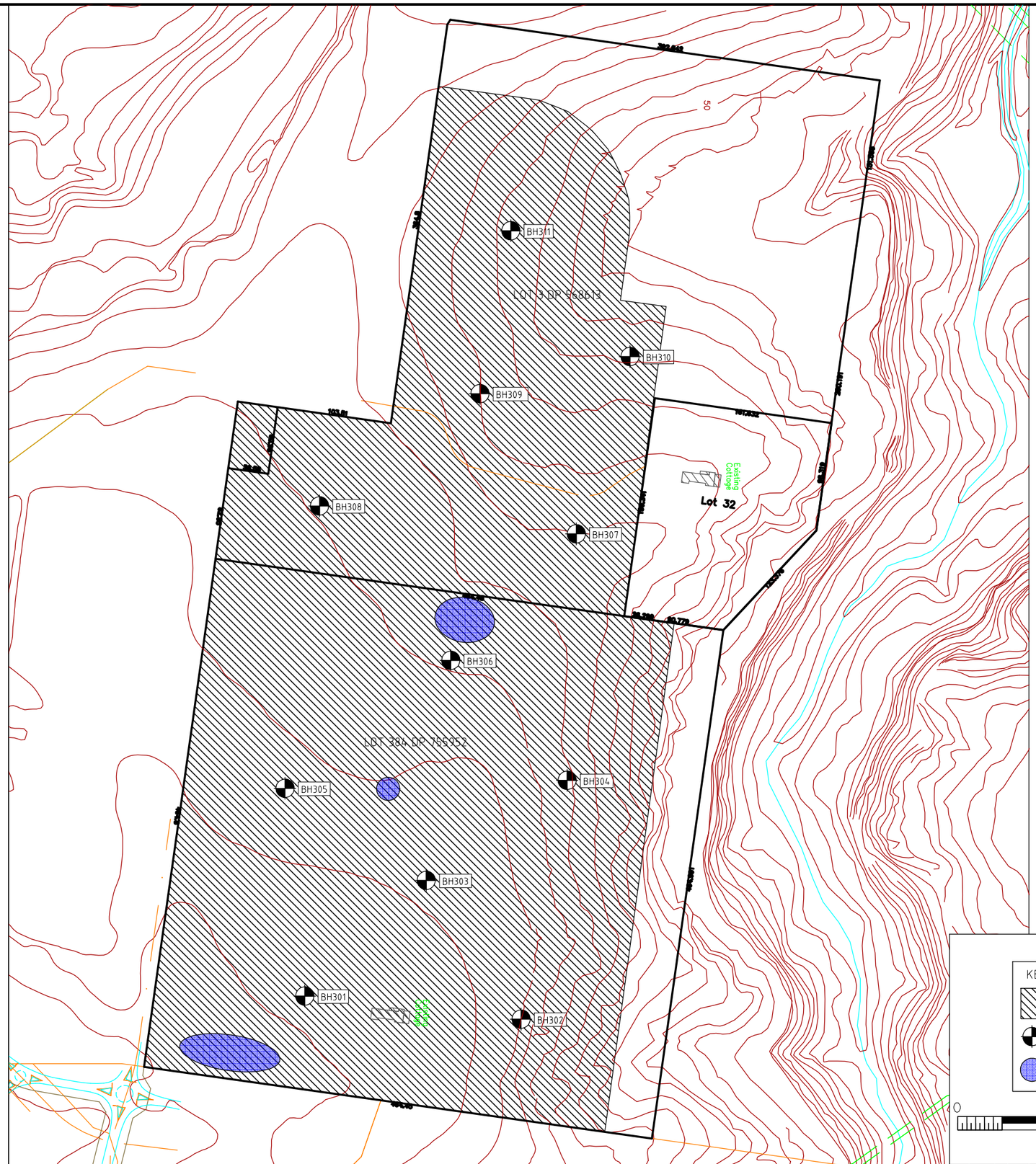
Department of Conservation and Land Management (incorporating the Soil Conservation Service of NSW), *Soil Landscapes of the Kiama 1:100,000 Sheet.*

Geologic Survey of NSW, Department of Minerals and Energy (1991), Geological Series 1:100,000, Wollongong Sheet.

Martens and Associates (2011), *Hydrogeological Assessment: Proposed sub-dvision, Mundamia Release Area, Mundamia, NSW*, report REF: P1002761JR01V02.

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

6 Attachment A – Site Plan/Borehole Locations



NOTE:
- SITE PLAN PROVIDED BY ALLEN PRICE P/L, SEPTEMBER 2008

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MARTENS & ASSOCIATES PTY LTD
Sustainable Solutions
Environmental - Geotechnical - Civil
Hydraulic - Wastewater Engineers

CLIENT/PROJECT
TWYNAM PROPERTY GROUP
MUNDAMIA

TITLE
PRELIMINARY ACID SULFATE SOIL ASSESSMENT BOREHOLE LOCATIONS

THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in m unless otherwise specified.

PROJECT MANAGER: MR GRAY TAYLOR

DRAWING NUMBER: P0802193JD04V01

DESIGNED:	JSF/BR
DRAWN:	JSF/BR
REVIEWED:	GT/ASN
DATUM:	mAHD
HORIZONTAL RATIO:	1:2000 @ A1 1:4000 @ A3
VERTICAL RATIO:	1:2000 @ A1 1:4000 @ A3
SHEET	1 OF 1 SHEETS
PAPER SIZE:	A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	PRELIMINARY ACID SULFATE ASSESSMENT	19.03.2014	BR

7 Attachment B – Borehole Logs

CLIENT	**Twynam Property Group**	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH301**
PROJECT	**Acid Sulfate Soils Assessment**	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Lot 3 DP568613 and Lot 384 DP755952**	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Truck mounted hydraulic auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	95mmØ X 2.5m depth	**NORTHING**	NA	**ASPECT**	North East	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
V	Nil	N	M	0.2			SP	SAND - Fine to medium grained, light brown, slightly moist.			A	0.1	2193/301/0.1	
V	Nil	N	M	0.7			SC	CLAYEY SAND - Yellow brown, grades to layer below.			A	0.5	2193/301/0.5	
V	Nil	N	M	1.0 2.0 2.2			EL	SANDSTONE - Medium grained, yellow brown, extremely weathered, extremely low strength, clayey sand properties, tends to red orange colour with sandy clay properties by 1.5m.			A A A	0.75 1.5 2.0	2193/301/0.75 2193/301/1.5 2193/301/2.0	1.0 2.0
V	Nil	N	M	2.5			EL	SANDSTONE - Medium grained, light grey, extremely weathered, extremely low strength, sugary grains, sandy clay properties.			A	2.5	2193/301/2.5	
				3.0 4.0 4.5				Borehole terminated at 2.5m on extremely low strength sandstone.						3.0 4.0 4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
E Environmental sample (JAR)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample
PID Photo Ionization Detector

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

Quality Sheet No. 4

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Engineering Log - Borehole

CLIENT	**Twynam Property Group**	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH302**
PROJECT	**Acid Sulfate Soils Assessment**	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Lot 3 DP568613 and Lot 384 DP755952**	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Truck mounted hydraulic auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	95mmØ X 1.1m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	2-4%

EXCAVATION DATA						MATERIAL DATA						SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	D	0.15			SM	SILTY SAND - Fine to medium grained, brown, rootlets.			A	0.1	2193/302/0.1
V	Nil	N	M	0.4			SC	CLAYEY SAND - Yellow brown, slightly moist.			A	0.3	2193/302/0.3
V	Nil	N	M	0.8			SP	SAND - With some quartz gravels 5-20mm, orange/yellow brown.			A	0.5	2193/302/0.5
V	Nil	N	M	1.0 1.1			EL	SANDSTONE - Yellow, light grey, orange and pink, extremely weathered, extremely low strength, sugary grains, clayey sand properties.			A	1.0	- Sandstone outcrops in immediate vicinity of borehole. 2193/302/1.0 1.0
				2.0				V bit refusal at 1.1m on extremely low strength sandstone.					2.0
				3.0									3.0
				4.0									4.0
				4.5									4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
E Environmental sample (JAR)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample
PID Photo Ionization Detector

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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Engineering Log - Borehole

CLIENT	**Twynam Property Group**	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH303**
PROJECT	**Acid Sulfate Soils Assessment**	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Lot 3 DP568613 and Lot 384 DP755952**	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Truck mounted hydraulic auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	95mmØ X 1.1m depth	**NORTHING**	NA	**ASPECT**	North North East	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
V	Nil	N	D	0.4			ML	SILT - Trace of gravels 5-15mm, light brown, rootlets.			A	0.1	2193/303/0.1	
V	Nil	N	D	0.7			SW	SAND - With some gravels 5-20mm, fine grained, yellow brown.			A	0.5	2193/303/0.5	
V	Nil	N	D	1.0 1.1			VL	SANDSTONE - Light grey, extremely to highly weathered, very low strength.			A	1.0	- Sandstone outcrops in vicinity of borehole. 2193/303/1.0	1.0
				2.0				V bit refusal at 1.1m on very low strength sandstone.						2.0
				3.0										3.0
				4.0										4.0
				4.5										4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
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Water level
Water outflow
Water inflow

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Wl Liquid limit

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Engineering Log - Borehole

CLIENT	Twynam Property Group	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH304**
PROJECT	Acid Sulfate Soils Assessment	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Lot 3 DP568613 and Lot 384 DP755952	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Hand Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	100mmØ X 0.55m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	0-2%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
HA	Nil	N	M	0.55			SC	CLAYEY SAND - Medium grained, trace fine gravels, minor clay content, orange/brown.			A	0.2	2193/304/ 0.2
				1.0				Borehole terminated at 0.55m on extremely weathered sandstone.					
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
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S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
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L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
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B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
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E Environmental sample (JAR)
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VS Vane shear
DCP Dynamic cone penetrometer
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EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	**Twynam Property Group**	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH305**
PROJECT	**Acid Sulfate Soils Assessment**	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Lot 3 DP568613 and Lot 384 DP755952**	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Truck mounted hydraulic auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	95mmØ X 2.5m depth	**NORTHING**	NA	**ASPECT**	North North East	**SLOPE**	2%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
V	Nil	N	M	0.2			SM	SILTY SAND - Fine to medium grained, grey.			A	0.1	2193/305/0.1	
V	Nil	N	M	0.35			SP	SAND - Fine to medium grained, light grey.						
V	Nil	N	M	0.5			CL	SANDY CLAY - Yellow brown, grades to layer below.						
V	Nil	N	M	0.8			EL	SANDSTONE - Red orange and light grey, extremely weathered, extremely low strength, sandy clay properties.			A	0.6	2193/305/0.6	
V	Nil	N	M	1.0 1.2			CL	SANDY CLAY - Orange brown, brown, red brown and light grey mottled.			A	1.0	2193/305/1.0	1.0
V	Nil	N	M	2.0 2.1			CL	SAND CLAY - Light grey and red mottled, red mottling gone >≈1.7m.			A A	1.5 2.0	2193/305/1.5 2193/305/2.0	2.0
V	Nil	N	M/W	2.5			SC	CLAYEY SAND - Light grey, very moist, possibly holding groundwater.			A	2.5	2193/305/2.5	
				3.0 4.0 4.5				Borehole terminated at 2.5m on clayey sand.						3.0 4.0 4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
E Environmental sample (JAR)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample
PID Photo Ionization Detector

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	Twynam Property Group	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH306**
PROJECT	Acid Sulfate Soils Assessment	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Lot 3 DP568613 and Lot 384 DP755952	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Hand Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	100mmØ X 0.7m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
HA	Nil	N	M	0.05			SM	SILTY SAND - Medium grained sand, brown/dark brown.					
HA	Nil	N	M	0.15			SC	CLAYEY SAND - Medium grained sands, rounded, light brown/brown.			A	0.1	2193/306/0.1
HA	Nil	N	M	0.55			SC	CLAYEY SAND - Medium to coarse grained, rounded, orange/gold.			A	0.3	2193/306/0.3
HA	Nil	N	M	0.7			Rs	SANDSTONE - Medium/coarse grained, grey/orange mottled residual soil (clayey sand).			A	0.6	2193/306/0.6
				1.0				Borehole terminated at 0.7m on extremely weathered sandstone.					
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
E Environmental sample (JAR)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample
PID Photo Ionization Detector

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	Twynam Property Group	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH307**
PROJECT	Acid Sulfate Soils Assessment	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Lot 3 DP568613 and Lot 384 DP755952	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Hand Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	100mmØ X 0.25m depth	**NORTHING**	NA	**ASPECT**	North West	**SLOPE**	0-2%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
HA	Nil	N	D	0.1			SM	SILTY SAND - Medium grained.					
HA	Nil	N	M	0.25			SP	SAND - Medium grained, fine to coarse gravels (1-40mm, 25%), orange/brown minor clay contents.			A A	0.2 0.25	2193/307/ 0.2 2193/307/ 0.25
								Borehole terminated at 0.25m on slightly weathered sandstone.					
				1.0									
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
E Environmental sample (JAR)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample
PID Photo Ionization Detector

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	**Twynam Property Group**	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH308**
PROJECT	**Acid Sulfate Soils Assessment**	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Lot 3 DP568613 and Lot 384 DP755952**	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Truck mounted hydraulic auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	95mmØ X 2.0m depth	**NORTHING**	NA	**ASPECT**	North East	**SLOPE**	1-2%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
V	Nil	N	M	0.2			SM	SILTY SAND - Fine to medium grained, brown.			A	0.1	2193/308/0.1	
V	Nil	N	M	0.6			SC	CLAYEY SAND - Yellow brown.			A	0.4	2193/308/0.4	
V	Nil	N	M	1.0 1.1			SW	SAND - Trace of gravels 5-10mm, orange and yellow brown, slightly moist.			A	0.7	2193/308/0.7	1.0
V	Nil	N	M	1.5			CL	SANDY CLAY - Trace of gravels, red brown and grey.			A	1.5	2193/308/1.5	
V	Nil	N	M	2.0			VL	SANDSTONE - Red brown, extremely to highly weathered, very low strength, clayey sand like properties.			A	2.0	2193/308/2.0	2.0
				3.0				V bit refusal at 2.0m on very low strength sandstone.						3.0
				4.0										4.0
				4.5										4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
E Environmental sample (JAR)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample
PID Photo Ionization Detector

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	**Twynam Property Group**	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH309**
PROJECT	**Acid Sulfate Soils Assessment**	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	**1 of 1**
SITE	**Lot 3 DP568613 and Lot 384 DP755952**	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Truck mounted hydraulic auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	95mmØ X 1.8m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	5%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS	
V	Nil	N	M	0.2			ML	SILT - Grey.			A	0.1	2193/309/0.1	
V	Nil	N	M	0.4			SP	SAND - Fine to medium grained, grey.			A	0.3	2193/309/0.3	
V	Nil	N	M	0.7			SC	CLAYEY SAND - Light brown, slightly moist.			A	0.5	2193/309/0.5	
V	Nil	N	M	1.0			CL	SANDY CLAY - Grey, light brown and red brown mottled, tending to predominantly red after approximately 1.25m.			A	1.0	2193/309/1.0	1.0
				1.7							A	1.5	2193/309/1.5	
V	Nil	N	M	1.8			CL	SANDY CLAY - Light grey, possibly moist enough to be indicative of holding ground water, sugary.			A	1.75	2193/309/ 1.75	
				2.0				V bit refusal at 1.8m on sandstone (assumed).						2.0
				3.0										3.0
				4.0										4.0
				4.5										4.5

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
E Environmental sample (JAR)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample
PID Photo Ionization Detector

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

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Engineering Log - Borehole

CLIENT	Twynam Property Group	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH310**
PROJECT	Acid Sulfate Soils Assessment	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Lot 3 DP568613 and Lot 384 DP755952	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Hand Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	100mmØ X 0.08m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	3-5%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
HA	Nil	N	M	0.08			SM	SILTY SAND - Medium rounded grained, dark grey/black.			A	0.05	2193/310/ 0.05 - Minor organics.
								Borehole terminated at 0.08m on slightly weathered sandstone.					
				1.0									
				2.0									
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
E Environmental sample (JAR)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample
PID Photo Ionization Detector

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
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Engineering Log - Borehole

CLIENT	Twynam Property Group	**COMMENCED**	6/3/14	**COMPLETED**	6/3/14	**REF**	**BH311**
PROJECT	Acid Sulfate Soils Assessment	**LOGGED**	BR	**CHECKED**	GT	**Sheet**	1 of 1
SITE	Lot 3 DP568613 and Lot 384 DP755952	**GEOLOGY**	Nowra Sandstone	**VEGETATION**	Grass	**PROJECT NO.**	P0802193
EQUIPMENT	Hand Auger	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	100mmØ X 1.0m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	3-5%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
HA	Nil	N	M	0.08			ML	ORGANIC SILTY SAND - Fine grained, grey/brown.					
HA	Nil	N	M	0.25			SP	SAND - Fine to medium grained, rounded, grey.			A	0.15	2193/311/0.15
HA	Nil	N	M	0.45			SP	SAND - Medium grained, rounded, brown/orange.					
HA	Nil	N	M	0.75			CL	SANDY CLAY - Medium grained sands, trace angular fine to medium grained gravels, gold/orange.			A	0.6	2193/311/0.6 - Clay content increasing with depth.
HA	Nil	N	M	1.0			CL	CLAY - Medium grained rounded sands, orange/brown mottled, low plasticity.			A	1.0	2193/311/1.0
				2.0				Borehole terminated at 1.0m on stiff clays.					
				3.0									
				4.0									
				4.5									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
HA Hand auger
E Excavator
CC Concrete Corer
V V-Bit
TC Tungsten Carbide Bit
S Spade

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)
E Environmental sample (JAR)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample
PID Photo Ionization Detector

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Engineering Log - Borehole

8 Attachment C – Laboratory Results Summary

SPOCUS LABORATORY TEST INTERPRETATION FORM

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Client	Tynam Property Group	**Page No.**	1 of 1
Project	Acid Sulfate Soils Assessment	**Date**	18.03.2014
Sampling Site	Lot 3 DP 568613 and Lot 384 DP 755952	**Proceedure**	ST-50
Sample History	Sampled on 06.03.2014	**Job Number**	P0802193
		Sampled By	BR/GT

Assumed Parameters

Gs - Specific gravity (g/cm^3)	NA
M - Exposed soil mass (t)	NA

Borehole	Sample Depth (m)	Material Type [1]	pH_{KCL} [2]	pH_{OX} [3]	TPA (mol H+/t) [4]	TSA (mol H+/t) [5]	S_{POS} (%S oxidisable) [6]	Assessment [7]	Liming Rate (kg $CaCO_3$/t)
Assessment Criteria		(F) Fine grained. > 40 % clay.	≤ 4 = AASS	< 3.5 = PASS pHK_{CL}-pH_{OX}>1 = PASS	62	62	0.100	TPA, TSA, S_{POS} > criteria = PASS. Exposed soil >1000t, use coarse grained material criteria.	
		(M) Medium grained. 5-40 % clay.			36	36	0.060		
		(C) Coarse grained. < 5 % Clay.			18	18	0.030		
BH301	0.50	M	4.7	4.3	41	21	<0.005	PASS	1.50
BH301	2.50	M	4.0	4.6	69	<5	<0.005	AASS	5.50
BH302	0.30	M	4.8	3.6	36	21	<0.005	PASS	1.20
BH303	0.10	M	4.8	3.1	41	14	0.05	PASS	4.50
BH303	0.50	C	4.8	3.4	81	56	0.01	PASS	2.40
BH304	0.20	M	4.6	4.3	26	<5	<0.005	NA	1.70
BH305	1.00	M	4.4	4.2	61	16	0.01	PASS	3.90
BH305	2.50	M	4.2	4.8	41	<5	<0.005	PASS	3.60
BH306	0.30	M	4.5	3.8	66	36	0.03	PASS	3.80
BH307	0.20	C	4.6	4.2	94	59	0.02	PASS	3.50
BH308	1.50	M	4.8	4.4	29	<5	<0.005	NA	1.90
BH309	0.50	M	5.0	4.6	9	<5	0.01	NA	1.70
BH309	1.75	M	4.0	4.3	71	<5	<0.005	AASS	5.50
BH310	0.05	C	6.3	3.8	<5	<5	0.02	PASS	0.87
BH311	0.60	M	4.4	4.2	56	9	0.006	PASS	3.90
BH311	1.00	F	4.3	4.3	66	<5	<0.005	PASS	4.90

Notes

1. Material type based on field texture assessment or laboratory report

2. Field or laboratory pH can be used here. Change header if field pH used.

3. Post peroxide oxidation pH

4. Total Potential Acidity

5. Total Sulfidic Acidity

6. Percentage oxidisable sulphur

7. NA = not AASS or PASS, AASS = Actual Acid Sulfate Soil, PASS = Potential Acid Sulfate Soil

9 Attachment D – Laboratory Report

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS 106204

Client:

Martens & Associates Pty Ltd
6/37 Leighton Place
Hornsby
NSW 2077

Attention: Ben Rose

Sample log in details:

Your Reference:	**ASS- Mundamia (2193)**		
No. of samples:	16 soils		
Date samples received / completed instructions received	07/03/14	/	07/03/14

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	17/03/14	/	17/03/14
Date of Preliminary Report:	Not issued		

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Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

sPOCAS Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ---------- ----------	106204-1 2193/301 0.5 06/03/2014 soil	106204-2 2193/301 2.5 06/03/2014 soil	106204-3 2193/302 0.3 06/03/2014 soil	106204-4 2193/303 0.1 06/03/2014 soil	106204-5 2193/303 0.5 06/03/2014 soil
Date prepared	-	10/03/2014	10/03/2014	10/03/2014	10/03/2014	10/03/2014
Date analysed	-	10/03/2014	10/03/2014	10/03/2014	10/03/2014	10/03/2014
pH $_{kcl}$	pH units	4.7	4.0	4.8	4.8	4.8
TAA pH 6.5	moles H^+/t	20	72	15	27	25
s-TAA pH 6.5	%w/w S	0.03	0.12	0.02	0.04	0.04
pH $_{Ox}$	pH units	4.3	4.6	3.6	3.1	3.4
TPA pH 6.5	moles H^+/t	41	69	36	41	81
s-TPA pH 6.5	%w/w S	0.07	0.11	0.06	0.07	0.13
TSA pH 6.5	moles H^+/t	21	<5	21	14	56
s-TSA pH 6.5	%w/w S	0.03	<0.01	0.03	0.02	0.09
ANC$_E$	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
a-ANC$_E$	moles H^+/t	<5	<5	<5	<5	<5
s-ANC$_E$	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
S$_{KCl}$	%w/w S	0.01	0.02	<0.005	<0.005	0.02
S$_P$	%w/w	0.01	0.02	<0.005	0.05	0.03
S$_{POS}$	%w/w	<0.005	<0.005	<0.005	0.05	0.01
a-S$_{POS}$	moles H^+/t	<5	<5	<5	33	7
Ca$_{KCl}$	%w/w	0.02	<0.005	0.01	0.07	0.009
Ca$_P$	%w/w	0.02	<0.005	0.01	0.06	0.01
Ca$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg$_{KCl}$	%w/w	0.007	0.010	0.006	0.022	0.006
Mg$_P$	%w/w	0.007	0.010	0.006	0.025	0.007
Mg$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
S$_{HCl}$	%w/w S	[NT]	0.023	[NT]	[NT]	[NT]
S$_{NAS}$	%w/w S	[NT]	<0.005	[NT]	[NT]	[NT]
a-S$_{NAS}$	moles H^+/t	[NT]	<5	[NT]	[NT]	[NT]
s-S$_{NAS}$	%w/w S	[NT]	<0.01	[NT]	[NT]	[NT]
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	20	73	16	60	32
Liming rate	kg $CaCO_3$/t	1.5	5.5	1.2	4.5	2.4
a-Net Acidity without ANCE	moles H^+/t	NA	NA	NA	NA	NA
Liming rate without ANCE	kg $CaCO_3$/t	NA	NA	NA	NA	NA

sPOCAS Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ---------- ----------	106204-6 2193/304 0.2 06/03/2014 soil	106204-7 2193/305 1.0 06/03/2014 soil	106204-8 2193/305 2.5 06/03/2014 soil	106204-9 2193/306 0.3 06/03/2014 soil	106204-10 2193/307 0.2 06/03/2014 soil
Date prepared	-	10/03/2014	10/03/2014	10/03/2014	10/03/2014	10/03/2014
Date analysed	-	10/03/2014	10/03/2014	10/03/2014	10/03/2014	10/03/2014
pH $_{kcl}$	pH units	4.6	4.4	4.2	4.5	4.6
TAA pH 6.5	moles H^+/t	22	45	47	30	35
s-TAA pH 6.5	%w/w S	0.04	0.07	0.08	0.05	0.06
pH $_{Ox}$	pH units	4.3	4.2	4.8	3.8	4.2
TPA pH 6.5	moles H^+/t	26	61	41	66	94
s-TPA pH 6.5	%w/w S	0.04	0.1	0.07	0.11	0.15
TSA pH 6.5	moles H^+/t	<5	16	<5	36	59
s-TSA pH 6.5	%w/w S	<0.01	0.03	<0.01	0.06	0.09
ANC_E	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
a-ANC_E	moles H^+/t	<5	<5	<5	<5	<5
s-ANC_E	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
S_{KCl}	%w/w S	<0.005	0.02	0.02	0.02	<0.005
S_P	%w/w	<0.005	0.03	0.01	0.05	0.02
S_{POS}	%w/w	<0.005	0.01	<0.005	0.03	0.02
a-S_{POS}	moles H^+/t	<5	6	<5	20	12
Ca_{KCl}	%w/w	<0.005	0.007	<0.005	<0.005	0.005
Ca_P	%w/w	<0.005	0.006	<0.005	<0.005	0.005
Ca_A	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg_{KCl}	%w/w	0.005	0.019	0.010	0.007	0.008
Mg_P	%w/w	<0.005	0.020	0.010	0.007	0.010
Mg_A	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
S_{HCl}	%w/w S	[NT]	0.024	0.015	[NT]	[NT]
S_{NAS}	%w/w S	[NT]	<0.005	<0.005	[NT]	[NT]
a-S_{NAS}	moles H^+/t	[NT]	<5	<5	[NT]	[NT]
s-S_{NAS}	%w/w S	[NT]	<0.01	<0.01	[NT]	[NT]
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	22	52	47	50	47
Liming rate	kg $CaCO_3$/t	1.7	3.9	3.6	3.8	3.5
a-Net Acidity without ANCE	moles H^+/t	NA	NA	NA	NA	NA
Liming rate without ANCE	kg $CaCO_3$/t	NA	NA	NA	NA	NA

sPOCAS Our Reference: Your Reference Depth Date Sampled Type of sample	UNITS ---------- ----------	106204-11 2193/308 1.5 06/03/2014 soil	106204-12 2193/309 0.5 06/03/2014 soil	106204-13 2193/309 1.75 06/03/2014 soil	106204-14 2193/310 0.05 06/03/2014 soil	106204-15 2193/311 0.6 06/03/2014 soil
Date prepared	-	10/03/2014	10/03/2014	10/03/2014	10/03/2014	10/03/2014
Date analysed	-	10/03/2014	10/03/2014	10/03/2014	10/03/2014	10/03/2014
pH $_{kcl}$	pH units	4.8	5.0	4.0	6.3	4.4
TAA pH 6.5	moles H^+/t	25	12	72	<5	47
s-TAA pH 6.5	%w/w S	0.04	0.02	0.12	<0.01	0.08
pH $_{Ox}$	pH units	4.4	4.6	4.3	3.8	4.2
TPA pH 6.5	moles H^+/t	29	9	71	<5	56
s-TPA pH 6.5	%w/w S	0.05	0.01	0.11	<0.01	0.09
TSA pH 6.5	moles H^+/t	<5	<5	<5	<5	9
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	0.01
ANC_E	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
a-ANC_E	moles H^+/t	<5	<5	<5	<5	<5
s-ANC_E	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
S_{KCl}	%w/w S	0.05	<0.005	0.02	<0.005	0.02
S_P	%w/w	0.05	0.02	0.02	0.02	0.03
S_{POS}	%w/w	<0.005	0.01	<0.005	0.02	0.006
a-S_{POS}	moles H^+/t	<5	10	<5	10	<5
Ca_{KCl}	%w/w	0.01	0.06	0.007	0.17	0.03
Ca_P	%w/w	0.01	0.06	<0.005	0.20	0.03
Ca_A	%w/w	<0.005	<0.005	<0.005	0.032	<0.005
Mg_{KCl}	%w/w	0.023	0.013	0.025	0.026	0.018
Mg_P	%w/w	0.023	0.014	0.027	0.038	0.018
Mg_A	%w/w	<0.005	<0.005	<0.005	0.012	<0.005
S_{HCl}	%w/w S	[NT]	[NT]	0.021	[NT]	0.018
S_{NAS}	%w/w S	[NT]	[NT]	<0.005	[NT]	<0.005
a-S_{NAS}	moles H^+/t	[NT]	[NT]	<5	[NT]	<5
s-S_{NAS}	%w/w S	[NT]	[NT]	<0.01	[NT]	<0.01
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	26	22	73	12	51
Liming rate	kg $CaCO_3$/t	1.9	1.7	5.5	0.87	3.9
a-Net Acidity without ANCE	moles H^+/t	NA	NA	NA	NA	NA
Liming rate without ANCE	kg $CaCO_3$/t	NA	NA	NA	NA	NA

sPOCAS		
Our Reference:	UNITS	106204-16
Your Reference	----------	2193/311
Depth	----------	1.0
Date Sampled		06/03/2014
Type of sample		soil
Date prepared	-	10/03/2014
Date analysed	-	10/03/2014
pH kcl	pH units	4.3
TAA pH 6.5	moles H^+/t	65
s-TAA pH 6.5	%w/w S	0.10
pH Ox	pH units	4.3
TPA pH 6.5	moles H^+/t	66
s-TPA pH 6.5	%w/w S	0.11
TSA pH 6.5	moles H^+/t	<5
s-TSA pH 6.5	%w/w S	<0.01
ANCE	%$CaCO_3$	<0.05
a-ANCE	moles H^+/t	<5
s-ANCE	%w/w S	<0.05
SKCl	%w/w S	0.04
SP	%w/w	0.04
SPOS	%w/w	<0.005
a-SPOS	moles H^+/t	<5
CaKCl	%w/w	0.006
CaP	%w/w	0.005
CaA	%w/w	<0.005
MgKCl	%w/w	0.020
MgP	%w/w	0.019
MgA	%w/w	<0.005
SHCl	%w/w S	0.031
SNAS	%w/w S	<0.005
a-SNAS	moles H^+/t	<5
s-SNAS	%w/w S	<0.01
Fineness Factor	-	1.5
a-Net Acidity	moles H^+/t	65
Liming rate	kg $CaCO_3$/t	4.9
a-Net Acidity without ANCE	moles H^+/t	NA
Liming rate without ANCE	kg $CaCO_3$/t	NA

Method ID	Methodology Summary
Inorg-064	sPOCAS determined using titrimetric and ICP-AES techniques. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			10/03/2014	106204-1	10/03/2014 || 10/03/2014	LCS-1	10/03/2014
Date analysed	-			10/03/2014	106204-1	10/03/2014 || 10/03/2014	LCS-1	10/03/2014
pH $_{kcl}$	pH units		Inorg-064	[NT]	106204-1	4.7 || 4.8 || RPD: 2	LCS-1	96%
TAA pH 6.5	moles H^+/t	5	Inorg-064	<5	106204-1	20 || 20 || RPD: 0	LCS-1	121%
s-TAA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	106204-1	0.03 || 0.03 || RPD: 0	[NR]	[NR]
pH $_{Ox}$	pH units		Inorg-064	[NT]	106204-1	4.3 || 4.5 || RPD: 5	LCS-1	106%
TPA pH 6.5	moles H^+/t	5	Inorg-064	<5	106204-1	41 || 29 || RPD: 34	LCS-1	103%
s-TPA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	106204-1	0.07 || 0.05 || RPD: 33	[NR]	[NR]
TSA pH 6.5	moles H^+/t	5	Inorg-064	<5	106204-1	21 || 9 || RPD: 80	LCS-1	102%
s-TSA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	106204-1	0.03 || 0.01 || RPD: 100	[NR]	[NR]
ANC_E	% $CaCO_3$	0.05	Inorg-064	<0.05	106204-1	<0.05 || <0.05	[NR]	[NR]
a-ANC_E	moles H^+/t	5	Inorg-064	<5	106204-1	<5 || <5	[NR]	[NR]
s-ANC_E	%w/w S	0.05	Inorg-064	<0.05	106204-1	<0.05 || <0.05	[NR]	[NR]
S_{KCl}	%w/w S	0.005	Inorg-064	<0.005	106204-1	0.01 || 0.01 || RPD: 0	LCS-1	97%
S_P	%w/w	0.005	Inorg-064	<0.005	106204-1	0.01 || 0.01 || RPD: 0	LCS-1	93%
S_{POS}	%w/w	0.005	Inorg-064	<0.005	106204-1	<0.005 || <0.005	LCS-1	92%
a-S_{POS}	moles H^+/t	5	Inorg-064	<5	106204-1	<5 || <5	LCS-1	93%
Ca_{KCl}	%w/w	0.005	Inorg-064	<0.005	106204-1	0.02 || 0.03 || RPD: 40	LCS-1	101%
Ca_P	%w/w	0.005	Inorg-064	<0.005	106204-1	0.02 || 0.02 || RPD: 0	[NR]	[NR]
Ca_A	%w/w	0.005	Inorg-064	<0.005	106204-1	<0.005 || <0.005	[NR]	[NR]
Mg_{KCl}	%w/w	0.005	Inorg-064	<0.005	106204-1	0.007 || 0.006 || RPD: 15	LCS-1	99%
Mg_P	%w/w	0.005	Inorg-064	<0.005	106204-1	0.007 || 0.007 || RPD: 0	[NR]	[NR]
Mg_A	%w/w	0.005	Inorg-064	<0.005	106204-1	<0.005 || <0.005	[NR]	[NR]
S_{HCl}	%w/w S	0.005	Inorg-064	<0.005	[NT]	[NT]	[NR]	[NR]
S_{NAS}	%w/w S	0.005	Inorg-064	<0.005	[NT]	[NT]	[NR]	[NR]
a-S_{NAS}	moles H^+/t	5	Inorg-064	<5	[NT]	[NT]	[NR]	[NR]
s-S_{NAS}	%w/w S	0.01	Inorg-064	<0.01	[NT]	[NT]	[NR]	[NR]
Fineness Factor	-	1.5	Inorg-064	<1.5	106204-1	1.5 || 1.5 || RPD: 0	LCS-1	94%
a-Net Acidity	moles H^+/t	10	Inorg-064	<10	106204-1	20 || 21 || RPD: 5	LCS-1	93%
Liming rate	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	106204-1	1.5 || 1.6 || RPD: 6	[NR]	[NR]

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
a-Net Acidity without ANCE	moles H^+/t	10	Inorg-064	<10	106204-1	NA || NA	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	106204-1	NA || NA	[NR]	[NR]

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.