Annex G – Geotechnical and Acid Sulphate Soils Assessment

Ammos Resource Management Pty Ltd
C/ Tattersall Lander Pty Ltd

Preliminary Geotechnical and Acid Sulfate Soils Assessment - Proposed Sand Quarry at 3631, 3679 and 3721 Nelson Bay Road and 774 Marsh Road, Bobs Farm, NSW

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martens consulting engineers

ENVIRONMENTAL

WATER

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

Contents

1 Introduction

1.1 Overview

This report documents findings of a preliminary geotechnical and acid sulfate soils assessment for a proposed sand quarry over 4 lots, namely 3631, 3679 and 3721 Nelson Bay Road and 774 Marsh Road, Bobs Farm, NSW (the site). The site is located approximately 28 km north east of Newcastle and 5 km south of Port Stephens, at the northern end of the Stockton Bight Dunal system (Appendix A, Figure 1).

This report has been prepared to meet NSW Director General's Requirements associated with the proposed quarry development. The requirements include a geotechnical assessment, an Acid Sulfate Soils assessment and an assessment of possible impacts of soil conditions on potential resources. The assessment results are presented in Sections 3, 4 and 5 of this report respectively, following summaries of the proposed development, background information relevant and related to the proposed development and our assessment and of our scope of works (Sections 1 and 2).

1.2 Site Mining Plan

At the time of preparing this report, a Site Mining Plan (SMP) had not been developed. Details regarding proposed mining operations are based on information from previous assessments by Quarry Mining Systems (2013) and VGT & Quarry Mining Systems (2013). Assumptions made for, and recommendations presented in, this report should be reviewed by Martens and Associates (MA) following development of the SMP. If required, findings and recommendations should be revised to reflect the SMP.

1.3 Proposed Development

For the purpose of this assessment, site extraction works are assumed to occur over the entire site excluding a 15 m buffer zone along site boundaries. A preliminary plan and cross sections of proposed extraction works are provided in Appendix A, Figures 2 and 3 respectively.

From Quarry Mining Systems (2013), VGT & Quarry Mining Systems (2013) and Tattersall Lander (2014) the proposed development is likely to include:

- Preliminary works, including: provision of access roads and an intersection with Nelson Bay Road; initial clearing of existing structures; setting up of screening operations, loading ramp and

storage shed; and construction of the main exit road onto the existing bitumen sealed road within Lot 10 DP1071458.

- Clearing of topsoil and stockpiling, for likely processing into landscape soil base and sports field top-dress material.

- Stage 1 extraction of aeolian sands to approximately 3 m above groundwater table, using conventional excavation/extraction techniques, and stockpiling for later use for various purposes.

- Stage 2 extraction of aeolian sands to approximately 1 m above groundwater table, using specialised excavation/extraction techniques, and stockpiling for later use for various purposes.

- Stage 3 extraction of aeolian and marine sand from approximately 1 m above to 16 m below the groundwater table, by dredging, and stockpiling for later use for various purposes.

- Rehabilitation for likely use of the resultant lake as a tourist attraction.

1.4 Existing Relevant and Related Documentation

Previous site assessments and background information relating to the proposed development and considered relevant to, and reviewed as part of, our assessment include:

- Martens and Associates (2014), *Preliminary Groundwater Assessment, Proposed Sand Quarry: 3631 Nelson Bay Rd, Bobs Farm, NSW*, Document reference P1303897JR01V01.

- Quarry Mining Systems (2013), *Bobs Farm Sand Deposit Stage 2 Investigation*, report reference 2013-11-02-D.

- VGT & Quarry Mining Systems (2013), *Bobs Farm Stage Two Geological Assessment*, report reference BF13A.

- Tattersall Lander (2014), *letter dated February 21, 2014, Request for Director-General's Requirements – Supporting Documentation Proposed Sand Mine, Nelson Bay Road, Bobs Farm Port Stephens Local Government Area.*

- NSW Department of Local Land Services – Hunter (2014), *Letter dated 14th March 2014, Bobs Farm Sand Project – SDD Number TBA – DGRS input request.*

- NSW Department of Office of Environment & Heritage (2014), *Letter dated 24th February 2014, Director General's Requirements for Proposed Bobs Farm Sand Project,* report REF: DOC14/12504; FIL14/1226.

- NSW Department of Primary Industries (2014), *Letter dated 26th February 2014, Bobs Farm Sand Quarry (SSD 14_6395) – Request for input into Director General Requirements,* report REF: OUT14/6325.

- NSW Department of Transport – Roads & Maritime Services (2014), *Letter dated 13th March 2014, Nelson Bay Road (B63): Proposed Sand Quarry – Lot 254 DP 753204, Lot 51 DP 1015671 & Lot 10 DP 1071458, Nelson Bay Road, Bobs Farm – Director General's Environmental Assessment Requirements (SSD TBA),* report REF: SF2014/019270.

- NSW Environmental Protection Authority (2014), *Letter dated 20th February 2014, Bobs Farm Sand Project AMMOS Resources Management Pty Ltd, (SSD Number TBA), Director – General's Requirements (DGR's),* report REF: DOC14/12442-01; EF14/611.

- Port Stephens Council (2014), *Letter dated 12th March 2014, Bobs Farm Sand Project, Request for Input into DGRs.*

- NSW Department of Trade & Investment, Resources & Energy (2014), *Letter dated 12th February 2014, Request for Director General Requirements – Bobs Farm Sand Project,* report REF: OUT14/5153.

1.5 Assessment Objectives

Objectives of the geotechnical assessment include:

- Assess likely site conditions from review of previous investigation results relevant to the geotechnical assessment objectives.

- Additional borehole drilling and Dynamic Cone Penetration (DCP) testing in areas previously not accessed and considered necessary to complete the preliminary assessment of soil properties and design parameters for the underlying soil profile.

- Supplementary laboratory testing to confirm previous test results and close assessed data gaps.

- Assessment of site stability (SLIDE Modelling analysis) associated with the proposed works, including suitability of proposed excavation batter angles of 1V: 2H.

- Provide geotechnical recommendations for safe and economic sand extraction.

- Assess soil erosion and sediment transport management requirements.

- Provide recommended mitigation and management options to limit, control and abate impacts on surrounding land use and the environment. This is to include assessment of the effectiveness and reliability of intended measures and associated residual impacts.

Objectives of the ASS assessment include:

- Review site conditions and previous investigation results, relevant to the ASS assessment objectives.
- Additional borehole drilling and sampling for laboratory (sPOCAS) analysis.
- Prepare a preliminary ASSMP.

In addition, the potential impact of the following soil conditions on soil resources was to be assessed:

- Salinity
- Dispersivity
- Aggressivity

1.6 Scope of Works

A summary of scope of works undertaken to address the objectives of the geotechnical and ASS assessment is provided in Table 1.

Table 1: MA scope of works.

Scope	Objective
Site inspection by Senior Geotechnical Engineer.	Walkover inspection to assess topography, geology, soil characteristics, hydrology, vegetation and access limitations for proposed investigation plant.
Fieldwork by MA geotechnical engineers involving: - Drilling of 8 boreholes up to 13 mBGL. - DCP testing at 6 locations. -Collection of soil samples from boreholes for laboratory testing and future reference. Laboratory testing: - sPOCAS. - EC. - Dispersion.	- Supplement existing data with additional information to confirm previous characterisation of underlying soils and groundwater depths. - Assess soil strength properties in accordance with AS 1289.6.3.2 (1997). - Assess possible PASS and ASS across site and prepare a preliminary ASSMP.
Geotechnical and ASS assessment including SLOPE stability modelling.	- Assess likely minimum safe batters angles for sand extraction. - Provision of geotechnical recommendations for safe and economic extraction. - Recommended possible mitigation and management options to limit, control and abate impacts on surrounding land use and the environment. - Assess soil erosion and sediment transport management requirements. - Assess possibility of saline, aggressive and dispersive soils at the site and their potential impact on soil resources and recommend potential management options (if required).

1.7 Relevant Guidelines and Standards

The geotechnical and acid sulfate soils assessment was carried out in accordance with the following guidelines:

- Port Stephens Local Environmental Plan (2013).
- State Environmental Planning Policy (State and Regional Development, 2011), *Schedule 1 State significant development-general.*
- State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries, 2007).
- Protection of the Environment Operations Act (1997) No. 156.
- Water Management Act (2000) No. 92.

- Acid Sulfate Soils Assessment Guidelines (1998).
- Australian Standard 1726 (1993) *Geotechnical site investigations.*
- Australian Standard 1289.6.3.2 (1997), *Determination of the Penetration Resistance of a soil - 9kg dynamic cone penetrometer test.*
- NSW Department of Conservation & Land Management (1992).
- Australian Drinking Water Guidelines (2011).

All laboratory testing was carried out by National Association of Testing Authorities, Australia (NATA) accredited laboratories.

1.8 Abbreviations

AASS – actual acid sulfate soil

ASS – acid sulfate soil

ASSMAC – acid sulfate soils management advisory committee

ASSMP – acid sulfate soils management plan

BH – borehole

DCP – Dynamic Cone Penetrometer test

EC – electrical conductivity

FOS – factor of safety

ha – hectare

kg – kilogram

mBGL – metres below ground level

mAHD – metres above Australian Height Datum

NATA – National Association of Testing Authority

NO_X – Nitrogen oxide

PASS – potential acid sulfate soil

SMP – site mining plan

sPOCAS – Suspension Peroxide Oxidation Combined Acidity & Sulfur

SWL – standing water level

T – tonnes

TDS – total dissolved solids

TKN – total kjehldahl nitrogen

TN – total nitrogen

TP – total phosphorous

WBZ – water bearing zone

2 Background Information

2.1 Site Location and Setting

Site background information is summarised in Table 2. An aerial photo with elevation contours is provided in Appendix A, Figure 2.

Table 2: Site background information.

Item	Detail
Site address	3631, 3679 and 3721 Nelson Bay Road and 774 Marsh Road, Bobs Farm, NSW.
Lot and DP (Title Information)	Lot 254 DP753204. Lot 51 DP1015671. Lot 10 DP1071458. Lot 1 DP1082774.
Local government area (LGA)	Port Stephens Council.
Site Area	Approximately 40 ha.
Existing Site Development	Approximately 25 % of the site area is utilised for agricultural purposes (primarily olive and fig plantations) with a small proportion of this area occupied by farm sheds, a farm hand residence and a master residence. A power transmission line easement (poles and wires) cuts across the southern corner of the site. The remaining 75 % of the site area remains undeveloped apart from some unpaved vehicle tracks.
Current land use	Rural residential and agriculture.
Proposed land use	Extractive (mining).
Surrounding land uses	Rural-residential allotments border the site to the north, west and south west. Nelson Bay Road borders the site to the south east, with Worimi National Park located on the southern side of Nelson Bay road. The Australian Shark and Ray Centre is located along the western end of the northern site boundary.
Topography and drainage	The site is located near the northern edge of the east-north-east to west-south-west aligned Stockton Bight dunal system, which comprises moderately to steeply undulating land with grades of typically between 2 and 50 %. The Tilligerry Creek floodplain to the north of the site comprises predominantly flat and near-level land. The site has a predominant easterly aspect with some areas sloping down towards the east. The remaining areas slope to the north, west or south west. Slopes are low (typically 0-5 %) in the eastern portion of the site and higher (typically 10-50 %) over the remainder and majority of the site. The high slopes occur on dune knolls. Site elevations range from approximately 35 m AHD at a knoll in the north west of the site to approximately 2 m AHD at a depression in the north. The lower eastern portion of the site has typical elevations of between 2 m and 8 m AHD.

Item	Detail
	The majority of the site drains southwards towards Stockton Beach. A small portion adjacent to the north west site boundaries drains northwards towards Tilligerry Creek.
Vegetation	Approximately 75% of the site consists of uncleared tall open forest dominated by the canopy species *Eucalyptus pilularis* (Blackbutt) and *Angophora costata* (Smooth-barked Apple). The remaining low lying areas near Nelson Bay Road comprise olive and fig plantations. Two smaller areas of wetter forest are also present within the lower lying areas.

2.2 Expected Geology

The Newcastle and Port Stephens 1:100,000 Geological Series Sheet 9232 indicates that the site is underlain by Quaternary Holocene sand (stable dunes). The area to the north of the site (beyond the northern boundary) is underlain by estuarine sands, silts and clays derived from deposition within Tilligerry Creek. The area to the south of the site (southern side of Nelson Bay Road) is underlain by Quaternary Holocene sands derived from older beach deposition and covered by low level windblown dunes (Appendix A, Figure 4).

2.3 Expected Subsoil Conditions

VGT & Quarry Mining Systems Pty Ltd (QMS) in August, 2013, drilled and sampled five boreholes (BH1 to BH5) to a target depth of 16 m below the groundwater table. The boreholes were converted to wells upon completion. An additional 5 test pits (TP1 to TP5) were excavated but did not reach their target depth due to significant soil cave-in during excavation. Borehole/well and test pit locations are provided in Appendix A, Figure 5. The main objective of the boreholes/test pits was to assess sand quality changes with depth across the site and whether retrieval and subsequent processing of the sand would be commercially viable and sustainable.

The soil profile at the site was divided by VGT & QMS (2013) into five major units:

- Unit 1: Organic Topsoil
- Unit 2: Mottled Sand (Upper Grey Sand)
- Unit 3: Blonde Sand
- Unit 4: Sand/Black Dark Mud
- Unit 5: Lower Grey Sand

Indicative depth ranges of the soil units making up the soil profile at the borehole locations are provided in Appendix B, Table 16.

Results of laboratory testing of soil samples selected by VGT & QMS (2013) indicate:

- Site sands are generally subrounded to rounded with moderately high sphericity.
- Soil acidity ranges from slight to extreme.
- Soil salinity is generally low, apart from 3 samples collected from below the water table: BH1-BL-G1-SO 0.5, a moderately saline sand sampled from BH1; BH5-M-SO 0.633, an extremely saline clay sampled from BH5; and BH2-10.5-12.0-SO 0.7, a very highly saline clay sampled from BH2,.
- The level of exchangeable sodium and soil sodicity is generally high, indicating that where clay soils occur, they are prone to dispersion.

2.4 Surface Water and Groundwater Conditions

2.4.1 Site Flooding

Areas to the north west of the site, below 10 m AHD, are below the 1 in 100 year flood level. These may be affected by flooding from Tilligerry Creek (Appendix A, Figure 6). However, given these areas are located beyond elevated parts of the buffer zone, we have assumed that flooding of Tilligerry Creek will not impact the proposed development. No further consideration of flooding of Tilligerry Creek has been included in this assessment.

2.4.2 Groundwater Levels

MA (2014) installed automated data loggers in wells constructed by VGT & QMS (2013). Groundwater levels were measured from 22.08.2013 at 15 minute intervals to 09.01.2014 (approximately 3 months) for BH4 and BH5 and to 17.07.2014 (approximately 11 months) for BH1 to BH3 (ref. P1303897JR01V01). Summaries of measured groundwater levels are provided in Table 3 (datum = mBGL) and Table 4 (datum = mAHD).

Table 3: Statistical summary of groundwater depths (m BGL) measured by data loggers in existing site wells (BH1 to BH5) between 22.08.2013 and 17.07.2014.

	Groundwater Depth (m BGL)				
	BH1	**BH2**	**BH3**	**BH4**	**BH5**
Minimum	2.72	9.13	13.08	7.25	15.30
Mean	3.28	9.50	13.28	7.36	15.42
Maximum	3.53	9.78	13.55	7.50	15.57
Range	0.81	0.65	0.47	0.26	0.27

Table 4: Statistical summary of groundwater levels (m AHD) measured by data loggers in existing site wells (BH1 to BH5) between 22.08.2013 and 17.07.2014.

	Groundwater Level (m AHD)				
	BH1	**BH2**	**BH3**	**BH4**	**BH5**
Minimum	2.29	1.94	1.93	1.95	2.68
Mean	2.55	2.22	2.20	2.09	2.83
Maximum	3.10	2.59	2.40	2.21	2.95
Range	0.81	0.65	0.47	0.26	0.27

The following observations are made:

- Mean groundwater level ranges from 2.09 m AHD in BH4 (located near south west site boundary) to 2.83 m AHD in BH5 (located near northern site boundary).
- Groundwater level responds to rainfall.
- BH1 and BH2 displayed the most prominent response to a recharge event, which occurred between 17.11.2013 and 19.11.2013 and comprised 137 mm of rainfall. Increases in groundwater level associated with this event were approximately 0.42 m and 0.32 m for BH1 and BH2 respectively.
- We note that groundwater level fluctuations at BH1 and BH2 may be influenced by irrigation of fig plantations. The plantations are typically watered daily for a period of 2 hours with a sprinkler head at every fig plant.
- Further to the above, groundwater levels in BH1 may also be influenced by pumping of the site water supply bore, located to the south of the main dwelling.

2.4.3 Background Groundwater Quality

Groundwater quality samples were taken from site bores by MA (2014) on 22.08.2013 (ref. P1303897JR01V01) and submitted to a NATA accredited laboratory for analysis. Analysis results for key analytes (pH, EC, TDS, TKN, NOx, TN, TP) are reproduced in Appendix B, Table 17. Laboratory certificates for the complete suite of analytes are provided in Appendix E. The results indicate the following:

- Groundwater is slightly acidic.
- Groundwater has an estimated maximum salinity concentration of 275 mg/L considered fresh in the context of salinity classes provided in the NSW Department of Conservation and Land Management (1992) and the Australian Drinking Water Guidelines (2011).
- pH was between 5.2 (BH4) and 6.0 (BH5). Based on a pH of less than 5.5 for three samples, the presence of AASS was considered likely.

2.5 Acid Sulfate Soils

2.5.1 Acid Sulfate Soils Risk Map Classification

Council mapping (Appendix A, Figure 7) has assigned a Class 4 category to the bulk of the site with a Class 3 category assigned to a small portion in the north:

- Class 3 – works beyond 1 m below the natural ground surface and works where the water table is likely to be lowered beyond 1 m are likely to present an environmental risk if undertaken in Class 3 land.
- Class 4 - works beyond 2 m below the natural ground surface and works where the water table is likely to be lowered beyond 2 m are likely to present an environmental risk if undertaken in Class 4 land.

Considering the above, the proposed development is likely to present an environmental risk as a result of the presence of ASS.

2.5.2 Previous ASS Assessment

A preliminary ASS assessment was completed by MA (2014) to assess the presence of AASS or PASS at the site. A total of 27 soil samples, collected by VGT & QMS from three boreholes (BH3, BH4 and BH5), were selected by MA for sPOCAS testing. The samples covered a range of locations and depths (Table 5). In addition, groundwater samples

were collected from each groundwater monitoring well (BH1 to BH5) for sPOCAS testing.

Table 5: Summary of samples analysed by laboratory for sPOCAS

BH	Samples Analysed	Surface Elevation	Upper Sample Elevation (m AHD)	Lower Sample
BH3	8	15.48	12.5	-13
BH4	8	9.45	5.5	-13.5
BH5	11	18.25	8.5	-7.5

Laboratory certificates for previous sPOCAS testing are provided in Appendix E, with results summarised in Appendix B, Table 18.

Results for 13 of the 27 samples tested exceeded the ASSMAC action criteria, indicating PASS to be present at the site below approximately 0.8 m AHD, except for one anomalous sample located at 12.5 – 11.5 m AHD.

The pH of collected groundwater samples was between 5.2 (BH4) and 6.0 (BH5). Based on a pH of less than 5.5 for three samples, the presence of AASS was considered likely.

MA (2014) concluded that a detailed ASSMP is required and recommended that additional sampling/laboratory testing is carried out to better delineate spatial extent and depth of PASS and enable application of variable liming rates for treatment.

3 Geotechnical Assessment

3.1 Supplementary Scope of Works

Supplementary field investigations, undertaken between 29/7/2014 and 30/7/2014 by MA geotechnical engineers, included:

- Drilling of eight boreholes up to 13 mBGL.
- DCP testing at six locations.
- Collection of soil samples from boreholes for laboratory testing and future reference.

Approximate borehole and DCP test locations are provided on Figure 5 in Appendix A.

Laboratory testing of collected soil samples included:

- Twenty one samples for sPOCAS.
- Twenty one samples for EC.
- Six samples for Dispersion.

3.2 Encountered Subsurface Conditions

Supplementary borehole investigations by MA confirmed the presence of the five general units described by VGT & QMS (2013). A generalised description of these units is presented below, from youngest to oldest:

- Unit 1: Very loose grey organic sand with rootlets (topsoil), typically less than 0.4 m thick across the site.
- Unit 2: Very loose and loose light grey/grey aeolian sand, typically 1.2 m thick across the site.
- Unit 3: Loose and medium dense orange/yellow aeolian sand, with minor dense layers, typically 8.7 m thick across the site, and very loose sand in dune knolls in the western end of the site (DCP105).
- Unit 4: Medium dense marine sand and clayey sand with organic content, below ground water level likely derived from the paleo tidal zone of Tilligerry Creek. This unit is likely to be encountered in lenses across the site given that it was only intercepted in BH102 and BH103 by MA and BH1 to BH5 by VGT from levels ranging between approximately 3.9 m and -1.8 m AHD.

- Unit 5: Dense light brown/grey marine sand, containing minor heavy mineral bands, below the groundwater table from levels ranging between approximately 3.0 m and -4.4 m AHD.

Detailed borehole logs are provided in Appendix C.

A summary of the soil profiles and depth ranges encountered in each of the boreholes drilled at the site (BH1 to BH5 and BH101 to BH108) is provided in Appendix B, Table 16.

An interpretation of the depositional history of the units is summarised below from oldest to youngest.

- Unit 5: Marine beach sands derived from Stockton Beach are deposited across the site.
- Unit 4: Tidal zone of Tilligerry Creek extends across the site and deposits organic rich sands, silts and clays in low-lying areas.
- Unit 3: Tilligerry Creek tidal zone regresses with localised erosion of Unit 4 sands. Aeolian sands from Stockton Beach transgress across the site in a north westerly direction (dominant wind direction).
- Unit 2: Sequence of deposition of aeolian sand and erosion of these and the underlying Unit 3 sands.
- Unit 1: Recent stabilisation of dunes by vegetation, mainly consisting of grasses and trees, and development of a thin surface layer of organic-containing topsoil.

3.3 Assessments

3.3.1 Preliminary Geotechnical Material Properties and design parameters

Preliminary geotechnical soil strength, estimated from visual assessment, DCP test results and rate of auger advancement (V-bit), using our experience from similar environments, are provided in Table 6.

A typical increase in soil density was observed corresponding with age of deposition or overburden pressure. An exception to this general trend are two cone shaped sand dunes (between BH105 and BH106), found to consist of loose to very loose sands from surface to about 10.05 m BGL.

Owing to varying conditions, design of footings should consider conditions at actual location. For preliminary assessment, an allowable end bearing pressure of 50 kPa may be adopted for shallow footings founding on loose and medium dense (or bedded) sand subject to >1 m above groundwater table; to at least 2 x width of footing below

foundation level; and embedment of >0.75 m in the unit. Preliminary earth pressures for retaining wall design of Ka = 0.4 and Kp = 2.8 may be adopted for aeolian sands and Ka = 0.3 and Kp = 3.3 for marine sands.

Table 6: Preliminary estimates of soil strength properties.

Unit	Description[1]	Y_{dry}[2] (kN/m³)	Y_{sat}[3] (kN/m³)	Cu[4]	ϕ'[5] (°)	E[6]
Unit 1: Organic Sand	Very Loose	14	17	-	23	2
Unit 2: Aeolian Sand	Very Loose or Loose[7]	14	17	-	25	3
Unit 3: Aeolian Sand	Loose	15	18	-	27	5
	Medium Dense	17	20	-	32	15
Unit 4: Marine Organic Sandy Clay/Clayey Sand	Loose or Medium Dense[7]	17	20	-	30	10
	Soft	15	17	-	-	5
Unit 5: Marine Sand	Loose, Medium Dense and Dense[7]	19	21	-	36	30

Notes:
[1] Typical density. Refer to borehole logs (Appendix C) for full soil description details.
[2] Dry unit weight (+/- 2kN/m³).
[3] Saturated unit weight (+/- 2kN/m³).
[4] Undrained cohesion.
[5] Effective friction angle (+/-2°).
[6] Effective elastic modulus (based on visual assessment, +/- 10 %).
[7] Assumed average value for unit.

3.3.2 Safe Excavation Batter Assessment

Modelling Approach

A slope stability analysis was undertaken using the *SLIDE 6.0* modelling software to assess a Factor of Safety (FOS) against soil sliding. Cross Section A-A, shown on Figure 3, was used as a basis for the model.

Existing site conditions and expected ground conditions, resulting from the proposed development (extraction Stages 2 and 3), were analysed adopting the design batter angle of 1V:2H, expected soil properties presented in Table 7 and a mean groundwater level groundwater level of 2 m AHD.

Additional sensitivity analyses were carried out to assess potential impacts of model parameter variations on FOS, including:

- Decrease in batter angle of 1:2.5 and 1:3.
- Peak soil conditions, assuming material is stronger than expected, and residual conditions, assuming material is weaker than expected (Table 7).
- A groundwater level of 3 m AHD, considered the peak groundwater level (MA, February 2014).

Modelling Assumptions

Development of the model assumed:

- Cross section A-A (Attachment A, Figure 3) is representative of conditions across the proposed mine footprint.
- Profile divided into 3 soil layers according to composition and inferred density/ consistency.
  - A: Very loose and loose Aeolian sand.
  - B: Medium dense Aeolian and marine sand with some loose and dense layers.
  - C: Very loose to medium dense marine clayey sand/ soft sandy clay.
- No impacts from excavation-induced vibrations.
- No earthquake-induced impacts.
- No impacts from wave movements during dredging.
- Interpolated unit thicknesses and conditions between boreholes.
- Unit 4 marine organic sands/clays are present across the entire site.
- Homogeneous soil conditions throughout each unit.
- Similar or better soil conditions in all other areas of the site, not modelled.
- Eastern section considered only stage 3 (full excavation).
- Only considered rotational failure mechanism, likely to be the dominant failure mechanism impacting site stability.

- A minimum design FOS of 1.1 was adopted, which is considered typical for medium to long term (> 1 month <20 years) mining operations.

Table 7: Assumed soil strength properties used in *SLIDE 6.0* model.

Layer	Material[1]	δ_d (kN/m³)[2]	δ_{sat} (kN/m³)[3]	Expected Strength[5]		Sensitivity Analysis			
						Peak Strength		Residual Strength	
				C' (kPa)[4]	ϕ'(°)[5]	C' (kPa)[4]	ϕ'(°)[5]	C' (kPa)[4]	ϕ'(°)[5]
A	Very loose and loose Aeolian sand	16	20	-	26	-	28	-	24
B	Loose and medium dense Aeolian and marine sand	17	21	-	28	-	30	-	26
C	Clayey sand/sandy clay layer	17	21	1	22	2	24	0	20

Notes:
[1] Preliminary soil strength properties estimated from DCP data; adopted average value for unit thickness.
[2] Dry unit weight.
[3] Saturated unit weight.
[4] Inferred effective cohesion.
[5] Inferred friction angle.

Modelling Results

Table 8 summarises the lowest FOS of all slip surfaces analysed for each modelled scenario. Results for each analysis are shown as images in Appendix F.

Table 8: Minimum FOS for modelled conditions using *SLIDE 6.0*.

Soil Strength States	Groundwater Levels	FOS For Batter Angle[2]		
		Varying		
Existing site conditions				
Expected	2m AHD	1.69[1]		
	3m AHD	1.69[1]		
		1:2	**1:2.5**	**1:3**
Stage 2 (excavation to 1m AHD)				
Expected	2m AHD	1.065	1.202	1.641
	3m AHD	1.065	1.202	1.641
Stage 2 (excavation to 1m AHD)				
Expected	2m AHD	1.073	1.281	1.612
	3m AHD	1.071	1.198	1.587
Stage 3 (excavation to -15m AHD)				
Expected	2m AHD	1.050[3]	1.237[3]	1.541
	3m AHD	1.046[3]	1.233[3]	1.537
Peak (upper bound)	2m AHD	1.142	1.397	1.675
	3m AHD	1.139	1.393	1.671
Residual (lower bound)	2m AHD	0.960	1.175	1.411
	3m AHD	0.957	1.172	1.408

Notes:
[1] An assessed minimum FOS of 1.011 for an isolated existing cutting along an access track was considered to be of small scale and non-representative of site conditions; therefore not included in our assessment.
[2] Design batter angle (Vertical:Horizontal).
[3] Assessment of the eastern excavation face along section AA at Stage 3 indicates a FOS of 1.064 and 1.331 for batter angels of 1:2 and 1:2.5 respectively.

Assessed Safe Batter Angles

A batter angle of 1:2 is considered generally to provide a FOS of > 1 but may result in unstable conditions from excavations below groundwater level. We therefore recommend adopting a safe batter angle of 1:2.5.

This can be revisited once operations proceed and exposed excavations are monitored, and long-term stability is observed.

3.3.3 Risk Assessment

A geotechnical hazard risk assessment for the proposed works has been completed in accordance with the qualitative risk matrices provided in Section 7 of the AGS (2007) guidelines. Four forms of slope movement are considered likely at the site: translational slide, rotational slide, soil creep and lateral spread. Soil creep and gross instability (slide) are considered most likely to impact or be impacted by the proposed development. A summary of a risk assessment for these hazards is presented in Table 9. The assessment is based on treatment measures, recommended in this report and shown in Table 9 as a minimum, having been implemented. Risk evaluation calculations are provided in Appendix G.

Table 9: Summary of slope instability risk assessment, based on AGS (2007).

Description	Treatment Measures	Likelihood[1]	Risk to Life		Risk to Property	
			Established Probability[2]	Risk	Consequence	Risk
Soil creep	Maintain vegetation of undeveloped areas. Maintain good site drainage.	Possible[1]	5.35×10^{-7}	Tolerable	Minor	Low
Gross Instability (slide)	Good hill slope engineering practice. Maintain good site drainage. Do not load crest of excavation batter. Limit vibrations near batters. Do not over-steepen batters (maximum batter slope of not greater than 25° i.e. about 1V:2H).	Unlikely[1]	8.20×10^{-7}	Tolerable	Moderate	Low

Notes:
[1] Based on 'treated' site conditions.
[2] Annual probability of loss of life of an individual most at risk.

Based on AGS, the risk is considered acceptable. However, we point out that it is the responsibility of the client and stakeholders to ultimately decide whether the risk is acceptable.

3.4 Recommendations

3.4.1 Recommended Safe Batter Angles

Proposed extraction of sand resources will need to take into consideration long-term stability of the excavation perimeter, such that impact on buffer zones of adjacent land is limited. To this extent, it is suggested that an average batter slope of not greater than 22° (about 1V:2.5H) be adopted both above and below groundwater level.

Recommended interim maximum safe batters are provided in Table 10. These can be refined with further assessment at detailed design stage.

Table 10: Recommended interim maximum batter angles.

Unit	Maximum Slope Batter[1]
Unit 1: Organic Sand	1:3.0
Unit 2: Aeolian Sand	1:3.0
Unit 3: Aeolian Sand	1:2.5
Unit 4: Marine Organic Sand	1:2.5
Unit 5: Marine Sand	1:2.5

Notes:
[1] Maximum batter slopes (vertical : horizontal).

3.4.2 Existing Infrastructure

The edge of the proposed sand mine excavation is offset approximately 15 m from Nelson Bay Road. The deepest proposed excavation nearest Nelson Bay Road will be approximately 16 m BGL.

Should the recommended maximum batter slope angles be adopted, the excavation will be located outside the zone of influence of Nelson Bay Road (estimated by extending down 30 degrees from the edge of Nelson Bay Road). If excavation extends into the zone of influence, then these excavations should take into consideration requirements of the NSW Department of Planning and Environment (DoPE) and RMS *Development Near Rail Corridors and Busy Roads – Interim Guideline, 2008)*. Alternatively, batter angles may need to be further reduced.

3.4.3 New Infrastructure

Owing to varying subsurface conditions across the site and with depth, foundation design for new infrastructure should consider conditions at actual locations. However, allowable end bearing pressures of 50 kPa may be adopted for preliminary design of high-level lightly loaded footings founding on loose and medium dense (or better) sand respectively, subject to a minimum cover of 1 m to the groundwater

table; uniform foundation conditions to a depth of at least twice the least footing dimension below foundation level and a minimum embedment of 0.75 m. Preliminary retaining wall designs, should they be required, may be carried out using a triangular pressure distribution and adopting active and passive earth pressure coefficients of Ka = 0.4 and Kp = 2.8 respectively for aeolian sands and Ka = 0.3 and Kp = 3.3 respectively for marine sands.

3.4.4 Additional Testing

DCP testing was limited to 5 locations. We recommend that additional testing is carried out to assist with detailed site design to better define soil strength properties across the entire site and identify anomalies to the general conditions assumed for this report. The following additional DCP testing is recommended:

- Along the boundary to Nelson Bay Road.
- At the crest of the sand dunes to the north and west of the site.
- Along site boundaries.
- Within the current orchards and low lying areas.

3.4.5 Construction Considerations

Stage one mining of the soil profile would most likely involve stripping topsoil and root affected sand (Unit 1) by dozer and/or excavator. Subsequent mining of Units 2 and 3 will likely also be carried out by dozer/ excavator. Stockpiling of soil may be required before loading onto trucks and removal from site. As the groundwater table is approached, it is anticipated that trafficability may be reduced due to potential ground heave of saturated soils. A dredging system is expected to be utilised for excavation of soils below groundwater level (stage two).

Table 11 provides recommendations for consideration during construction and expected mining operations.

Table 11: Recommendations for consideration in construction and mining operations.

Item	Recommendations
Excavations and Vibrations	All excavation work should be completed with reference to the Code of Practice 'Excavation Work', dated October 2013 by Safe Work Australia. Excessive vibrations in the vicinity of any open sand excavation should be avoided to limit the risk of vibration-induced slope movement. Slopes below groundwater are particularly sensitive to vibrations.
Working Platforms, where required	Working platforms will be required where high localised loading is expected. Engineer to design working platforms, particularly where adjacent to crest of excavations or natural batters.
Trafficability and Access	Trafficability on exposed sand above the groundwater table is likely to be poor. Excavation of the site may be limited to the use of tracked machinery. Trafficability closer to the groundwater table is expected to deteriorate and sand dredging methods may need to be employed or dewatering may need to be carried out. Crushed concrete or aggregate should be placed along access and haul roads to facilitate site access by dump trucks and utility vehicles. Further assessment of subgrade e.g. CBR conditions be carried out for pavement thickness design of longer term access roads.
Soil Erosion Control	Sand mining should be performed in a manner that reduces the risk of soil erosion and sedimentation on neighbouring lands by water or wind. Site vegetation should only be cleared as mining progresses and maintained where possible. Surface drainage should be directed away from the crest of batters and batter slopes should be kept vegetated or covered to limit erosion. Erosion of, and transportation of sediments off-site from, soil stockpiles should be limited by providing erosion control measures such as bunding and cover, e.g. geotextile or plastic sheeting.

4 Acid Sulfate Soils Assessment

4.1 Supplementary Laboratory Testing

In addition to the 27 soil samples tested by QMS (2013), a total of 21 samples collected by MA (2014) were analysed by Envirolab Services.

4.2 Results

Laboratory test results are summarised in Appendix B, Table 18 with laboratory certificates provided in Appendix E. Exceedances of the action criteria for pH_{OX}, TPA, TSA and S_{POS}, by 7 of the 21 samples indicate the presence of PASS. Samples exceeding action criteria were generally from close to or below the 2-3 m AHD groundwater table, confirming previous findings by MA (2013) that PASS are likely to be present below 0.8 m AHD. However, of 22 samples tested close to or below the groundwater table, 10 were outside action criteria, indicating the presence of possible layers below the water table are not AASS or PASS.

One sample (3897/BH03/+12.5 to +11.5) out of the 26 collected from above groundwater level exceeded the criteria, indicated PASS.

4.3 Conclusions

PASS are likely to be present at the site at levels close to or below groundwater table, typically located between 2 and 3 m AHD. A detailed ASS management plan (ASSMP) is required for the proposed sand dredging operations. As AASS or PASS was generally not found above the groundwater table (apart from one anomaly in BH3 at +12.5 to +11.5 m AHD), no management plan is considered necessary for sand mining of this material.

4.4 Acid Sulfate Soils Management Plan (ASSMP)

4.4.1 Introduction

Current and previous soil test results indicate that AASS/PASS are likely to be encountered below the groundwater table, but unlikely to be present above groundwater levels. This ASSMP covers proposed works associated with soil extraction below the water table only (stages 2 & 3).

4.4.2 Source

The potential source of impact comprises oxidised sulfide minerals that, if exposed to the atmosphere, may oxidise and generate sulfidic acidity. The acidity can mobilise iron, aluminium, arsenic and other heavy metals from the soil profile (sands/ clays). The release of these

heavy metals can be detrimental to biota, human health and infrastructure. Oxidisation of sulfide minerals may occur during the dredging of sand containing PASS or as a result of a lowering of the water table.

4.4.3 Pathways

If oxidisation of *in-situ* PASS generates sulfidic acid, then groundwater is the initial pathway by which impacts may migrate. Acidity could migrate downwards by leachate, upwards with groundwater rebound or laterally through groundwater flows and through dispersion. If acidic groundwater mobilises heavy metals they may migrate along similar pathways. Given the proposed method of sand extraction below the water table by dredging, groundwater levels at the site and at surrounding bores will unlikely be significantly altered. Although significant groundwater drawdown from dredging is unlikely, some local groundwater level reduction may occur due to evaporation of the 'window lake'. However, this is expected to be minor given the high conductivity of the aquifer material surrounding the 'window lake'.

4.4.4 Receptors

Possible ecological, human and built environment receptors include site workers, flora and fauna and mining equipment. Off-site receptors include Tilligerry Creek (approximately 1.4 km to the north), Stockton Beach (approximately 1.8 km to the south), Worimi National Park (approximately 60 m to the south), areas using non-potable water or irrigated areas.

4.4.5 Groundwater

Groundwater across the site is naturally slightly acidic with a pH ranging from 5.2 to 6.0. The slightly acid conditions are not likely to pose an immediate risk to ecological receptors.

4.4.6 Treatment Plan

Treatment plan for the below groundwater level mining process (Stages 2 & 3) is summarised in Table 12. It should be noted that at the time of report writing, details of possible methodologies for sand dredging and soil processing were unknown.

Table 12: Treatment plan for mine operations.

Mining Operation	Treatment
Dredge slurry separation	o Coarse material = no treatment required. o Fines to sedimentation pond: - pH testing against trigger value of 4.

Mining Operation	Treatment
	- If pH <4, application of lime to neutralise. - Stockpile on-site. - Lime treatment if necessary. - Retain on site, or disposal off-site.
Periodic removal of fines from sedimentation pond:	o Stockpile on-site. o Lime treatment, if necessary. o Retain on site, or disposal off-site.

4.4.7 Monitoring Plan

A monitoring plan for the five wells on-site and the dredge pond is summarised in Table 13.

Table 13: Dredging pond and groundwater wells monitoring plan.

Location	Frequency	Parameters	Trigger Value[1]
Dredge pond	3 months[2]	pH, EC	pH <4, EC = NA
5 on-site wells	3 months[2]	pH, EC	pH <4, EC = NA

Notes:
[1] Preliminary value to be revised after 6 months monitoring.
[2] 3 month monitoring over at least a 12 month period.

4.4.8 Further works

We recommend the following additional investigation works are carried out:

- Supplementary borehole drilling, sampling and testing across the site and along site boundaries to better define the extent and depth of PASS below the groundwater table.
- Further testing of soil above the groundwater level in the vicinity of BH3 to confirm assumed anomalous test results.
- Installation of 5 new wells around the dredge pond to detect possible movement of sulfidic acidic impacted groundwater.

5 Impact on Soil Resources

5.1 Background

Previous soil lab testing by VGT & QMS (2013) indicated that some soils at the site are potential saline soils and aggressive to buried structures and possibly dispersive. Additional salinity and dispersion testing was undertaken to augment these results and assess the potential impact of the soil resource.

5.2 Soil Salinity Assessment

5.2.1 Observed Site Conditions

Field observations did not identify obvious evidence of the presence of saline soils at the site:

- Vegetation growth appeared healthy and uninhibited.
- No water marks or salt crystals were observed on the ground surface.
- Site surface drainage appeared generally good at the time of inspection.

5.2.2 Laboratory Test Results

A total of 21 samples from 8 boreholes were submitted to Envirolab Services for salinity (EC, pH) testing. The samples were selected to provide representative coverage of the site. Laboratory certificates are provided in Appendix E.

Salinity test results are summarised in Table 14.

Table 14: Salinity test results.

Sample ID[1]	EC(1:5) (dS/m)	ECe (dS/m)[2]	Salinity Class Indication[3]
3897/101/2.5	0.01	0.17	Non - Saline
3897/101/8.5	0.01	0.17	Non - Saline
3897/101/13.0	0.02	0.34	Non - Saline
3897/102/2.5	0.01	0.17	Non - Saline
3897/102/5.0	0.05	0.85	Non - Saline

Sample ID[1]	EC(1:5) (dS/m)	ECe (dS/m)[2]	Salinity Class Indication[3]
3897/102/7.0	0.02	0.34	Non - Saline
3897/103/2.5	0.01	0.17	Non - Saline
3897/103/8.0	0.02	0.34	Non - Saline
3897/103/10.0	0.02	0.34	Non - Saline
3897/104/2.5	0.01	0.17	Non - Saline
3897/104/10.0	0.01	0.17	Non - Saline
3897/105/2.5	0.01	0.17	Non - Saline
3897/105/10.0	0.01	0.17	Non - Saline
3897/106/5.5	0.01	0.17	Non - Saline
3897/106/10.0	0.01	0.17	Non - Saline
3897/107/5.5	0.01	0.17	Non - Saline
3897/107/10.0	0.01	0.17	Non - Saline
3897/108/2.5	0.04	0.68	Non - Saline
3897/108/5.5	0.03	0.51	Non - Saline
3897/108/8.5	0.05	0.85	Non - Saline
3897/108/13.0	0.03	0.51	Non - Saline

Notes:
[1] Project#/Borehole#/Depth (m BGL)
[2] Based on EC to ECe multiplication factor of 17 (Table 6.1) in Department of Land and Water Conservation (2002) Guidelines.
[3] Based on Table 6.2 of Department of Land and Water Conservation (2002) where ECe <2 dS/m = Non-Saline, ECe of 2-4 dS/m = Slightly Saline, ECe of 4-8 dS/m = Moderately Saline, ECe of 8-16 dS/m = Very Saline, ECe of >16 dS/m = Highly Saline.

Results indicate tested sands are non – saline with ECe values <2 dS/m for all samples tested. This condition was confirmed by quality testing of groundwater samples taken from site bores by MA (2013), indicating fresh groundwater conditions with maximum salinity concentration of 275 mg/L.

5.3 Soil Dispersivity Assessment

5.3.1 Observed Site Conditions

Field observations did not identify obvious evidence of the presence of dispersive soils at the site.

5.3.2 Laboratory Testing

A total of 6 samples from 8 boreholes were submitted to Envirolab Services for testing to assess the Dispersion Index of the soils. Laboratory Certificates are provided in Appendix E. Dispersion test results are summarised in Table 15.

Table 15: Dispersion test results.

Sample ID[1]	Dispersion Index	Dispersivity[2]
3897/101/13.0	0	Negligible/aggregated
3897/102/5.0	1	Slight
3897/102/7.0	0	Negligible/aggregated
3897/103/8.0	4	Slight
3897/108/5.5	1	Slight
3897/108/13.0	0	Negligible/aggregated

Notes:
[1] Project#/Borehole#/Depth (m BGL)
[2] Based on Table 2.24 of Interpreting Soil Test Results, What Do All The Numbers Mean (2007).

Results indicate tested sands containing clays have negligible/aggregated to slight dispersibility with dispersion index values ranging from 0 to 4.

5.4 Soil Aggressivity Assessment

The results of laboratory analysis of electrical conductivity and pH (Table 14 and Table 18) of the soils were compared with criteria presented in Tables 6.4.2 (C) and 6.5.2 (C) of AS2159-2009. The results indicate these soils to have the following classification:

Soils above groundwater – Mildly aggressive to concrete
Non-aggressive to steel

Soils below groundwater – Moderately aggressive to concrete
Mildly to Non-aggressive to steel

5.5 Conclusions

We conclude that:

- No specific management is required associated with soil salinity.
- Use of soil materials will need to consider mild aggressivity.
- No specific management is required associated with soil dispersion.

6 Limitations

This report is a preliminary geotechnical and acid sulfate soils assessment. 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 implications before recommencement.

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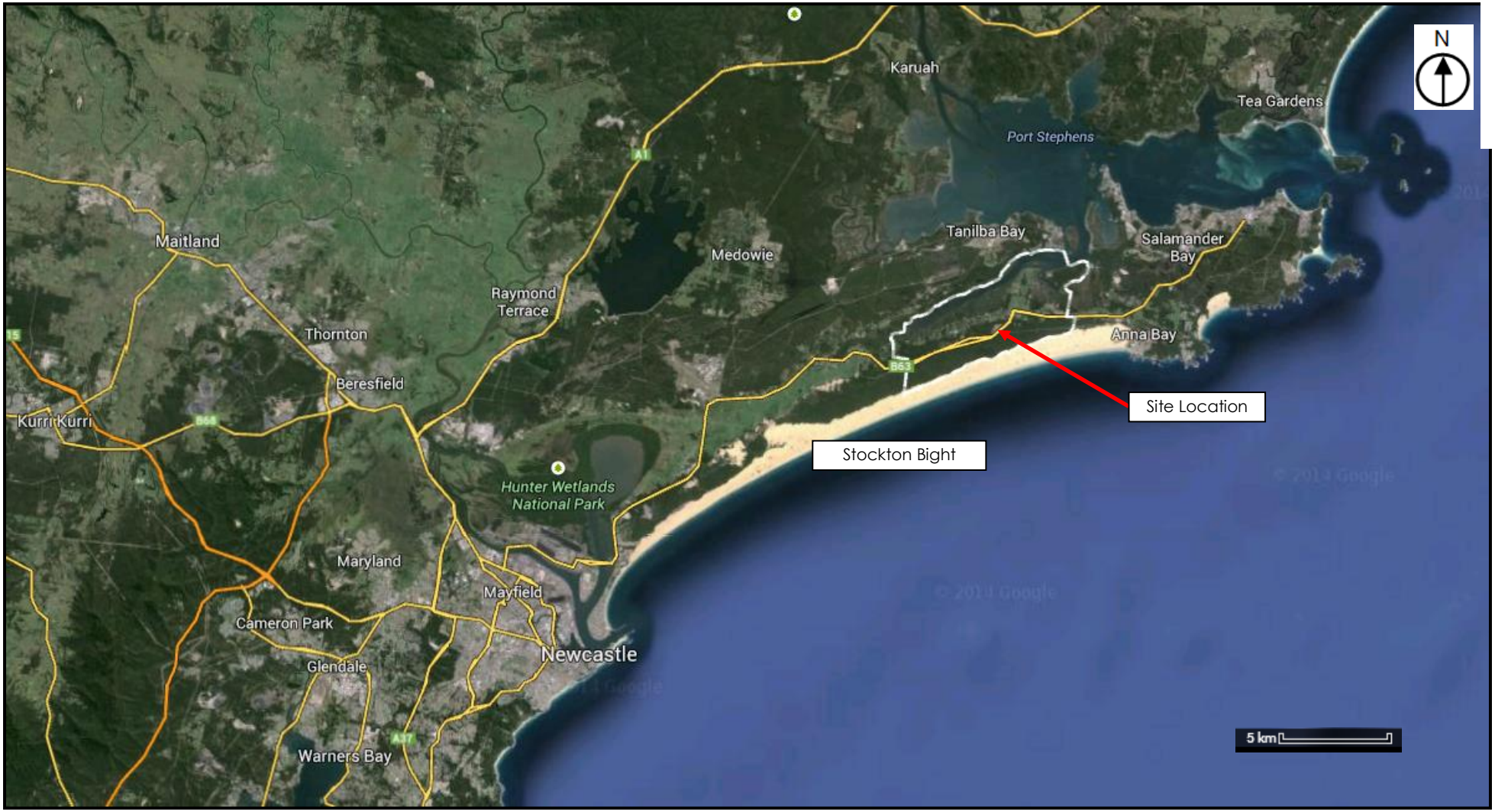
8 Appendix A - Figures



martens

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	GMT	**SITE LOCALITY** **SOURCE: GOOGLE MAPS**	Drawing No: FIGURE 1
Approved:	RE		
Date:	11.08.2014		
Scale:	NA		Job No: P1303897

MARSH ROAD

BAY ROAD

NELSON BAY ROAD

WORIMI NATIONAL PARK

B / B

A / A

KEY

- 15m BUFFER TO SITE BOUNDARY
- POWERLINE TRANSMISSION EASEMENT
- EXTRACTION BATTER (PROPOSED)
- APPROX PROPOSED SITE BOUNDARY
- CROSS SECTION LOCATION (REFER FIGURE 3)

0 50 100 150 200 250

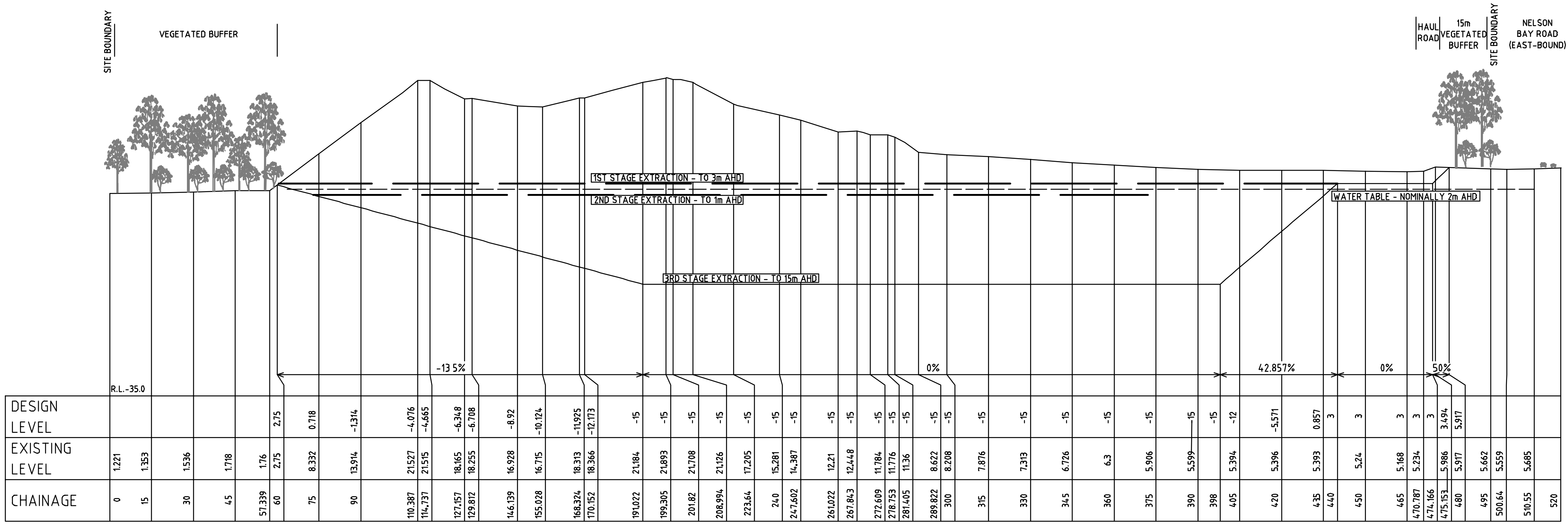
UNITS - METRES

N W E S

SOURCE: NEARMAP 2014.

martens

Martens & Associates Pty Ltd	ABN 85 070 240 890	Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	KT	PLAN OF PROPOSED SAND MINE LOT 254 IN DP 753204, LOT 51 IN DP 1015671 LOT 10 IN DP 1071458 AND LOT 1 IN DP 1082774 3631, 3679 AND 3721 NELSON BAY ROAD AND 774 MARSH ROAD, BOBS FARM, NSW	Drawing No. FIGURE 2
Approved:	GT		
Date:	04.11.14		
Scale @A3:	1:5000	20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767 Email: mail@martens.com.au Internet: http://www.martens.com.au	Project: P1303897 | File: JD03V01 | Revision: A



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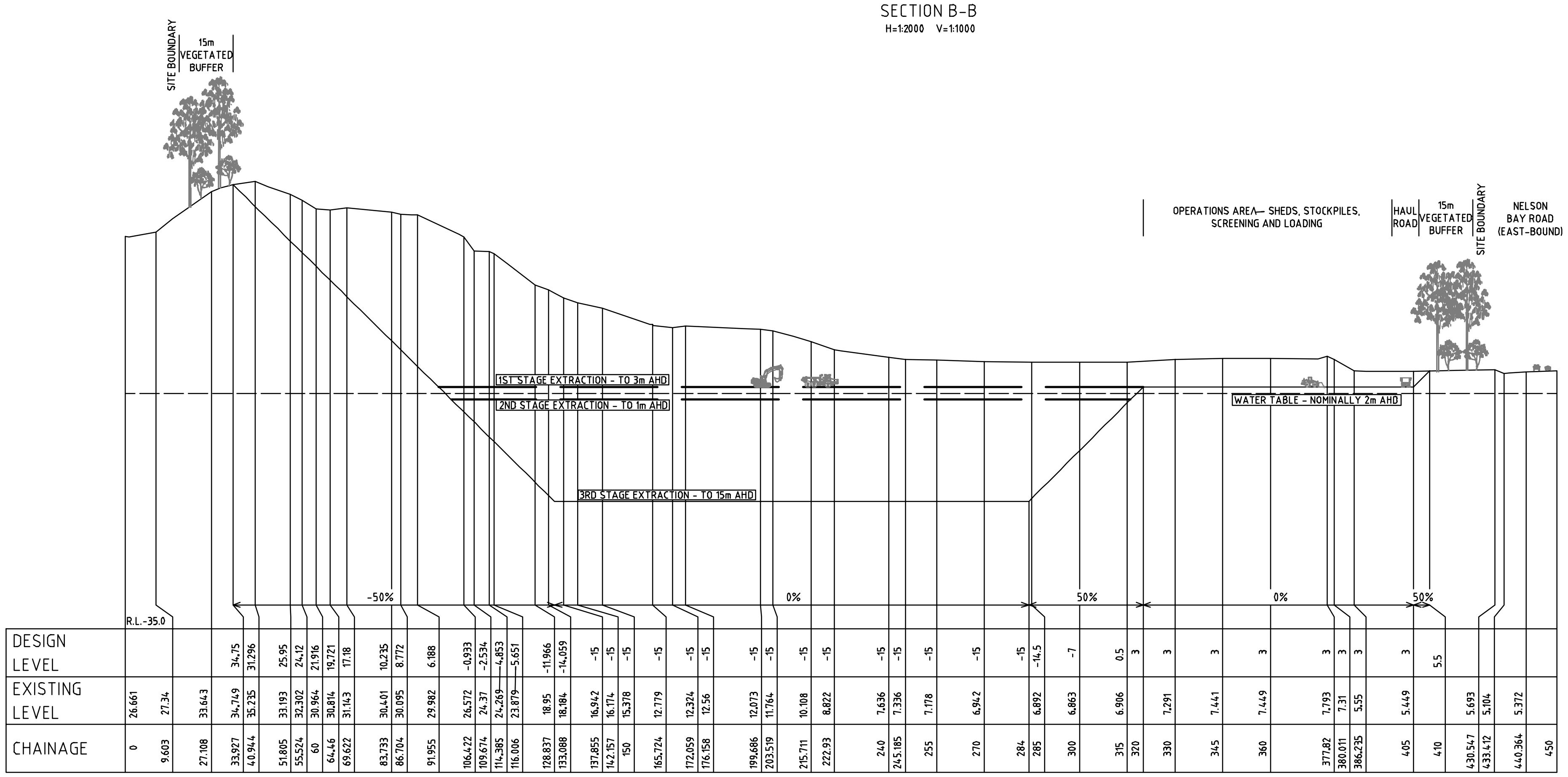

SECTION A-A
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INDICATIVE VOLUMES

STAGE 1	3,000,000m^3
STAGE 2	600,000m^3
STAGE 3	3,700,000m^3

0 20 40 60 80 100
UNITS - METRES

SOURCE: TATTERSALL LANDER PTY LTD.

Martens & Associates Pty Ltd ABN 85 070 240 890	Environment | Water | Wastewater | Geotechnical | Civil | Management
Drawn: KT	**INDICATIVE CROSS SECTIONS LOT 254 IN DP 753204, LOT 51 IN DP 1015671 LOT 10 IN DP 1071458 AND LOT 1 IN DP 1082774 3631, 3679 AND 3721 NELSON BAY ROAD AND 774 MARSH ROAD, BOBS FARM, NSW**
Approved: GT	Drawing No. **FIGURE 3**
Date: 04.11.14	Project: P1303897 File: JD03V01 Revision: A
Scale @A3: 1:2000	20 George St, Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767 Email: mail@martens.com.au Internet: http://www.martens.com.au

Plan of:	Bobs Farm Geology Map	*Location:*	Bobs Farm, Port Stephens	*Projection:*	N/A	*Date:*	2/05/2013	*Version:*	A
				Contour Interval:	N/A	*Sheet:*	1 of 1	*Survey:*	N/A
						Plan By:	TO	*Source:*	N/A
Figure:	TWO	*Council:*	Port Stephens			*Project Manager:*	GVT		
Client:	QMS Pty Ltd	*Scale:*				*Office:*	Thornton	*Our Ref:*	V:\Jobs_EMS Quarry Works\Bobs Farm.cdr

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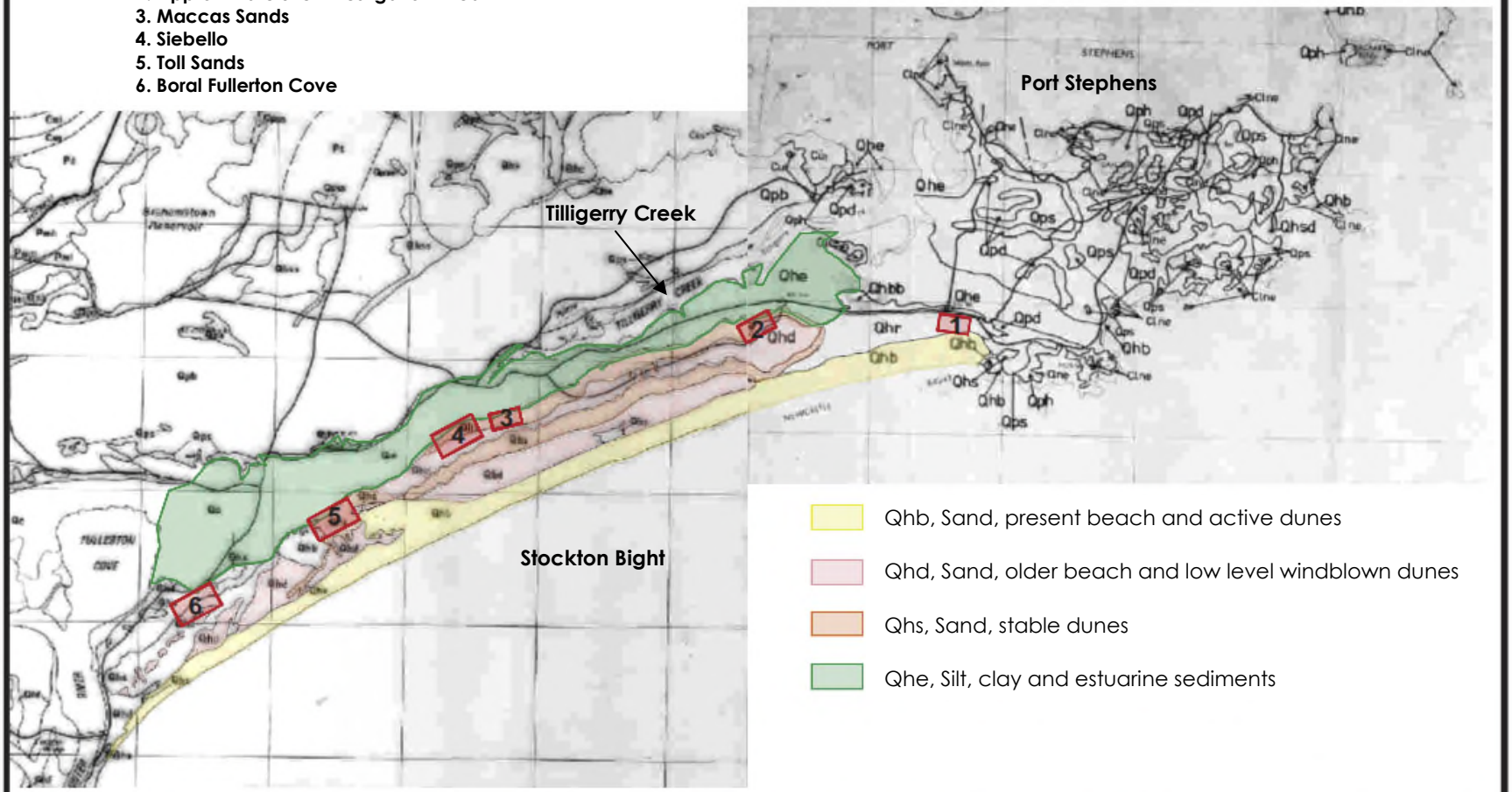
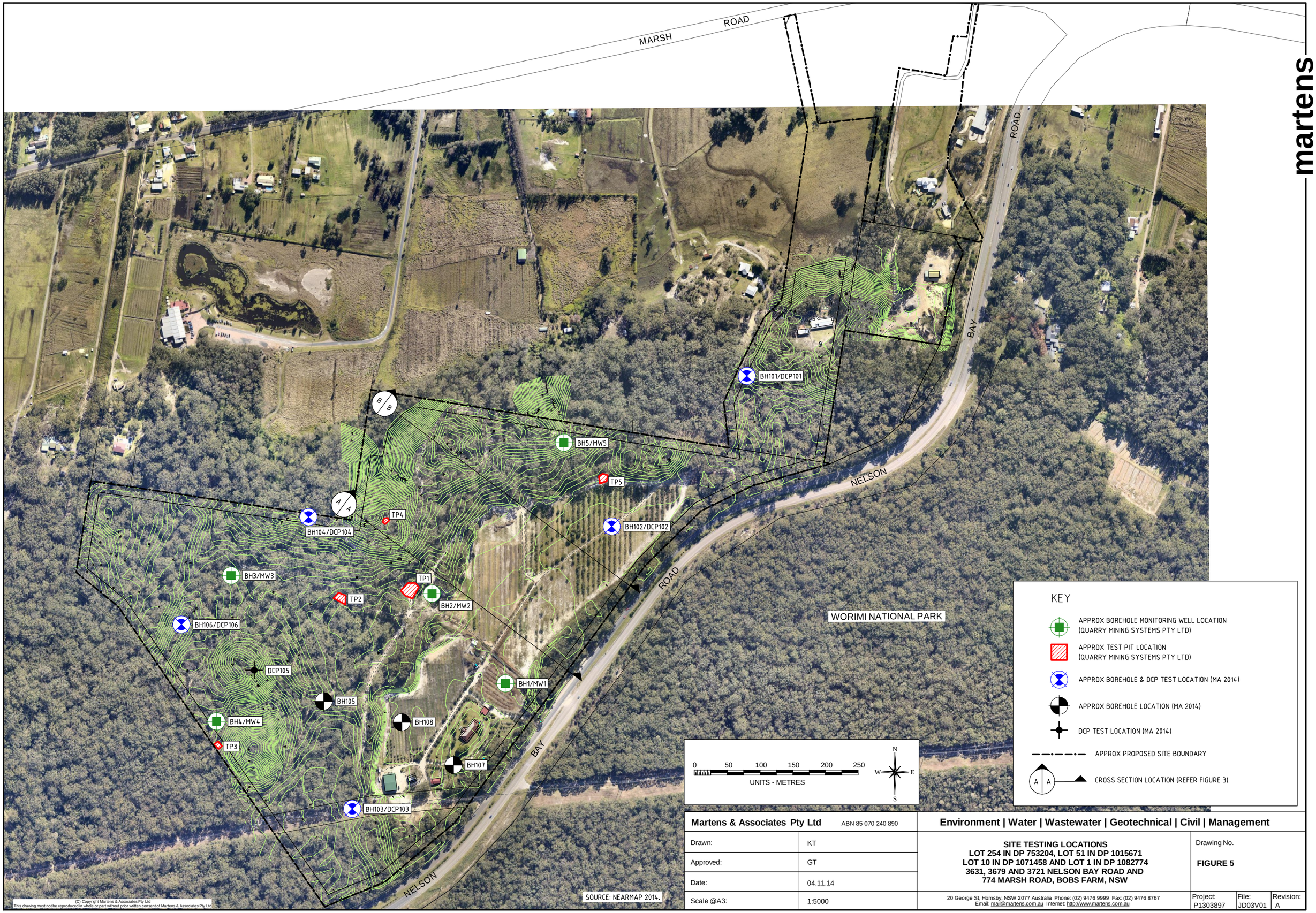
2. Approximate Site Investigation Area
3. Maccas Sands
4. Siebello
5. Toll Sands
6. Boral Fullerton Cove



VGT Pty Ltd 4/30 Glenwood Drive, Thornton NSW 2322 PO Box 2335, Greenhill NSW 2323 ph: (02) 4028 6412 fax: (02) 4028 6413 email: mail@vgt.com.au www.vgt.com.au ABN: 79 103 636 353

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	GMT	**Expected Geology** **SOURCE: VGT Environmental Compliance Services (2013)**	Drawing No: FIGURE 4
Approved:	RE		
Date:	11.08.2014		
Scale:	NA		Job No: P1303897

martens



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Martens & Associates Pty Ltd ABN 85 070 240 890	**Environment | Water | Wastewater | Geotechnical | Civil | Management**
Drawn: KT	**SITE TESTING LOCATIONS** **LOT 254 IN DP 753204, LOT 51 IN DP 1015671** **LOT 10 IN DP 1071458 AND LOT 1 IN DP 1082774** **3631, 3679 AND 3721 NELSON BAY ROAD AND** **774 MARSH ROAD, BOBS FARM, NSW**
Approved: GT	Drawing No. **FIGURE 5**
Date: 04.11.14	
Scale @A3: 1:5000	

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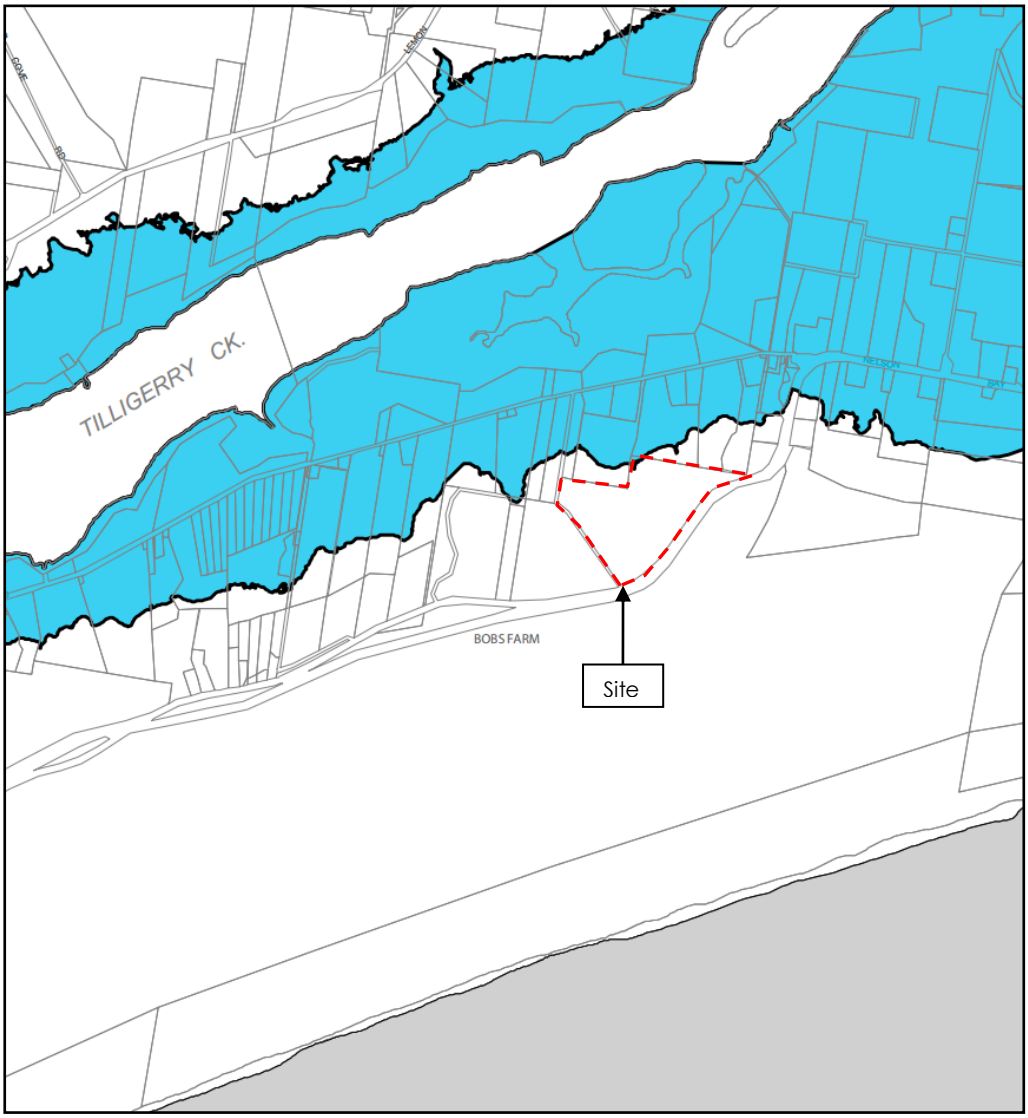
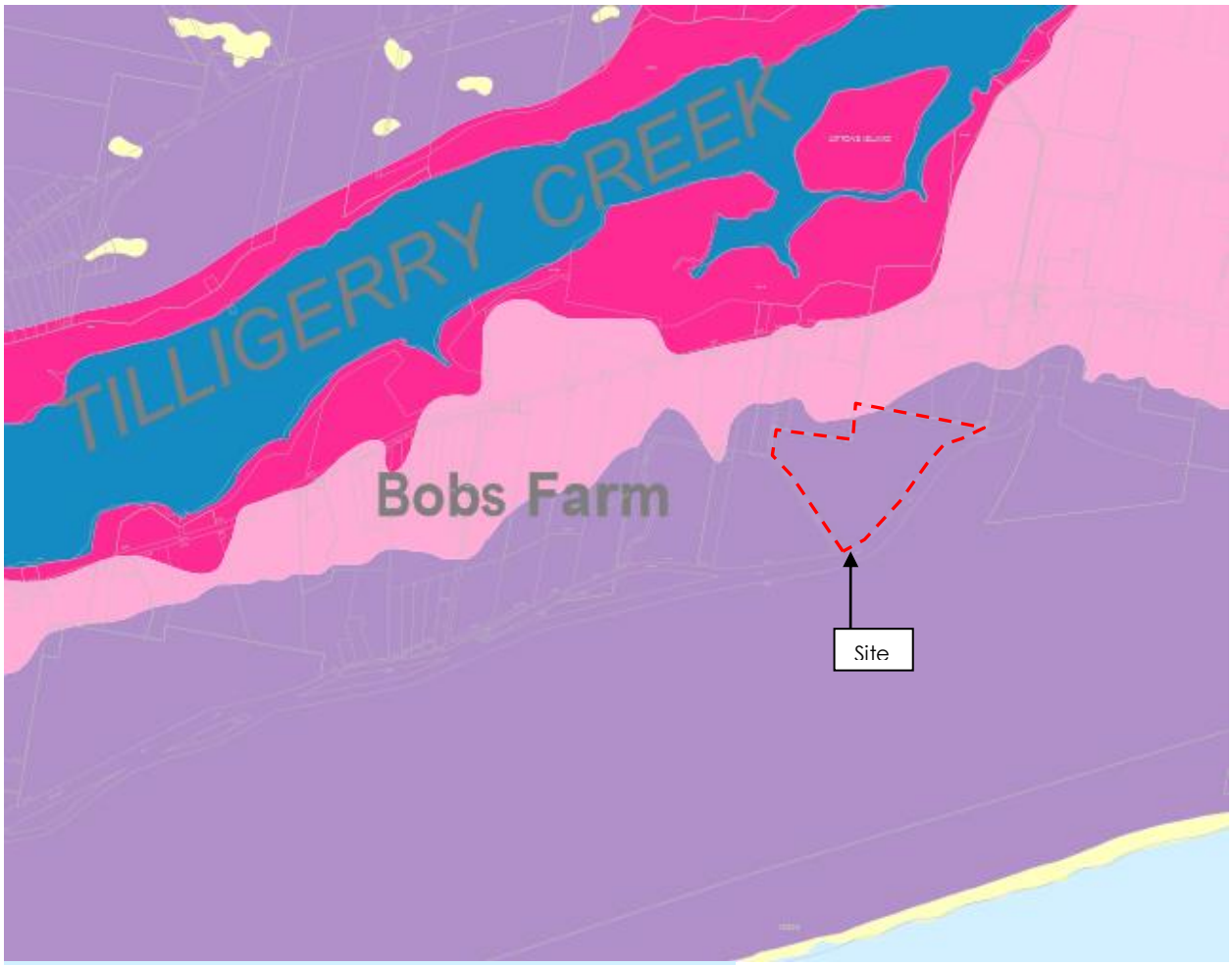
Project:	File:	Revision:
P1303897	JD03V01	A



Flood Planning Land

Flood Planning Area

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	GMT	**Flood Planning Land** **MAPPING BY PORT STEPHENS COUNCIL**	Drawing No: FIGURE 6
Approved:	GT		
Date:	17.09.2014		
Scale:	NA		Job No: P1303897



LEGEND

Acid Sulfate Soil Planning Categories

- (1) Any Works
- (2) Works Below the Ground Surface
- (3) Works Beyond 1m Below the Natural Ground Surface
- (4) Works Beyond 2m Below the Natural Ground Surface
- (5) Works Within 500m of Adjacent Class
- Adjacent Local Government Area
- Ocean

Map prepared by Land Use Planning, Sustainable Planning Group. Printed February, 2007

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	BR	**ACID SULFATE SOIL MAPPING MAPPING BY PORT STEPHENS COUNCIL**	Drawing No: FIGURE 7
Approved:	GT		
Date:	14.09.2014		
Scale:	NA		Job No: P1303897

9 Appendix B – Tables

Table 16: Summary of inferred soil profiles at borehole locations drilled by Quarry Mining Systems Pty Ltd (2013) and Martens and Associates (2014).

		Depth (m BGL[2]) *Elevation (m AHD)*																							
Unit	**Layer[1]**	**BH101[3]**		**BH102[3]**		**BH103[3]**		**BH104[3]**		**BH105[3]**		**BH106[3]**		**BH107[3]**		**BH108[3]**		**BH1[3]**		**BH2[4]**		**BH3[4]**		**BH4[4]**		**BH5**	
Unit 1: Topsoil	SAND with Organics – Grey	0.0	***11.0***	0.0	***5.0***	0.0	***10.0***	0.0	***29.0***	0.0	***12.0***	0.0	***20.0***	0.0	***6.0***	0.0	***6.0***	0.0	***5.8***	0.0	***11.7***	0.0	***15.5***	0.0	***9.5***	0.0	***18.2***
Unit 2: Aeolian Sand	SAND: Light Grey/Grey	0.2	***10.8***	0.3	***4.7***	0.2	***9.8***	0.2	***28.8***	0.3	***11.7***	0.3	***19.7***	NE	***NE***	0.4	***5.6***	NE	***NE***	0.5	***11.2***	0.3	***15.2***	0.2	***9.3***	NE	***NE***
Unit 3: Aeolian Sand	SAND: Orange/ Brown	1.5	***9.5***	2.0	***3.0***	0.9	***9.1***	1.2	***27.8***	1.5	***10.5***	NE	***NE***	NE	***NE***	1.0	***5.0***	1.0	***4.8***	3.5	***8.2***	1.0	***14.5***	NE	***NE***	1.0	***17.2***
	SAND: Yellow/Brown	NE	***NE***	NE	***NE***	NE	***NE***	3.5	***25.5***	NE	***NE***	2.5	***17.5***	0.2	***5.8***	NE	***NE***	NE	***NE***	5.0	***6.7***	4.0	***11.5***	3.0	***6.5***	5.5	***12.7***
	SAND: Light Yellow/White	4.5	***6.5***	3.5	***1.5***	4.8	***5.2***	7.0	***22.0***	3.0	***9.0***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	14.0	***1.5***	NE	***NE***	19.5	***-1.3***
Unit 4: Marine Organic Sand	CLAYEY SAND/CLAY with Organics: – Dark Brown/Grey/ Black	NE	***NE***	4.9	***0.1***	8.0	***2.0***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	3.8	***2.0***	10.5	***1.2***	14.5	***1.0***	5.6	***3.9***	20.0	***-1.8***
	Water Table	11.0	***0.0***	3.5	***2.5***	6.8	***2.2***	NE	***NE***	NE	***NE***	NE	***NE***	4.5	***1.5***	3.5	***2.5***	3.5	***2.3***	10.2	***1.5***	13.2	***2.3***	7.3	***2.2***	15.4	***2.8***
Unit 5: Marine Sand	SAND: Light Brown/Grey	NE	***NE***	6.5	***-1.5***	8.5	***1.5***	NE	***NE***	NE	***NE***	NE	***NE***	4.0	***2.0***	3.5	***2.5***	4.5	***1.3***	NE	***NE***	NE	***NE***	6.5	***3.0***	22.6	***-4.4***
	SAND: Lower Grey Bands	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	NE	***NE***	6.0	***0.0***	6.0	***-0.2***	12.0	***-0.3***	16.0	***-0.5***	11.5	***-2.0***	23.5	***-5.3***
Borehole Depth		13.0	***-2.0***	10.0	***-5.0***	10.0	***0.0***	10.0	***19.0***	10.0	***2.0***	10.0	***10.0***	10.0	***-4.0***	13.0	***-7.0***	19.0	***-13.2***	26.5	***-14.8***	26.5	***-11.0***	24.0	***-14.5***	26.5	***-8.3***

Notes:
[1] Based on visual assessment of drilling spoil. Refer to borehole logs (Appendix C) for more detailed descriptions.
[2] Approximate depths in metres below ground level to top of layer and elevation (RL) of Surface level at borehole location approximated from survey plan; boreholes not surveyed.
[3] Borehole drilled by MA (2014).
[4] Borehole drilled by QMS (2014).
NE = Not encountered or included in bordering unit.

Table 17: Summary of laboratory test results - site groundwater quality[1].

Monitoring Well[2]	Sample date[2]	pH	EC µS/cm	TDS[3] mg/L	TKN mg/L	NOx mg/L	TN mg/L	TP mg/L
MW1	22.08.2013	5.3	500	275	1.9	16	17.9	0.1
MW2	22.08.2013	5.4	490	270	2.3	21	23.3	<0.05
MW3	22.08.2013	5.6	250	138	0.5	0.01	0.51	<0.05
MW4	22.08.2013	5.2	190	105	0.3	<0.005	0.3	<0.05
MW5	22.08.2013	6.0	270	149	1.7	0.86	1.7	0.07

Notes:
[1] Refer to Appendix E for laboratory certificates.
[2] Samples collected by MA from groundwater monitoring wells installed by QMS.
[3] TDS = total dissolved solids, estimated from EC * 0.55 (South Australian Murray-Darling Basin Natural Resources Management Board).

Table 18: ASS (sPOCAS) testing results. (Samples exceeding the ASSMAC action criteria are highlighted).

Sample ID	Sample Depth (mAHD) [2]	Material Type [1]	pH_{KCL} [3]	pH_{ox} [3]	TPA (mol H+/t) [4]	TSA (mol H+/t) [5]	S_{POS} (%) [6]	Assessment [7]	Recommended Liming Rate [9] (kg $CaCO_3$/t)
Assessment Criteria		(F) Fine grained. > 40 % clay.	≤ 4 = AASS	< 3.5 = PASS	62	62	0.100	TPA, TSA, S_{POS} > criteria = PASS. Exposed soil >1000t, used coarse grained material criteria.	
		(M) Medium grained. 5-40 % clay.		pHK_{CL}-pH_{OX}>1 = PASS	36	36	0.060		
		(C) Coarse grained. < 5 % Clay.			18	18	0.030		
3897/101/2.5	8.5	C	5.0	4.4	5	5	0.005	NA	<0.75
3897/101/8.5	2.5	C	5.6	4.3	5	5	0.005	NA	<0.75
3897/101/13.0	-2.0	C	5.4	5.7	5	5	0.005	NA	<0.75
3897/102/2.5	2.5	C	4.6	3.5	5	5	0.005	NA	0.9
3897/102/5.0	0.0	M	4.8	2.1	190	180	0.260	PASS	13
3897/102/7.0	-2.0	C	5.1	2.7	47	40	0.100	PASS	5
3897/103/2.5	7.5	C	5.4	4.2	5	5	0.005	NA	<0.75
3897/103/8.0	1.0	C	5.0	2.5	25	20	0.050	PASS	2.6
3897/103/10.0	0.0	C	5.4	3.3	12	10	0.040	PASS	2.1
3897/104/2.5	26.5	C	5.0	4.5	5	5	0.005	NA	<0.75
3897/104/10.0	19.0	C	5.7	5.0	5	5	0.005	NA	<0.75
3897/105/2.5	9.5	C	5.2	3.9	5	5	0.005	NA	<0.75
3897/105/10.0	2.0	C	5.5	5.5	5	5	0.005	NA	<0.75
3897/106/5.5	14.5	C	5.6	5.1	5	5	0.005	NA	<0.75
3897/106/10.0	10.0	C	5.2	4.7	5	5	0.005	NA	<0.75
3897/107/5.5	0.5	C	5.2	6.3	5	5	0.005	NA	<0.75
3897/107/10.0	-4.0	C	5.2	4.0	5	5	0.005	NA	<0.75
3897/108/2.5	3.5	C	4.5	3.4	22	12	0.005	PASS	0.75
3897/108/5.5	0.5	C	5.3	5.2	5	5	0.010	NA	0.93
3897/108/8.5	-2.5	C	5.2	2.8	35	30	0.060	PASS	3.1
3897/108/13.0	-7.0	C	5.2	2.8	35	32	0.050	PASS	2.8
3897/BH03/+12.5 to +11.5	+12.5 to +11.5	C	4.8	3.9	30	20	<0.005	PASS	0.75
3897/BH03/+6.5 to +5.5	+6.5 to +5.5	C	5.4	4.5	<5	<5	<0.005	NA	<0.75
3897/BH03/+1.5 to +0.5	+1.5 to +0.5	F	5.6	4.5	<5	<5	<0.005	NA	<0.75
3897/BH03/-0.5 to -1.1	-0.5 to -1.1	C	5.6	4.4	10	7	<0.005	NA	<0.75
3897/BH03/-1.3 to -1.5	-1.3 to -1.5	C	5.4	3.2	250	240	0.080	PASS	4.6
3897/BH03/-1.3	-1.3	C	5.2	2.7	460	450	0.130	PASS	7
3897/BH03/-3.1	-3.1	C	4.5	2.3	360	340	0.510	PASS	25
3897/BH03/-13	-13.0	C	5.3	3.3	27	25	0.030	PASS	1.5
3897/BH04/+5.5 to +3.0	+5.5 to +3.0	C	5.2	4.3	17	12	<0.005	NA	<0.75
3897/BH04/+3.3 to +2.5	+3.3 to +2.5	C	5.3	4.5	17	15	<0.005	NA	<0.75
3897/BH04/+0.8 to +0.5	+0.8 to +0.5	C	4.9	3.8	37	27	<0.005	PASS	0.75
3897/BH04/-0.5 to -1.5	-0.5 to -1.5	C	5.3	4.4	12	7	<0.005	NA	<0.75
3897/BH04/-2.5 to -3.0	-2.5 to -3.0	C	5.5	4.4	17	16	<0.005	NA	<0.75
3897/BH04/-6.0 to -7.5	-6.0 to -7.5	C	5.3	3.4	27	26	0.020	PASS	1.2
3897/BH04/-11.0 to -13.5	-11.0 to -13.5	C	5.4	3.8	20	19	0.020	PASS	0.93
3897/BH04/-13.5 to -12.1	-13.5 to -12.1	C	5.4	3.7	20	17	0.020	NA	0.92
3897/BH05/+2.0 to +1.0	+2.0 to +1.0	C	5.5	4.5	12	10	<0.005	NA	<0.75
3897/BH05/+0.0 to -0.5	+0.0 to -0.5	C	4.4	3.4	47	40	<0.005	PASS	<0.75
3897/BH05/+0.0 to -1.0	+0.0 to -1.0	C	5.3	4.5	7	<5	<0.005	NA	<0.75
3897/BH05/-1.1 to -1.5	-1.1 to -1.5	C	5.7	4.5	5	<5	<0.005	NA	<0.75
3897/BH05/-1.5 to -2.0	-1.5 to -2.0	F	5.6	4.6	<5	<5	<0.005	NA	<0.75
3897/BH05/-2.5 to -3.0	-2.5 to -3.0	F	5.6	4.4	<5	<5	<0.005	NA	<0.75
3897/BH05/-5	-5.0	C	5.9	2.2	1500	1500	2.6	PASS	120
3897/BH05/-5.5	-5.5	C	7.9	4.1	120	120	1.4	PASS	28
3897/BH05/-6.5	-6.50	C	7.0	2.2	820	820	1.5	PASS	65
3897/BH05/-7.5	-7.50	C	8.1	2.9	67	67	0.2	PASS	6.6

Notes:

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

[2] Metres above Australian Height Datum. Surface level at borehole location approximated from survey plan; boreholes not surveyed.

[3] pH (actual acidity).

[4] pH after oxidation with peroxide (potential acidity).

[5] Titratable Peroxide Acidity (Moles H^+/tonne).

[6] Titratable Sulfidic Acidity (Moles H^+/tonne). [5] Oxidisable sulphur (%). [6] ASSMAC (1998) p.27, for >1,000 tonnes disturbed soil. [7] Soil samples are clay – all other samples are sand.

[7] Percentage oxidisable sulphur.

[8] NA = not AASS or PASS, AASS = Actual Acid Sulfate Soil, PASS = Potential Acid Sulfate Soil.

[9] Refer to laboratory certificates (Appendix E).

10 Appendix C – Borehole Logs

CLIENT	Ammos Resource Management Pty Ltd	COMMENCED	29/07/14	COMPLETED	29/07/14	**REF**	**BH101**
PROJECT	Acid Sulphate Soils & Geotechnical Assessment	LOGGED	GMT/BR	CHECKED	RE	Sheet	1 of 1
SITE	3631, 3679 & 3721 Nelson Bay Rd & 774 Marsh Rd, Bobs Farm, NSW	GEOLOGY	Aeolian Sand	VEGETATION	NA	PROJECT NO.	P1303897
EQUIPMENT	4WD Truck Mounted Hydraulic Auger	EASTING	NA	RL SURFACE	Approx 11m AHD		
EXCAVATION DIMENSIONS	Ø95mm X 13.0m depth	NORTHING	NA	ASPECT	South South West	SLOPE	5%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION (SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour, strength, weathering.)	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.2			SP	SAND - Medium grained, light grey/grey, with minor organics, rootlets.		VL			- TOPSOIL - AEOLIAN
				1.0			SP	SAND - Medium grained, light yellow/white.		VL			1.0
				1.5				Grading to					- AEOLIAN
				2.0									2.0
											A	2.5	3897/101/ 2.5
				3.0			SP	light brown/orange/ light yellow.		L			3.0
				4.0									4.0
				4.5				Grading to					- AEOLIAN
				5.0						MD			5.0
											A	5.5	3897/101/ 5.5
				6.0									6.0
V	Nil	N	M	7.0									7.0
				8.0									8.0
											A	8.5	3897/101/ 8.5
				9.0			SP	light yellow/white.		L			9.0
				10.0							A	10.0	3897/101/ 10.0
		11.0 ▽		11.0									- Groundwater at ~11.0m.
		Y	W	12.0									12.0
				13.0							A	13.0	3897/101/ 13.0
								Borehole terminated at 13.0m in sand.					
				14.0									14.0
				15.0									15.0
				16.0									16.0
				17.0									17.0
				18.0									18.0

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

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

DRILLING RESISTANCE
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)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

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	Ammos Resource Management Pty Ltd	**COMMENCED**	29/07/14	**COMPLETED**	29/07/14	**REF**	**BH102**
PROJECT	Acid Sulphate Soils & Geotechnical Assessment	**LOGGED**	GMT/BR	**CHECKED**	RE	**Sheet**	1 of 1
SITE	3631, 3679 & 3721 Nelson Bay Rd & 774 Marsh Rd, Bobs Farm, NSW	**GEOLOGY**	Aeolian Sand	**VEGETATION**	NA	**PROJECT NO.**	P1303897
EQUIPMENT	4WD Truck Mounted Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	Approx 6m AHD		
EXCAVATION DIMENSIONS	Ø95mm X 10.0m depth	**NORTHING**	NA	**ASPECT**	South East	**SLOPE**	2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour, strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.3			SP	SAND - Medium grained, grey/black, minor organics and rootlets.		VL			- TOPSOIL
													- AEOLIAN
V	Nil	N	M	1.0			SP	SAND - Medium grained, light grey/yellow/white.		L	A	1.5	3897/102/ 1.5
				2.0									- AEOLIAN
							SP	Grading to orange/brown.		L	A	2.5	3897/102/ 2.5
				3.0									
		3.5 ▽		3.5									- Groundwater at ~3.5m.
								Grading to					- AEOLIAN
				4.0							A	4.0	3897/102/ 4.0
V	Nil	Y	W				SP	yellow/white.		VL			
				4.9									
				5.0							A/B	5.0	3897/102/ 5.0 - MARINE
V	Nil	Y	W	6.0			SC	Clayey SAND - Medium grained, grey with sandy clay layers, dark grey.		MD			
				6.5									- MARINE
				7.0							A/B	7.0	3897/102/ 7.0
											A	7.5	3897/102/ 7.5
				8.0									
V	Nil	Y	W				SP	SAND - Medium grained, light grey, inferred dense.		D			
											A	8.5	3897/102/ 8.5
				9.0									
				10.0							A	10.0	3897/102/ 10.0
								Borehole terminated at 10.0m in sand.					
				11.0									
				12.0									
				13.0									
				14.0									
				15.0									
				16.0									
				17.0									
				18.0									

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

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

DRILLING RESISTANCE
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)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

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	Ammos Resource Management Pty Ltd	**COMMENCED**	29/07/14	**COMPLETED**	29/07/14	**REF**	**BH103**
PROJECT	Acid Sulphate Soils & Geotechnical Assessment	**LOGGED**	GMT/BR	**CHECKED**	RE	**Sheet**	1 of 1
SITE	3631, 3679 & 3721 Nelson Bay Rd & 774 Marsh Rd, Bobs Farm, NSW	**GEOLOGY**	Aeolian Sand	**VEGETATION**	NA	**PROJECT NO.**	P1303897
EQUIPMENT	4WD Truck Mounted Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	Approx 9m AHD		
EXCAVATION DIMENSIONS	Ø95mm X 10.0m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour, strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.2			SP	SAND - Medium grained, dark grey, some organics, rootlets.		VL			- TOPSOIL
				0.9			SP			L	A/B	0.5	3897/103/ 0.5 - AEOLIAN
				1.0				SAND - Medium grained, light grey.					- AEOLIAN 1.0
								Grading to		L	A/B	1.5	3897/103/ 1.5
				2.0									2.0
											A	2.5	3897/103/ 2.5
				3.0			SP	yellow/orange.		MD			3.0
V	Nil	N	M	4.0							A	4.0	3897/103/ 4.0 4.0
				4.8									
				5.0				Grading to					- AEOLIAN 5.0
											A	5.5	3897/103/ 5.5
				6.0									6.0
		6.8					SP	yellow/white.		L			- Groundwater at 6.8m.
				7.0							A/B	7.0	3897/103/ 7.0 7.0
		Y	W								A	7.5	3897/103/ 7.5
				8.0							A	8.0	3897/103/ 8.0 8.0
V	Nil	Y	W				SP	SAND - With minor organics, medium grained, inferred medium dense, dark brown.		MD			- MARINE
				8.5									- MARINE
				9.0									9.0
V	Nil	Y	W				SP	SAND - Medium grained, inferred medium dense, brown/light brown.		MD			
				10.0							A/B	10.0	3897/103/ 10.0 10.0
								Borehole terminated at 10.0m in sand.					
				11.0									11.0
				12.0									12.0
				13.0									13.0
				14.0									14.0
				15.0									15.0
				16.0									16.0
				17.0									17.0
				18.0									18.0

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

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

DRILLING RESISTANCE
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)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

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	Ammos Resource Management Pty Ltd	**COMMENCED**	30/07/14	**COMPLETED**	30/07/14	**REF**	**BH104**
PROJECT	Acid Sulphate Soils & Geotechnical Assessment	**LOGGED**	GMT/BR	**CHECKED**	RE	**Sheet**	1 of 1
SITE	3631, 3679 & 3721 Nelson Bay Rd & 774 Marsh Rd, Bobs Farm, NSW	**GEOLOGY**	Aeolian Sand	**VEGETATION**	NA	**PROJECT NO.**	P1303897
EQUIPMENT	4WD Truck Mounted Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	27m AHD		
EXCAVATION DIMENSIONS	Ø95mm X 10.0m depth	**NORTHING**	NA	**ASPECT**	South South West	**SLOPE**	2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour, strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.2			SP	SAND - Medium grained, dark grey/grey, minor organics.		MD			- TOPSOIL
							SP	SAND - Medium grained, light grey/grey.		L	A	0.5	3897/104/ 0.5 - AEOLIAN
				1.0									1.0
				1.2				Grading to					- AEOLIAN
				2.0									2.0
							SP	orange/brown.		L	A	2.5	3897/104/ 2.5
				3.0									3.0
				3.5				Grading to					- AEOLIAN
				4.0									4.0
V	Nil	N	M										
				5.0			SP	yellow/brown.		L	A	5.5	3897/104/ 5.5
				6.0									6.0
				7.0				Grading to					- AEOLIAN 7.0
				8.0									8.0
							SP	light yellow white.		L			
				9.0									9.0
										MD			
				10.0							A	10.0	3897/104/ 10.0 10.0
								Borehole terminated at 10.0m in sand.					
				11.0									11.0
				12.0									12.0
				13.0									13.0
				14.0									14.0
				15.0									15.0
				16.0									16.0
				17.0									17.0
				18.0									18.0

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

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

DRILLING RESISTANCE
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)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

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	Ammos Resource Management Pty Ltd	**COMMENCED**	30/07/14	**COMPLETED**	30/07/14	**REF**	**BH105**
PROJECT	Acid Sulphate Soils & Geotechnical Assessment	**LOGGED**	GMT/BR	**CHECKED**	RE	**Sheet**	1 of 1
SITE	3631, 3679 & 3721 Nelson Bay Rd & 774 Marsh Rd, Bobs Farm, NSW	**GEOLOGY**	Aeolian Sand	**VEGETATION**	NA	**PROJECT NO.**	P1303897
EQUIPMENT	4WD Truck Mounted Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	Approx 15m AHD		
EXCAVATION DIMENSIONS	Ø95mm X 10.0m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	2-4%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour, strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.3			SP	SAND - Medium grained, dark grey, minor organics.		L			- TOPSOIL
											A	0.5	3897/105/ 0.5 - AEOLIAN
				1.0			SP	SAND - Medium grained, light grey/orange.		L			1.0
				1.5				Grading to					- AEOLIAN
				2.0						L			2.0
							SP	brown/orange.					
										VL	A	2.5	3897/105/ 2.5
				3.0				Grading to					- AEOLIAN
				4.0									4.0
V	Nil	N	M	5.0									5.0
											A	5.5	3897/105/ 5.5
				6.0									6.0
							SP	light yellow/white.		VL			
				7.0									7.0
				8.0									8.0
				9.0									9.0
				10.0							A	10.0	3897/105/ 10.0 10.0
								Borehole terminated at 10.0m in sand.					
				11.0									11.0
				12.0									12.0
				13.0									13.0
				14.0									14.0
				15.0									15.0
				16.0									16.0
				17.0									17.0
				18.0									18.0

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

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

DRILLING RESISTANCE
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)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

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	**Ammos Resource Management Pty Ltd**	**COMMENCED**	30/07/14	**COMPLETED**	30/07/14	**REF**	**BH106**
PROJECT	**Acid Sulphate Soils & Geotechnical Assessment**	**LOGGED**	GMT/BR	**CHECKED**	RE	**Sheet**	**1 of 1**
SITE	**3631, 3679 & 3721 Nelson Bay Rd & 774 Marsh Rd, Bobs Farm, NSW**	**GEOLOGY**	Aeolian Sand	**VEGETATION**	NA	**PROJECT NO.**	P1303897
EQUIPMENT	4WD Truck Mounted Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	Approx 20m AHD		
EXCAVATION DIMENSIONS	Ø95mm X 10.0m depth	**NORTHING**	NA	**ASPECT**	South South West	**SLOPE**	2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour, strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.3			SP	SAND - Medium grained, beige.		VL			- TOPSOIL
										L	A	0.5	3897/106/0.5 - AEOLIAN
				1.0									
				1.5						MD			
				2.0									
											A	2.5	3897/106/2.5
				3.0						L			
				4.0									
V	Nil	N	M	5.0			SP	SAND - Medium grained, yellow tending to light yellow between 2.5m trace mineral bands <5mm thick, dark grey		MD			
											A	5.5	3897/106/5.5
				6.0									
				7.0									
				8.0									
				9.0									
				10.0							A	10.0	3897/106/10.0
								Borehole terminated at 10.0m in sand.					
				11.0									
				12.0									
				13.0									
				14.0									
				15.0									
				16.0									
				17.0									
				18.0									

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

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

DRILLING RESISTANCE
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)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

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

Quality Sheet No. 4

CLIENT	Ammos Resource Management Pty Ltd	**COMMENCED**	30/07/14	**COMPLETED**	30/07/14	**REF**	**BH107**
PROJECT	Acid Sulphate Soils & Geotechnical Assessment	**LOGGED**	GMT/BR	**CHECKED**	RE	**Sheet**	1 of 1
SITE	3631, 3679 & 3721 Nelson Bay Rd & 774 Marsh Rd, Bobs Farm, NSW	**GEOLOGY**	Aeolian Sand	**VEGETATION**	NA	**PROJECT NO.**	P1303897
EQUIPMENT	4WD Truck Mounted Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	Approx 6m AHD		
EXCAVATION DIMENSIONS	Ø95mm X 10.0m depth	**NORTHING**	NA	**ASPECT**	South East	**SLOPE**	2%

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour, strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.2			SP	SAND - Medium grained, minor organics and rootlets.		VL			- TOPSOIL - AEOLIAN
				1.0									1.0
				2.0			SP	SAND - Medium grained, light brown/yellow/orange.		L			2.0
				3.0									3.0
		N	M	4.0									4.0
		4.5 ▽						Grading to					- MARINE - Hole collapsed groundwater back to 4.5m.
V	Nil	Y	W	5.0							A/B	5.5	3897/107/5.5 5.0
				6.0						L			6.0
				7.0			SP	yellow/light grey.			A	7.0	3897/107/7.0 7.0
				8.0									8.0
											A	8.5	3897/107/8.5
				9.0						MD			9.0
				10.0							A	10.0	3897/107/10.0 10.0
								Borehole terminated at 10.0m in sand.					
				11.0									11.0
				12.0									12.0
				13.0									13.0
				14.0									14.0
				15.0									15.0
				16.0									16.0
				17.0									17.0
				18.0									18.0

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

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

DRILLING RESISTANCE
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)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

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	**Ammos Resource Management Pty Ltd**	**COMMENCED**	29/07/14	**COMPLETED**	29/07/14	**REF**	**BH108**
PROJECT	**Acid Sulphate Soils & Geotechnical Assessment**	**LOGGED**	GMT/BR	**CHECKED**	RE	**Sheet**	**1 of 1**
SITE	**3631, 3679 & 3721 Nelson Bay Rd & 774 Marsh Rd, Bobs Farm, NSW**	**GEOLOGY**	Aeolian Sand	**VEGETATION**	NA	**PROJECT NO.**	P1303897
EQUIPMENT	4WD Truck Mounted Hydraulic Auger	**EASTING**	NA	**RL SURFACE**	Approx 6m AHD		
EXCAVATION DIMENSIONS	Ø95mm X 13.0m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	0-2%

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	DRILLING RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	MATERIAL DESCRIPTION SOIL NAME, plasticity or particle characteristics, colour, secondary and minor components, moisture condition, consistency/relative density, ROCK NAME, grain size, texture/fabric, colour, strength, weathering.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
V	Nil	N	M	0.4			SP	SAND - Medium grained, grey/light grey, minor organics.		VL			- TOPSOIL
							SP	SAND - Medium grained, light grey.		VL	A	0.5	3897/108/0.5 - AEOLIAN
				1.0				Grading to					- AEOLIAN
				2.0			SP	light grey and brown.		L			
											A	2.5	3897/108/2.5
		3.5		3.0									
				3.5									- Groundwater at 3.5m.
								Grading to					- MARINE
				4.0			SP	brown.		MD			
				5.0							A	5.5	3897/108/5.5
				6.0				Grading to					- MARINE
V	Nil	Y	W	7.0						L			
				8.0							A	8.5	3897/108/8.5
				9.0			SP	grey.					
				10.0									
				11.0						MD			
				12.0									
				13.0							A	13.0	3897/108/13.0
								Borehole terminated at 13.0m in sand.					
				14.0									
				15.0									
				16.0									
				17.0									
				18.0									

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

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

DRILLING RESISTANCE
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)
pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

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

11 Appendix D – DCP Testing Results

Dynamic Cone Penetrometer Test Log Summary

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Site	51 Nelson Bay Road, Bobs Farm		
Client	AMMOS Resource Management Pty Ltd		
Logged by	GMT/BR	**Date Logged**	29/07/2014
Checked by	RE	**Date Checked**	
Comments			

TEST DATA

Depth Interval (m)	DCP 101	DCP 102	DCP 103	DCP 104	DCP 105	DCP 106		
0.15	1	1	1	5	1	1		
0.30	1	2	2	4	2	2		
0.45	2	3	4	4	2	3		
0.60	1	5	4	5	3	3		
0.75	1	4	4	4	4	4		
0.90	1	5	3	5	4	5		
1.05	1	3	3	6	2	5		
1.20	2	4	3	5	3	5		
1.35	3	6	4	5	3	6		
1.50	2	4	4	5	3	8		
1.65	4	4	5	5	2	9		
1.80	4	3	4	5	2	6		
1.95	4	3	4	5	2	6		
2.10	4	5	5	5	2	6		
2.25	4	4	6	4	2	7		
2.40	3	7	10	3	2	8		
2.55	3	4	15	3	2	7		
2.70	3	5	16	5	2	6		
2.85	4	3	14	5	2	5		
3.00	4	5	13	5	2	5		
3.15	4	4	14	5	3	5		
3.30	3	4	13	8	3	6		
3.45	3	4	10	8	2	6		
3.60	4	1	8	7	3	6		
3.75	5	2	10	6	3	7		
3.90	5	1	10	4	2	7		
4.05	6	1	9	4	2	7		
4.20	5	1	8	3	2	6		
4.35	10	2	8	4	3	8		
4.50	13	2	8	3	2	12		
4.65	12	2	8	3	2	9		
4.80	9	3	9	4	2	9		
4.95	9	7	8	4	2	12		
5.10	11	8	8	5	2	12		
5.25	9	8	8	5	2	15		
5.40	6	11	7	6	3	12		
5.55	6	12	8	7	3	15		
5.70	5	15	7	5	3	11		
5.85	6	16	7	6	3	17		
6.00	6	19	8	7	3	22		
6.15	6	21	8	9	3	19		
6.30	5	24	8	9	3	18		
6.45	6	25	8	9	2	16		
6.60	5	26	7	8	3	25		
6.75	6	25	5	7	3	20		
6.90	5	30	4	7	3	27		
7.05	6	Terminiated	5	6	3	30		
7.20	5	@	5	6	3	25		
7.35	5	6.9 m	9	5	4	15		
7.50	6		8	7	4	20		
7.65	7		9	5	4	17		
7.80	7		18	7	4	17		
7.95	7		25	4	4	18		
8.10	8		30	5	3	11		
8.25	9		18	10	4	9		
8.40	9		22	10	4	18		
8.55	8		40	12	4	15		
8.70	9		Terminiated	11	4	21		
8.85	9		@	13	4	18		
9.00	12		8.55 m	16	5	14		
9.15	11			12	3	10		
9.30	7			18	4	12		
9.45	10			18	5	25		
9.60	10			25	5	35		
9.75	9			20	5	39		
9.90	6			26	5	40		
10.05	7			29	5	Terminiated		
10.20	8			Terminiated	Terminiated	@		
10.35	8			@	@	9.9 m		
10.50	8			10.05 m	10.05 m			
	Terminiated							
	@							
	10.5 m							

12 Appendix E – Laboratory Certificates

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 96132

Client:

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

Attention: Ben Rose, Gray Taylor

Sample log in details:

Your Reference:	**P1303897, Bobs Farm**		
No. of samples:	5 waters		
Date samples received / completed instructions received	23/08/13	/	23/08/13

This report replaces the previous R00 report due to the addition of pH results

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:	30/08/13	/	8/01/14
Date of Preliminary Report:	Not issued		

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Results Approved By:

Jacinta Hurst
Laboratory Manager

Ion Balance Our Reference: Your Reference Date Sampled Type of sample	UNITS ---------- ----------	96132-1 3897/GMB01 22/08/2013 water	96132-2 3897/GMB02 22/08/2013 water	96132-3 3897/GMB03 22/08/2013 water	96132-4 3897/GMB04 22/08/2013 water	96132-5 3897/GMB05 22/08/2013 water
Date prepared	-	24/08/2013	24/08/2013	24/08/2013	24/08/2013	24/08/2013
Date analysed	-	24/08/2013	24/08/2013	24/08/2013	24/08/2013	24/08/2013
Calcium - Dissolved	mg/L	20	13	1.9	1.0	7.3
Potassium - Dissolved	mg/L	47	57	2.2	1.6	9.7
Sodium - Dissolved	mg/L	28	23	32	26	22
Magnesium - Dissolved	mg/L	16	13	4.0	3.2	7.8
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	7	7	8	<5	19
Carbonate Alkalinity as $CaCO_3$	mg/L	<5	<5	<5	<5	<5
Total Alkalinity as $CaCO_3$	mg/L	7	7	8	<5	19
Sulphate, SO4	mg/L	77	57	11	9	25
Chloride, Cl	mg/L	88	37	54	43	40
Ionic Balance	%	6.1	27	-1.3	1.9	4.4

Miscellaneous Inorganics						
Our Reference:	UNITS	96132-1	96132-2	96132-3	96132-4	96132-5
Your Reference	----------	3897/GMB01	3897/GMB02	3897/GMB03	3897/GMB04	3897/GMB05
Date Sampled	----------	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
Type of sample		water	water	water	water	water
Date prepared	-	24/08/2013	24/08/2013	24/08/2013	24/08/2013	24/08/2013
Date analysed	-	24/08/2013	24/08/2013	24/08/2013	24/08/2013	24/08/2013
pH	pH Units	5.3	5.4	5.6	5.2	6.0
Electrical Conductivity	µS/cm	500	490	250	190	270
Total Dissolved Solids (grav)	mg/L	310	[NA]	[NA]	[NA]	[NA]
Total Suspended Solids	mg/L	32	[NA]	[NA]	[NA]	[NA]
NOx as N in water	mg/L	16	21	0.01	<0.005	0.86
TKN in water	mg/L	1.9	2.3	0.5	0.3	1.7
Ammonia as N in water	mg/L	0.24	0.78	0.45	0.064	0.65
Nitrate as N in water	mg/L	16	21	0.015	<0.005	0.85

Metals in Water - Dissolved						
Our Reference:	UNITS	96132-1	96132-2	96132-3	96132-4	96132-5
Your Reference	----------	3897/GMB01	3897/GMB02	3897/GMB03	3897/GMB04	3897/GMB05
Date Sampled	----------	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
Type of sample		water	water	water	water	water
Date digested	-	26/08/2013	26/08/2013	26/08/2013	26/08/2013	26/08/2013
Date analysed	-	26/08/2013	26/08/2013	26/08/2013	26/08/2013	26/08/2013
Phosphorus - Dissolved	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05

Metals in Waters - Acid extractable						
Our Reference:	UNITS	96132-1	96132-2	96132-3	96132-4	96132-5
Your Reference	----------	3897/GMB01	3897/GMB02	3897/GMB03	3897/GMB04	3897/GMB05
Date Sampled	----------	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
Type of sample		water	water	water	water	water
Date prepared	-	26/08/2013	26/08/2013	26/08/2013	26/08/2013	26/08/2013
Date analysed	-	27/08/2013	27/08/2013	27/08/2013	27/08/2013	27/08/2013
Phosphorus - Total	mg/L	0.1	<0.05	<0.05	<0.05	0.07

Method ID	Methodology Summary
Metals-020 ICP-AES	Determination of various metals by ICP-AES.
Inorg-006	Alkalinity - determined titrimetrically in accordance with APHA 22nd ED, 2320-B.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.
Inorg-041	Gravimetric determination of the total solids content of water using APHA 22nd ED 2540B.
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Inorg-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180+/-5oC.
Inorg-019	Suspended Solids - determined gravimetrcially by filtration of the sample, in accordance with APHA 22nd ED, 2540-D. The samples are dried at 104+/-5oC.
Inorg-055	Nitrate - determined colourimetrically based on EPA353.2 and APHA 22nd ED NO3- F. Soils are analysed following a water extraction.
Inorg-062	TKN - determined colourimetrically based on APHA 22nd ED 4500 Norg.
Inorg-057	Ammonia - determined colourimetrically based on EPA350.1 and APHA 22nd ED 4500-NH3 F, Soils are analysed following a KCl extraction.

QUALITY CONTROL Ion Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			26/08/2013	96132-5	24/08/2013 || 24/08/2013	LCS-W3	26/08/2013
Date analysed	-			26/08/2013	96132-5	24/08/2013 || 24/08/2013	LCS-W3	26/08/2013
Calcium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	96132-5	7.3 || 7.2 || RPD: 1	LCS-W3	93%
Potassium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	96132-5	9.7 || 9.8 || RPD: 1	LCS-W3	96%
Sodium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	96132-5	22 || 23 || RPD: 4	LCS-W3	93%
Magnesium - Dissolved	mg/L	0.5	Metals-020 ICP-AES	<0.5	96132-5	7.8 || 7.8 || RPD: 0	LCS-W3	94%
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	5	Inorg-006	<5	96132-5	<5 || [N/T]	[NR]	[NR]
Bicarbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	96132-5	19 || [N/T]	[NR]	[NR]
Carbonate Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	96132-5	<5 || [N/T]	[NR]	[NR]
Total Alkalinity as $CaCO_3$	mg/L	5	Inorg-006	<5	96132-5	19 || [N/T]	LCS-W3	104%
Sulphate, SO4	mg/L	1	Inorg-081	<1	96132-5	25 || [N/T]	LCS-W3	99%
Chloride, Cl	mg/L	1	Inorg-081	<1	96132-5	40 || [N/T]	LCS-W3	90%
Ionic Balance	%		Inorg-041	[NT]	96132-5	4.4 || [N/T]	[NR]	[NR]

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			24/08/2013	96132-1	24/08/2013 || 24/08/2013	LCS-W1	24/08/2013
Date analysed	-			24/08/2013	96132-1	24/08/2013 || 24/08/2013	LCS-W1	24/08/2013
pH	pH Units		Inorg-001	[NT]	96132-1	5.3 || 5.3 || RPD: 0	LCS-W1	102%
Electrical Conductivity	µS/cm	1	Inorg-002	<1	96132-1	500 || 490 || RPD: 2	LCS-W1	102%
Total Dissolved Solids (grav)	mg/L	5	Inorg-018	<5	96132-1	310 || [N/T]	LCS-W1	95%
Total Suspended Solids	mg/L	5	Inorg-019	<5	96132-1	32 || [N/T]	LCS-W1	95%
NOx as N in water	mg/L	0.005	Inorg-055	<0.005	96132-1	16 || 15 || RPD: 6	LCS-W1	90%
TKN in water	mg/L	0.1	Inorg-062	<0.1	96132-1	1.9 || 1.9 || RPD: 0	LCS-W1	96%
Ammonia as N in water	mg/L	0.005	Inorg-057	<0.005	96132-1	0.24 || 0.23 || RPD: 4	LCS-W1	116%
Nitrate as N in water	mg/L	0.005	Inorg-055	<0.005	96132-1	16 || 15 || RPD: 6	LCS-W1	90%

QUALITY CONTROL Metals in Water - Dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date digested	-			26/08/2013	96132-5	26/08/2013 || 26/08/2013	LCS-W3	26/08/2013
Date analysed	-			26/08/2013	96132-5	26/08/2013 || 26/08/2013	LCS-W3	26/08/2013
Phosphorus - Dissolved	mg/L	0.05	Metals-020 ICP-AES	<0.05	96132-5	<0.05 || <0.05	LCS-W3	91%

QUALITY CONTROL Metals in Waters - Acid extractable	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			26/08/2013	[NT]	[NT]	LCS-W1	26/08/2013
Date analysed	-			26/08/2013	[NT]	[NT]	LCS-W1	26/08/2013
Phosphorus - Total	mg/L	0.05	Metals-020 ICP-AES	<0.05	[NT]	[NT]	LCS-W1	97%

QUALITY CONTROL Ion Balance	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	96132-1	24/08/2013 || 24/08/2013
Date analysed	-	96132-1	24/08/2013 || 24/08/2013
Calcium - Dissolved	mg/L	96132-1	20 || [N/T]
Potassium - Dissolved	mg/L	96132-1	47 || [N/T]
Sodium - Dissolved	mg/L	96132-1	28 || [N/T]
Magnesium - Dissolved	mg/L	96132-1	16 || [N/T]
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	96132-1	<5 || <5
Bicarbonate Alkalinity as $CaCO_3$	mg/L	96132-1	7 || 7 || RPD: 0
Carbonate Alkalinity as $CaCO_3$	mg/L	96132-1	<5 || <5
Total Alkalinity as $CaCO_3$	mg/L	96132-1	7 || 7 || RPD: 0
Sulphate, SO4	mg/L	96132-1	77 || [N/T]
Chloride, Cl	mg/L	96132-1	88 || [N/T]
Ionic Balance	%	96132-1	6.1 || [N/T]

Report Comments:

Sample#2:The mass inbalance may be caused by other ions that have not been measured.

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.

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consulting engineers since 1989

SOIL ANALYSIS CHAIN OF CUSTODY FORM

Additional Testing													
Name	3897 – bobs farm												
Martens Contact Officer	Ben Rose						**Contact Email**	brose@martens.com.au					
Sampling and Shipping	**Sample Date**	29/07/2014 + 30/07/2014		**Dispatch Date**		1/08/2014		**Turnaround Time**		Standard			
	Our Reference	P1303897JCOC01V01					**Shipping Method (X)**	**Hand**		**Post**		**Courier**	X
	On Ice (X)	X	**No Ice (X)**		**Other (X)**								

Laboratory									
Name	EnviroLab								
Sample Delivery Address	12 Ashley Street, Chatswood								
Delivery Contact	**Name**	Aileen	**Phone**	9910 6200	**Fax**		**Email**		
Please Send Report By (X)	**Post**		**Fax**		**Email**	X	**Reporting Email Address**	brose@martens.com.au (please cc rerni@martens.com.au)	

Analysis

	Sample ID	Spocus	EC	Dispersion (emerson crumb)
1)	3897/101/2.5✓	X	X	
2)	✓3897/101/8.5	X	X	
3)	3897/101/13.0	X	X	x
4)	✓3897/102/2.5	X	X	
5)	✓3897/102/5.0	X	X	x
6)	✓3897/102/7.0	X	X	x
7)	✓3897/103/2.5	X	X	
8)	✓3897/103/8.0	X	X	x
9)	✓3897/103/10.0	X	X	
10)	✓3897/104/2.5	X	X	

ENVIROLAB
Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

Job No: 114013

Date Received: 1/8/14
Time Received: 14:30
Received by: PT
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Head Office
Unit 6 / 37 Leighton Place
Hornsby NSW 2077, Australia
Ph 02 9476 9999 **Fax** 02 9476 8767

> mail@martens.com.au
> www.martens.com.au
MARTENS & ASSOCIATES P/L
ABN 85 070 240 890 ACN 070 240 890

ACEA The Association of Consulting Engineers Australia

SOIL ANALYSIS CHAIN OF CUSTODY

	Sample ID	Spocus	EC	Dispersion (emerson crumb)
11)	√3897/104/10.0	X	X	
12)	√3897/105/2.5	X	X	
13)	√3897/105/10.0	X	X	
14)	√3897/106/5.5	X	X	
15)	√3897/106/10.0	X	X	
16)	√3897/107/5.5	X	X	
17)	√3897/107/10.0	X	X	
18)	√3897/108/2.5	X	X	
19)	√3897/108/5.5	X	X	X
20)	√3897/108/8.5	X	X	
21)	√3897/108/13.0	X	X	x

11403

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 114013

Client:

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

Attention: Ben Rose

Sample log in details:

Your Reference:	**3897, Bobs Farm**		
No. of samples:	21 Soils		
Date samples received / completed instructions received	01/08/2014	/	01/08/2014

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:	11/08/14	/	11/08/14
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

Miscellaneous Inorg - soil						
Our Reference:	UNITS	114013-1	114013-2	114013-3	114013-4	114013-5
Your Reference	----------	3897/101	3897/101	3897/101	3897/102	3897/102
Depth	----------	2.5	8.5	13.0	2.5	5.0
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	04/08/2014	04/08/2014	04/08/2014	04/08/2014	04/08/2014
Date analysed	-	05/08/2014	05/08/2014	05/08/2014	05/08/2014	05/08/2014
Electrical Conductivity 1:5 soil:water	µS/cm	13	10	16	13	50

Miscellaneous Inorg - soil						
Our Reference:	UNITS	114013-6	114013-7	114013-8	114013-9	114013-10
Your Reference	----------	3897/102	3897/103	3897/103	3897/103	3897/104
Depth	----------	7.0	2.5	8.0	10.0	2.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	04/08/2014	04/08/2014	04/08/2014	04/08/2014	04/08/2014
Date analysed	-	05/08/2014	05/08/2014	05/08/2014	05/08/2014	05/08/2014
Electrical Conductivity 1:5 soil:water	µS/cm	24	4	15	19	7

Miscellaneous Inorg - soil						
Our Reference:	UNITS	114013-11	114013-12	114013-13	114013-14	114013-15
Your Reference	----------	3897/104	3897/105	3897/105	3897/106	3897/106
Depth	----------	10.0	2.5	10.0	5.5	10.0
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	04/08/2014	04/08/2014	04/08/2014	04/08/2014	04/08/2014
Date analysed	-	05/08/2014	05/08/2014	05/08/2014	05/08/2014	05/08/2014
Electrical Conductivity 1:5 soil:water	µS/cm	5	7	4	12	4

Miscellaneous Inorg - soil						
Our Reference:	UNITS	114013-16	114013-17	114013-18	114013-19	114013-20
Your Reference	----------	3897/107	3897/107	3897/108	3897/108	3897/108
Depth	----------	5.5	10.0	2.5	5.5	8.5
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	04/08/2014	04/08/2014	04/08/2014	04/08/2014	04/08/2014
Date analysed	-	05/08/2014	05/08/2014	05/08/2014	05/08/2014	05/08/2014
Electrical Conductivity 1:5 soil:water	µS/cm	8	10	36	32	47

Miscellaneous Inorg - soil		
Our Reference:	UNITS	114013-21
Your Reference	----------	3897/108
Depth	----------	13.0
Type of sample		Soil
Date prepared	-	04/08/2014
Date analysed	-	05/08/2014
Electrical Conductivity 1:5 soil:water	µS/cm	30

sPOCAS Our Reference: Your Reference Depth Type of sample	UNITS ---------- ----------	114013-1 3897/101 2.5 Soil	114013-2 3897/101 8.5 Soil	114013-3 3897/101 13.0 Soil	114013-4 3897/102 2.5 Soil	114013-5 3897/102 5.0 Soil
Date prepared	-	4/8/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014
Date analysed	-	4/8/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014
pH $_{kcl}$	pH units	5.0	5.6	5.4	4.6	4.8
TAA pH 6.5	moles H^+/t	5	<5	<5	10	10
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	0.02	0.02
pH $_{Ox}$	pH units	4.4	4.3	5.7	3.5	2.1
TPA pH 6.5	moles H^+/t	<5	<5	<5	<5	190
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	0.30
TSA pH 6.5	moles H^+/t	<5	<5	<5	<5	180
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	0.29
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	<0.005	<0.005	<0.005	0.02
S$_P$	%w/w	<0.005	<0.005	<0.005	<0.005	0.28
S$_{POS}$	%w/w	<0.005	<0.005	<0.005	<0.005	0.26
a-S$_{POS}$	moles H^+/t	<5	<5	<5	<5	170
Ca$_{KCl}$	%w/w	<0.005	<0.005	<0.005	<0.005	0.06
Ca$_P$	%w/w	0.007	<0.005	0.009	0.007	0.06
Ca$_A$	%w/w	0.005	<0.005	0.009	<0.005	<0.005
Mg$_{KCl}$	%w/w	<0.005	<0.005	<0.005	<0.005	0.014
Mg$_P$	%w/w	0.005	<0.005	0.005	0.007	0.016
Mg$_A$	%w/w	<0.005	<0.005	<0.005	0.006	<0.005
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	<10	<10	<10	12	180
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	0.90	13
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 Type of sample	UNITS ---------- ----------	114013-6 3897/102 7.0 Soil	114013-7 3897/103 2.5 Soil	114013-8 3897/103 8.0 Soil	114013-9 3897/103 10.0 Soil	114013-10 3897/104 2.5 Soil
Date prepared	-	4/8/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014
Date analysed	-	4/8/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014
pH $_{kcl}$	pH units	5.1	5.4	5.0	5.4	5.0
TAA pH 6.5	moles H^+/t	7	5	5	<5	5
s-TAA pH 6.5	%w/w S	0.01	<0.01	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	2.7	4.2	2.5	3.3	4.5
TPA pH 6.5	moles H^+/t	47	<5	25	12	<5
s-TPA pH 6.5	%w/w S	0.08	<0.01	0.04	0.02	<0.01
TSA pH 6.5	moles H^+/t	40	<5	20	10	<5
s-TSA pH 6.5	%w/w S	0.06	<0.01	0.03	0.02	<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	0.01	<0.005	<0.005	<0.005	<0.005
S$_P$	%w/w	0.10	<0.005	0.05	0.04	<0.005
S$_{POS}$	%w/w	0.1	<0.005	0.05	0.04	<0.005
a-S$_{POS}$	moles H^+/t	60	<5	30	26	<5
Ca$_{KCl}$	%w/w	0.01	<0.005	0.01	<0.005	<0.005
Ca$_P$	%w/w	0.01	<0.005	0.01	0.02	<0.005
Ca$_A$	%w/w	<0.005	<0.005	<0.005	0.014	<0.005
Mg$_{KCl}$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg$_P$	%w/w	<0.005	<0.005	<0.005	0.014	<0.005
Mg$_A$	%w/w	<0.005	<0.005	<0.005	0.013	<0.005
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	67	<10	35	28	<10
Liming rate	kg $CaCO_3$/t	5.0	<0.75	2.6	2.1	<0.75
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 Type of sample	UNITS ---------- ----------	114013-11 3897/104 10.0 Soil	114013-12 3897/105 2.5 Soil	114013-13 3897/105 10.0 Soil	114013-14 3897/106 5.5 Soil	114013-15 3897/106 10.0 Soil
Date prepared	-	4/8/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014
Date analysed	-	4/8/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014
pH $_{kcl}$	pH units	5.7	5.2	5.5	5.6	5.2
TAA pH 6.5	moles H^+/t	<5	5	<5	<5	<5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	5.0	3.9	5.5	5.1	4.7
TPA pH 6.5	moles H^+/t	<5	<5	<5	<5	<5
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
TSA pH 6.5	moles H^+/t	<5	<5	<5	<5	<5
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	<0.005	<0.005	<0.005	<0.005	<0.005
S_P	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
S_{POS}	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
a-S_{POS}	moles H^+/t	<5	<5	<5	<5	<5
Ca_{KCl}	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Ca_P	%w/w	<0.005	<0.005	<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	<0.005	<0.005	<0.005	<0.005
Mg_P	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg_A	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	<10	<10	<10	<10	<10
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	<0.75	<0.75
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 Type of sample	UNITS ---------- ----------	114013-16 3897/107 5.5 Soil	114013-17 3897/107 10.0 Soil	114013-18 3897/108 2.5 Soil	114013-19 3897/108 5.5 Soil	114013-20 3897/108 8.5 Soil
Date prepared	-	4/8/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014
Date analysed	-	4/8/2014	4/8/2014	4/8/2014	4/8/2014	4/8/2014
pH $_{kcl}$	pH units	5.2	5.2	4.5	5.3	5.2
TAA pH 6.5	moles H^+/t	5	5	10	5	5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	0.02	<0.01	<0.01
pH $_{Ox}$	pH units	6.3	4.0	3.4	5.2	2.8
TPA pH 6.5	moles H^+/t	<5	<5	22	<5	35
s-TPA pH 6.5	%w/w S	<0.01	<0.01	0.04	<0.01	0.06
TSA pH 6.5	moles H^+/t	<5	<5	12	<5	30
s-TSA pH 6.5	%w/w S	<0.01	<0.01	0.02	<0.01	0.05
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	<0.005	<0.005	<0.005	0.008
S$_P$	%w/w	<0.005	<0.005	<0.005	0.01	0.06
S$_{POS}$	%w/w	<0.005	<0.005	<0.005	0.01	0.06
a-S$_{POS}$	moles H^+/t	<5	<5	<5	7	36
Ca$_{KCl}$	%w/w	<0.005	<0.005	0.006	<0.005	<0.005
Ca$_P$	%w/w	0.02	<0.005	0.006	0.01	<0.005
Ca$_A$	%w/w	0.016	<0.005	<0.005	0.009	<0.005
Mg$_{KCl}$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg$_P$	%w/w	0.005	<0.005	<0.005	0.013	<0.005
Mg$_A$	%w/w	0.005	<0.005	<0.005	0.010	<0.005
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	<10	<10	10	12	41
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	0.75	0.93	3.1
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 Type of sample	UNITS ---------- ----------	114013-21 3897/108 13.0 Soil
Date prepared	-	4/8/2014
Date analysed	-	4/8/2014
pH $_{kcl}$	pH units	5.2
TAA pH 6.5	moles H^+/t	<5
s-TAA pH 6.5	%w/w S	<0.01
pH $_{Ox}$	pH units	2.8
TPA pH 6.5	moles H^+/t	35
s-TPA pH 6.5	%w/w S	0.06
TSA pH 6.5	moles H^+/t	32
s-TSA pH 6.5	%w/w S	0.05
ANC$_E$	% $CaCO_3$	<0.05
a-ANC$_E$	moles H^+/t	<5
s-ANC$_E$	%w/w S	<0.05
S$_{KCl}$	%w/w S	<0.005
S$_P$	%w/w	0.06
S$_{POS}$	%w/w	0.05
a-S$_{POS}$	moles H^+/t	35
Ca$_{KCl}$	%w/w	<0.005
Ca$_P$	%w/w	<0.005
Ca$_A$	%w/w	<0.005
Mg$_{KCl}$	%w/w	<0.005
Mg$_P$	%w/w	<0.005
Mg$_A$	%w/w	<0.005
Fineness Factor	-	1.5
a-Net Acidity	moles H^+/t	37
Liming rate	kg $CaCO_3$/t	2.8
a-Net Acidity without ANCE	moles H^+/t	NA
Liming rate without ANCE	kg $CaCO_3$/t	NA

Method ID	Methodology Summary
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
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 Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			04/08/2014	114013-1	04/08/2014 || 04/08/2014	LCS-1	04/08/2014
Date analysed	-			05/08/2014	114013-1	05/08/2014 || 05/08/2014	LCS-1	05/08/2014
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	114013-1	13 || 12 || RPD: 8	LCS-1	103%
QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			4/8/2014	114013-1	4/8/2014 || 4/8/2014	LCS-1	4/8/2014
Date analysed	-			4/8/2014	114013-1	4/8/2014 || 4/8/2014	LCS-1	4/8/2014
pH $_{kcl}$	pH units		Inorg-064	[NT]	114013-1	5.0 || 4.9 || RPD: 2	LCS-1	92%
TAA pH 6.5	moles H^+/t	5	Inorg-064	<5	114013-1	5 || 5 || RPD: 0	LCS-1	121%
s-TAA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	114013-1	<0.01 || <0.01	[NR]	[NR]
pH $_{Ox}$	pH units		Inorg-064	[NT]	114013-1	4.4 || 4.9 || RPD: 11	LCS-1	96%
TPA pH 6.5	moles H^+/t	5	Inorg-064	<5	114013-1	<5 || <5	LCS-1	90%
s-TPA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	114013-1	<0.01 || <0.01	[NR]	[NR]
TSA pH 6.5	moles H^+/t	5	Inorg-064	<5	114013-1	<5 || <5	LCS-1	89%
s-TSA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	114013-1	<0.01 || <0.01	[NR]	[NR]
ANC_E	% $CaCO_3$	0.05	Inorg-064	<0.05	114013-1	<0.05 || <0.05	[NR]	[NR]
a-ANC_E	moles H^+/t	5	Inorg-064	<5	114013-1	<5 || <5	[NR]	[NR]
s-ANC_E	%w/w S	0.05	Inorg-064	<0.05	114013-1	<0.05 || <0.05	[NR]	[NR]
S_{KCl}	%w/w S	0.005	Inorg-064	<0.005	114013-1	<0.005 || <0.005	LCS-1	100%
S_P	%w/w	0.005	Inorg-064	<0.005	114013-1	<0.005 || <0.005	LCS-1	91%
S_{POS}	%w/w	0.005	Inorg-064	<0.005	114013-1	<0.005 || <0.005	LCS-1	89%
a-S_{POS}	moles H^+/t	5	Inorg-064	<5	114013-1	<5 || <5	LCS-1	90%
Ca_{KCl}	%w/w	0.005	Inorg-064	<0.005	114013-1	<0.005 || <0.005	LCS-1	93%
Ca_P	%w/w	0.005	Inorg-064	<0.005	114013-1	0.007 || 0.006 || RPD: 15	[NR]	[NR]
Ca_A	%w/w	0.005	Inorg-064	<0.005	114013-1	0.005 || 0.005 || RPD: 0	[NR]	[NR]
Mg_{KCl}	%w/w	0.005	Inorg-064	<0.005	114013-1	<0.005 || <0.005	LCS-1	94%
Mg_P	%w/w	0.005	Inorg-064	<0.005	114013-1	0.005 || 0.009 || RPD: 57	[NR]	[NR]
Mg_A	%w/w	0.005	Inorg-064	<0.005	114013-1	<0.005 || 0.008	[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]

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
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	114013-1	1.5 || 1.5 || RPD: 0	[NR]	[NR]
a-Net Acidity	moles H^+/t	10	Inorg-064	<10	114013-1	<10 || <10	LCS-1	91%
Liming rate	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	114013-1	<0.75 || <0.75	LCS-1	90%
a-Net Acidity without ANCE	moles H^+/t	10	Inorg-064	<10	114013-1	NA || NA	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	114013-1	NA || NA	[NR]	[NR]

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	114013-11	04/08/2014 || 04/08/2014	LCS-2	04/08/2014
Date analysed	-	114013-11	05/08/2014 || 05/08/2014	LCS-2	05/08/2014
Electrical Conductivity 1:5 soil:water	µS/cm	114013-11	5 || 5 || RPD: 0	LCS-2	102%

QUALITY CONTROL sPOCAS	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	114013-11	4/8/2014 || 4/8/2014	LCS-2	4/8/2014
Date analysed	-	114013-11	4/8/2014 || 4/8/2014	LCS-2	4/8/2014
pH $_{kcl}$	pH units	114013-11	5.7 || 5.6 || RPD: 2	LCS-2	93%
TAA pH 6.5	moles H^+/t	114013-11	<5 || <5	LCS-2	113%
s-TAA pH 6.5	%w/w S	114013-11	<0.01 || <0.01	[NR]	[NR]
pH $_{Ox}$	pH units	114013-11	5.0 || 4.8 || RPD: 4	LCS-2	106%
TPA pH 6.5	moles H^+/t	114013-11	<5 || <5	LCS-2	83%
s-TPA pH 6.5	%w/w S	114013-11	<0.01 || <0.01	[NR]	[NR]
TSA pH 6.5	moles H^+/t	114013-11	<5 || <5	LCS-2	81%
s-TSA pH 6.5	%w/w S	114013-11	<0.01 || <0.01	[NR]	[NR]
ANC_E	% $CaCO_3$	114013-11	<0.05 || <0.05	[NR]	[NR]
a-ANC_E	moles H^+/t	114013-11	<5 || <5	[NR]	[NR]
s-ANC_E	%w/w S	114013-11	<0.05 || <0.05	[NR]	[NR]
S_{KCl}	%w/w S	114013-11	<0.005 || <0.005	LCS-2	106%
S_P	%w/w	114013-11	<0.005 || <0.005	LCS-2	88%
S_{POS}	%w/w	114013-11	<0.005 || <0.005	LCS-2	83%
a-S_{POS}	moles H^+/t	114013-11	<5 || <5	LCS-2	83%

QUALITY CONTROL sPOCAS	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Ca_{KCl}	%w/w	114013-11	<0.005 || <0.005	LCS-2	100%
Ca_{P}	%w/w	114013-11	<0.005 || <0.005	[NR]	[NR]
Ca_{A}	%w/w	114013-11	<0.005 || <0.005	[NR]	[NR]
Mg_{KCl}	%w/w	114013-11	<0.005 || <0.005	LCS-2	98%
Mg_{P}	%w/w	114013-11	<0.005 || <0.005	[NR]	[NR]
Mg_{A}	%w/w	114013-11	<0.005 || <0.005	[NR]	[NR]
Fineness Factor	-	114013-11	1.5 || 1.5 || RPD: 0	[NR]	[NR]
a-Net Acidity	moles H^+/t	114013-11	<10 || <10	LCS-2	84%
Liming rate	kg $CaCO_3$/t	114013-11	<0.75 || <0.75	LCS-2	83%
a-Net Acidity without ANCE	moles H^+/t	114013-11	NA || NA	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$/t	114013-11	NA || NA	[NR]	[NR]

QUALITY CONTROL sPOCAS	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	114013-21	4/8/2014 || 4/8/2014
Date analysed	-	114013-21	4/8/2014 || 4/8/2014
pH_{kcl}	pH units	114013-21	5.2 || 5.3 || RPD: 2
TAA pH 6.5	moles H^+/t	114013-21	<5 || <5
s-TAA pH 6.5	%w/w S	114013-21	<0.01 || <0.01
pH_{Ox}	pH units	114013-21	2.8 || 2.9 || RPD: 4
TPA pH 6.5	moles H^+/t	114013-21	35 || 22 || RPD: 46
s-TPA pH 6.5	%w/w S	114013-21	0.06 || 0.04 || RPD: 40
TSA pH 6.5	moles H^+/t	114013-21	32 || 20 || RPD: 46
s-TSA pH 6.5	%w/w S	114013-21	0.05 || 0.03 || RPD: 50
ANC_E	% $CaCO_3$	114013-21	<0.05 || <0.05
a-ANC_E	moles H^+/t	114013-21	<5 || <5
s-ANC_E	%w/w S	114013-21	<0.05 || <0.05
S_{KCl}	%w/w S	114013-21	<0.005 || 0.007
S_P	%w/w	114013-21	0.06 || 0.05 || RPD: 18
S_{POS}	%w/w	114013-21	0.05 || 0.04 || RPD: 22
a-S_{POS}	moles H^+/t	114013-21	35 || 25 || RPD: 33
Ca_{KCl}	%w/w	114013-21	<0.005 || <0.005
Ca_{P}	%w/w	114013-21	<0.005 || <0.005
Ca_{A}	%w/w	114013-21	<0.005 || <0.005

QUALITY CONTROL sPOCAS	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Mg_{KCl}	%w/w	114013-21	<0.005 || <0.005
Mg_{P}	%w/w	114013-21	<0.005 || <0.005
Mg_{A}	%w/w	114013-21	<0.005 || <0.005
S_{HCl}	%w/w S	[NT]	[NT]
S_{NAS}	%w/w S	[NT]	[NT]
a-S_{NAS}	moles H^+/t	[NT]	[NT]
s-S_{NAS}	%w/w S	[NT]	[NT]
Fineness Factor	-	114013-21	1.5 || 1.5 || RPD: 0
a-Net Acidity	moles H^+/t	114013-21	37 || 27 || RPD: 31
Liming rate	kg $CaCO_3$/t	114013-21	2.8 || 2.1 || RPD: 29
a-Net Acidity without ANCE	moles H^+/t	114013-21	NA || NA
Liming rate without ANCE	kg $CaCO_3$/t	114013-21	NA || NA

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.

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CERTIFICATE OF ANALYSIS 95948

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

Attention: Gray Taylor

Sample log in details:

Your Reference:	**P12303897, Bobs Farm**
No. of samples:	27 Soils
Date samples received / completed instructions received	21/08/2013 / 21/08/2013

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:	29/08/13 / 28/08/13
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 Type of sample	UNITS ---------- ----------	95948-1 3897/BH03 +12.5 to +11.5 Soil	95948-2 3897/BH03 +6.5 to +5.5 Soil	95948-3 3897/BH03 +1.5 to +0.5 Soil	95948-4 3897/BH03 -0.5 to -1.1 Soil	95948-5 3897/BH03 -1.3 to -1.5 Soil
Date prepared	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
Date analysed	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
pH $_{kcl}$	pH units	4.8	5.4	5.6	5.6	5.4
TAA pH 6.5	moles H^+/t	10	<5	<5	<5	10
s-TAA pH 6.5	%w/w S	0.02	<0.01	<0.01	<0.01	0.02
pH $_{Ox}$	pH units	3.9	4.5	4.5	4.4	3.2
TPA pH 6.5	moles H^+/t	30	<5	<5	10	250
s-TPA pH 6.5	%w/w S	0.05	<0.01	<0.01	0.02	0.40
TSA pH 6.5	moles H^+/t	20	<5	<5	7	240
s-TSA pH 6.5	%w/w S	0.03	<0.01	<0.01	0.01	0.38
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	<0.005	<0.005	<0.005	<0.005
S_P	%w/w	<0.005	<0.005	<0.005	<0.005	0.08
S_{POS}	%w/w	<0.005	<0.005	<0.005	<0.005	0.08
a-S_{POS}	moles H^+/t	<5	<5	<5	<5	51
Ca_{KCl}	%w/w	<0.005	<0.005	<0.005	<0.005	0.12
Ca_P	%w/w	<0.005	<0.005	<0.005	<0.005	0.13
Ca_A	%w/w	<0.005	<0.005	<0.005	<0.005	0.014
Mg_{KCl}	%w/w	<0.005	<0.005	<0.005	<0.005	0.15
Mg_P	%w/w	<0.005	<0.005	<0.005	<0.005	0.16
Mg_A	%w/w	<0.005	<0.005	<0.005	<0.005	0.009
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	10	<10	<10	<10	61
Liming rate	kg $CaCO_3$/t	0.75	<0.75	<0.75	<0.75	4.6
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 Type of sample	UNITS ---------- ----------	95948-6 3897/BH03 -1.3 Soil	95948-7 3897/BH03 -3.1 Soil	95948-8 3897/BH03 -13 Soil	95948-9 3897/BH04 +5.5 to +3.0 Soil	95948-10 3897/BH04 +3.3 to +2.5 Soil
Date prepared	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
Date analysed	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
pH $_{kcl}$	pH units	5.2	4.5	5.3	5.2	5.3
TAA pH 6.5	moles H^+/t	10	17	<5	5	<5
s-TAA pH 6.5	%w/w S	0.02	0.03	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	2.7	2.3	3.3	4.3	4.5
TPA pH 6.5	moles H^+/t	460	360	27	17	17
s-TPA pH 6.5	%w/w S	0.74	0.58	0.04	0.03	0.03
TSA pH 6.5	moles H^+/t	450	340	25	12	15
s-TSA pH 6.5	%w/w S	0.73	0.55	0.04	0.02	0.02
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	0.06	<0.005	<0.005	<0.005
S$_P$	%w/w	0.14	0.56	0.03	<0.005	<0.005
S$_{POS}$	%w/w	0.13	0.51	0.03	<0.005	<0.005
a-S$_{POS}$	moles H^+/t	84	320	18	<5	<5
Ca$_{KCl}$	%w/w	0.15	0.04	<0.005	<0.005	<0.005
Ca$_P$	%w/w	0.15	0.03	<0.005	<0.005	<0.005
Ca$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg$_{KCl}$	%w/w	0.15	0.044	<0.005	<0.005	<0.005
Mg$_P$	%w/w	0.13	0.036	<0.005	<0.005	<0.005
Mg$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	94	330	21	<10	<10
Liming rate	kg $CaCO_3$/t	7.0	25	1.5	<0.75	<0.75
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 Type of sample	UNITS ---------- ----------	95948-11 3897/BH04 +0.8 to +0.5 Soil	95948-12 3897/BH04 -0.5 to -1.5 Soil	95948-13 3897/BH04 -2.5 to -3.0 Soil	95948-14 3897/BH04 -6.0 to -7.5 Soil	95948-15 3897/BH04 -11.0 to -13.5 Soil
Date prepared	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
Date analysed	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
pH $_{kcl}$	pH units	4.9	5.3	5.5	5.3	5.4
TAA pH 6.5	moles H^+/t	10	5	<5	<5	<5
s-TAA pH 6.5	%w/w S	0.02	<0.01	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	3.8	4.4	4.4	3.4	3.8
TPA pH 6.5	moles H^+/t	37	12	17	27	20
s-TPA pH 6.5	%w/w S	0.06	0.02	0.03	0.04	0.03
TSA pH 6.5	moles H^+/t	27	7	16	26	19
s-TSA pH 6.5	%w/w S	0.04	0.01	0.03	0.04	0.03
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	<0.005	<0.005	<0.005	<0.005
S$_P$	%w/w	<0.005	<0.005	<0.005	0.03	0.02
S$_{POS}$	%w/w	<0.005	<0.005	<0.005	0.02	0.02
a-S$_{POS}$	moles H^+/t	<5	<5	<5	14	11
Ca$_{KCl}$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Ca$_P$	%w/w	<0.005	<0.005	<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	<0.005	<0.005	<0.005	<0.005
Mg$_P$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	10	<10	<10	16	12
Liming rate	kg $CaCO_3$/t	0.75	<0.75	<0.75	1.2	0.93
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 Type of sample	UNITS ---------- ----------	95948-16 3897/BH04 -13.5 to -12.1 Soil	95948-17 3897/BH05 +8.5 to +8.0 Soil	95948-18 3897/BH05 +2.0 to +1.0 Soil	95948-19 3897/BH05 +0.0 to -0.5 Soil	95948-20 3897/BH05 +0.0 to -1.0 Soil
Date prepared	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
Date analysed	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
pH $_{kcl}$	pH units	5.4	5.5	5.5	4.4	5.3
TAA pH 6.5	moles H^+/t	<5	<5	<5	7	5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	0.01	<0.01
pH $_{Ox}$	pH units	3.7	4.6	4.5	3.4	4.5
TPA pH 6.5	moles H^+/t	20	7	12	47	7
s-TPA pH 6.5	%w/w S	0.03	0.01	0.02	0.08	0.01
TSA pH 6.5	moles H^+/t	17	5	10	40	<5
s-TSA pH 6.5	%w/w S	0.03	<0.01	0.02	0.06	<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	<0.005	<0.005	<0.005	<0.005	<0.005
S$_P$	%w/w	0.02	<0.005	<0.005	<0.005	<0.005
S$_{POS}$	%w/w	0.02	<0.005	<0.005	<0.005	<0.005
a-S$_{POS}$	moles H^+/t	10	<5	<5	<5	<5
Ca$_{KCl}$	%w/w	<0.005	<0.005	<0.005	0.005	<0.005
Ca$_P$	%w/w	<0.005	<0.005	<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	<0.005	<0.005	<0.005	<0.005
Mg$_P$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
Mg$_A$	%w/w	<0.005	<0.005	<0.005	<0.005	<0.005
S$_{HCl}$	%w/w S	[NT]	[NT]	[NT]	<0.005	[NT]
S$_{NAS}$	%w/w S	[NT]	[NT]	[NT]	<0.005	[NT]
a-S$_{NAS}$	moles H^+/t	[NT]	[NT]	[NT]	<5	[NT]
s-S$_{NAS}$	%w/w S	[NT]	[NT]	[NT]	<0.01	[NT]
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	12	<10	<10	<10	<10
Liming rate	kg $CaCO_3$/t	0.92	<0.75	<0.75	<0.75	<0.75
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 Type of sample	UNITS ---------- ----------	95948-21 3897/BH05 -1.1 to -1.5 Soil	95948-22 3897/BH05 -1.5 to -2.0 Soil	95948-23 3897/BH05 -2.5 to -3.0 Soil	95948-24 3897/BH05 -5.0 Soil	95948-25 3897/BH05 -5.5 Soil
Date prepared	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
Date analysed	-	22/08/2013	22/08/2013	22/08/2013	22/08/2013	22/08/2013
pH $_{kcl}$	pH units	5.7	5.6	5.6	5.9	7.9
TAA pH 6.5	moles H^+/t	<5	<5	<5	5	<5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	<0.01	<0.01	<0.01
pH $_{Ox}$	pH units	4.5	4.6	4.4	2.2	4.1
TPA pH 6.5	moles H^+/t	5	<5	<5	1,500	120
s-TPA pH 6.5	%w/w S	<0.01	<0.01	<0.01	2.4	0.19
TSA pH 6.5	moles H^+/t	<5	<5	<5	1,500	120
s-TSA pH 6.5	%w/w S	<0.01	<0.01	<0.01	2.4	0.19
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	<0.005	<0.005	0.13	0.09
S$_P$	%w/w	<0.005	<0.005	<0.005	2.8	1.5
S$_{POS}$	%w/w	<0.005	<0.005	<0.005	2.6	1.4
a-S$_{POS}$	moles H^+/t	<5	<5	<5	1,600	870
Ca$_{KCl}$	%w/w	<0.005	<0.005	<0.005	0.32	0.39
Ca$_P$	%w/w	<0.005	<0.005	<0.005	0.39	1.5
Ca$_A$	%w/w	<0.005	<0.005	<0.005	0.075	1.2
Mg$_{KCl}$	%w/w	<0.005	<0.005	<0.005	0.23	0.14
Mg$_P$	%w/w	<0.005	<0.005	<0.005	0.28	0.16
Mg$_A$	%w/w	<0.005	<0.005	<0.005	0.048	0.014
Fineness Factor	-	1.5	1.5	1.5	1.5	1.5
a-Net Acidity	moles H^+/t	<10	<10	<10	1,600	370
Liming rate	kg $CaCO_3$/t	<0.75	<0.75	<0.75	120	28
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 Type of sample	UNITS ---------- ----------	95948-26 3897/BH05 -6.5 Soil	95948-27 3897/BH05 -7.5 Soil
Date prepared	-	22/08/2013	22/08/2013
Date analysed	-	22/08/2013	22/08/2013
pH $_{kcl}$	pH units	7.0	8.1
TAA pH 6.5	moles H^+/t	<5	<5
s-TAA pH 6.5	%w/w S	<0.01	<0.01
pH $_{Ox}$	pH units	2.2	2.9
TPA pH 6.5	moles H^+/t	820	67
s-TPA pH 6.5	%w/w S	1.3	0.11
TSA pH 6.5	moles H^+/t	820	67
s-TSA pH 6.5	%w/w S	1.3	0.11
ANC_E	% $CaCO_3$	<0.05	<0.05
a-ANC_E	moles H^+/t	<5	<5
s-ANC_E	%w/w S	<0.05	<0.05
S_{KCl}	%w/w S	0.08	0.01
S_P	%w/w	1.6	0.22
S_{POS}	%w/w	1.5	0.21
a-S_{POS}	moles H^+/t	960	130
Ca_{KCl}	%w/w	0.37	0.07
Ca_P	%w/w	0.54	0.10
Ca_A	%w/w	0.17	0.030
Mg_{KCl}	%w/w	0.19	0.016
Mg_P	%w/w	0.23	0.022
Mg_A	%w/w	0.039	0.006
Fineness Factor	-	1.5	1.5
a-Net Acidity	moles H^+/t	870	88
Liming rate	kg $CaCO_3$/t	65	6.6
a-Net Acidity without ANCE	moles H^+/t	NA	NA
Liming rate without ANCE	kg $CaCO_3$/t	NA	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	-			22/08/2013	95948-1	22/08/2013 || 22/08/2013	LCS-1	22/08/2013
Date analysed	-			22/08/2013	95948-1	22/08/2013 || 22/08/2013	LCS-1	22/08/2013
pH kcl	pH units		Inorg-064	[NT]	95948-1	4.8 || 4.8 || RPD: 0	LCS-1	95%
TAA pH 6.5	moles H^+/t	5	Inorg-064	<5	95948-1	10 || 7 || RPD: 35	LCS-1	129%
s-TAA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	95948-1	0.02 || 0.01 || RPD: 67	[NR]	[NR]
pH ox	pH units		Inorg-064	[NT]	95948-1	3.9 || 4.0 || RPD: 3	LCS-1	99%
TPA pH 6.5	moles H^+/t	5	Inorg-064	<5	95948-1	30 || 12 || RPD: 86	LCS-1	103%
s-TPA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	95948-1	0.05 || 0.02 || RPD: 86	[NR]	[NR]
TSA pH 6.5	moles H^+/t	5	Inorg-064	<5	95948-1	20 || 5 || RPD: 120	LCS-1	101%
s-TSA pH 6.5	%w/w S	0.01	Inorg-064	<0.01	95948-1	0.03 || <0.01	[NR]	[NR]
ANC_E	% $CaCO_3$	0.05	Inorg-064	<0.05	95948-1	<0.05 || <0.05	[NR]	[NR]
a-ANC_E	moles H^+/t	5	Inorg-064	<5	95948-1	<5 || <5	[NR]	[NR]
s-ANC_E	%w/w S	0.05	Inorg-064	<0.05	95948-1	<0.05 || <0.05	[NR]	[NR]
S_{KCl}	%w/w S	0.005	Inorg-064	<0.005	95948-1	<0.005 || <0.005	LCS-1	83%
S_P	%w/w	0.005	Inorg-064	<0.005	95948-1	<0.005 || <0.005	LCS-1	79%
S_{POS}	%w/w	0.005	Inorg-064	<0.005	95948-1	<0.005 || <0.005	LCS-1	79%
a-S_{POS}	moles H^+/t	5	Inorg-064	<5	95948-1	<5 || <5	LCS-1	79%
Ca_{KCl}	%w/w	0.005	Inorg-064	<0.005	95948-1	<0.005 || <0.005	LCS-1	89%
Ca_P	%w/w	0.005	Inorg-064	<0.005	95948-1	<0.005 || <0.005	[NR]	[NR]
Ca_A	%w/w	0.005	Inorg-064	<0.005	95948-1	<0.005 || <0.005	[NR]	[NR]
Mg_{KCl}	%w/w	0.005	Inorg-064	<0.005	95948-1	<0.005 || <0.005	LCS-1	87%
Mg_P	%w/w	0.005	Inorg-064	<0.005	95948-1	<0.005 || <0.005	[NR]	[NR]
Mg_A	%w/w	0.005	Inorg-064	<0.005	95948-1	<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	95948-1	1.5 || 1.5 || RPD: 0	[NR]	[NR]
a-Net Acidity	moles H^+/t	10	Inorg-064	<10	95948-1	10 || <10	LCS-1	81%
Liming rate	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	95948-1	0.75 || <0.75	LCS-1	80%

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	95948-1	NA || NA	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	Inorg-064	<0.75	95948-1	NA || NA	[NR]	[NR]

QUALITY CONTROL sPOCAS	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	95948-11	22/08/2013 || 22/08/2013	LCS-2	22/8/2013
Date analysed	-	95948-11	22/08/2013 || 22/08/2013	LCS-2	22/8/2013
pH $_{kcl}$	pH units	95948-11	4.9 || 4.9 || RPD: 0	LCS-2	94%
TAA pH 6.5	moles H^+/t	95948-11	10 || 7 || RPD: 35	LCS-2	113%
s-TAA pH 6.5	%w/w S	95948-11	0.02 || 0.01 || RPD: 67	[NR]	[NR]
pH $_{Ox}$	pH units	95948-11	3.8 || 3.8 || RPD: 0	LCS-2	93%
TPA pH 6.5	moles H^+/t	95948-11	37 || 37 || RPD: 0	LCS-2	102%
s-TPA pH 6.5	%w/w S	95948-11	0.06 || 0.06 || RPD: 0	[NR]	[NR]
TSA pH 6.5	moles H^+/t	95948-11	27 || 30 || RPD: 11	LCS-2	101%
s-TSA pH 6.5	%w/w S	95948-11	0.04 || 0.05 || RPD: 22	[NR]	[NR]
ANC_E	% $CaCO_3$	95948-11	<0.05 || <0.05	[NR]	[NR]
a-ANC_E	moles H^+/t	95948-11	<5 || <5	[NR]	[NR]
s-ANC_E	%w/w S	95948-11	<0.05 || <0.05	[NR]	[NR]
S_{KCl}	%w/w S	95948-11	<0.005 || <0.005	LCS-2	87%
S_P	%w/w	95948-11	<0.005 || <0.005	LCS-2	86%
S_{POS}	%w/w	95948-11	<0.005 || <0.005	LCS-2	86%
a-S_{POS}	moles H^+/t	95948-11	<5 || <5	LCS-2	86%
Ca_{KCl}	%w/w	95948-11	<0.005 || <0.005	LCS-2	91%
Ca_P	%w/w	95948-11	<0.005 || <0.005	[NR]	[NR]
Ca_A	%w/w	95948-11	<0.005 || <0.005	[NR]	[NR]
Mg_{KCl}	%w/w	95948-11	<0.005 || <0.005	LCS-2	88%
Mg_P	%w/w	95948-11	<0.005 || <0.005	[NR]	[NR]
Mg_A	%w/w	95948-11	<0.005 || <0.005	[NR]	[NR]
Fineness Factor	-	95948-11	1.5 || 1.5 || RPD: 0	[NR]	[NR]
a-Net Acidity	moles H^+/t	95948-11	10 || <10	LCS-2	87%
Liming rate	kg $CaCO_3$/t	95948-11	0.75 || <0.75	LCS-2	86%
a-Net Acidity without ANCE	moles H^+/t	95948-11	NA || NA	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$/t	95948-11	NA || NA	[NR]	[NR]

QUALITY CONTROL sPOCAS	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	95948-21	22/08/2013 || 22/08/2013
Date analysed	-	95948-21	22/08/2013 || 22/08/2013
pH $_{kcl}$	pH units	95948-21	5.7 || 5.6 || RPD: 2
TAA pH 6.5	moles H^+/t	95948-21	<5 || <5
s-TAA pH 6.5	%w/w S	95948-21	<0.01 || <0.01
pH $_{Ox}$	pH units	95948-21	4.5 || 4.5 || RPD: 0
TPA pH 6.5	moles H^+/t	95948-21	5 || <5
s-TPA pH 6.5	%w/w S	95948-21	<0.01 || <0.01
TSA pH 6.5	moles H^+/t	95948-21	<5 || <5
s-TSA pH 6.5	%w/w S	95948-21	<0.01 || <0.01
ANC$_E$	% $CaCO_3$	95948-21	<0.05 || <0.05
a-ANC$_E$	moles H^+/t	95948-21	<5 || <5
s-ANC$_E$	%w/w S	95948-21	<0.05 || <0.05
S$_{KCl}$	%w/w S	95948-21	<0.005 || <0.005
S$_P$	%w/w	95948-21	<0.005 || <0.005
S$_{POS}$	%w/w	95948-21	<0.005 || <0.005
a-S$_{POS}$	moles H^+/t	95948-21	<5 || <5
Ca$_{KCl}$	%w/w	95948-21	<0.005 || <0.005
Ca$_P$	%w/w	95948-21	<0.005 || <0.005
Ca$_A$	%w/w	95948-21	<0.005 || <0.005
Mg$_{KCl}$	%w/w	95948-21	<0.005 || <0.005
Mg$_P$	%w/w	95948-21	<0.005 || <0.005
Mg$_A$	%w/w	95948-21	<0.005 || <0.005
S$_{HCl}$	%w/w S	[NT]	[NT]
S$_{NAS}$	%w/w S	[NT]	[NT]
a-S$_{NAS}$	moles H^+/t	[NT]	[NT]
s-S$_{NAS}$	%w/w S	[NT]	[NT]
Fineness Factor	-	95948-21	1.5 || 1.5 || RPD: 0
a-Net Acidity	moles H^+/t	95948-21	<10 || <10
Liming rate	kg $CaCO_3$/t	95948-21	<0.75 || <0.75
a-Net Acidity without ANCE	moles H^+/t	95948-21	NA || NA
Liming rate without ANCE	kg $CaCO_3$/t	95948-21	NA || NA

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.

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ABN 82 125 442 382

ANALYSIS REPORT SOIL

Project No:	**EW140521**	**Date of Issue:**	**14/08/2014**
Customer:	Envirolab Services	Report No:	1
Address:	12 Ashley St Chatswood NSW 2067	Date Received:	5/08/2014
		Matrix:	Soil
Attention:	Aileen Hie	Location:	114013
Phone:	02 9910 6200	Sampler ID:	Client Supplied
Fax:	02 9910 6201	Date of Sampling:	22/07/2014
Email:	ahie@envirolabservices.com.au	Sample Condition:	Acceptable

Comments: Dispersion Index ranges from 0 – 16, with 0 being not dispersive and 16 being completely dispersive.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

Signed: Stephanie Cameron
Operations Manager

PROFICIENT LAB
Visit www.aspac-australasia.com to view our certification details.

East West is certified by the Australian-Asian Soil & Plant Analysis Council to perform various soil and plant tissue analysis. The tests reported herein have been performed in accordance with our terms of accreditation.
This report must not be reproduced except in full and EWEA takes no responsibility of the end use of the results within this report.
This analysis relates to the sample submitted and it is the client's responsibility to make certain the sample is representative of the matrix to be tested.
Samples will be discarded one month after the date of this report. Please advise if you wish to have your sample/s returned.

Results you can rely on.

ANALYSIS REPORT

Project No: Location: 114013

Test Parameter	Method Reference	Units	Sample ID	114013-3	114013-5	114013-6	114013-8
			Depth cm	-	-	-	-
			LOR	140521-1	140521-2	140521-3	140521-4
Dispersion Index	*Loveday & Pyle*	*%*	*na*	0	1	0	4

ANALYSIS REPORT

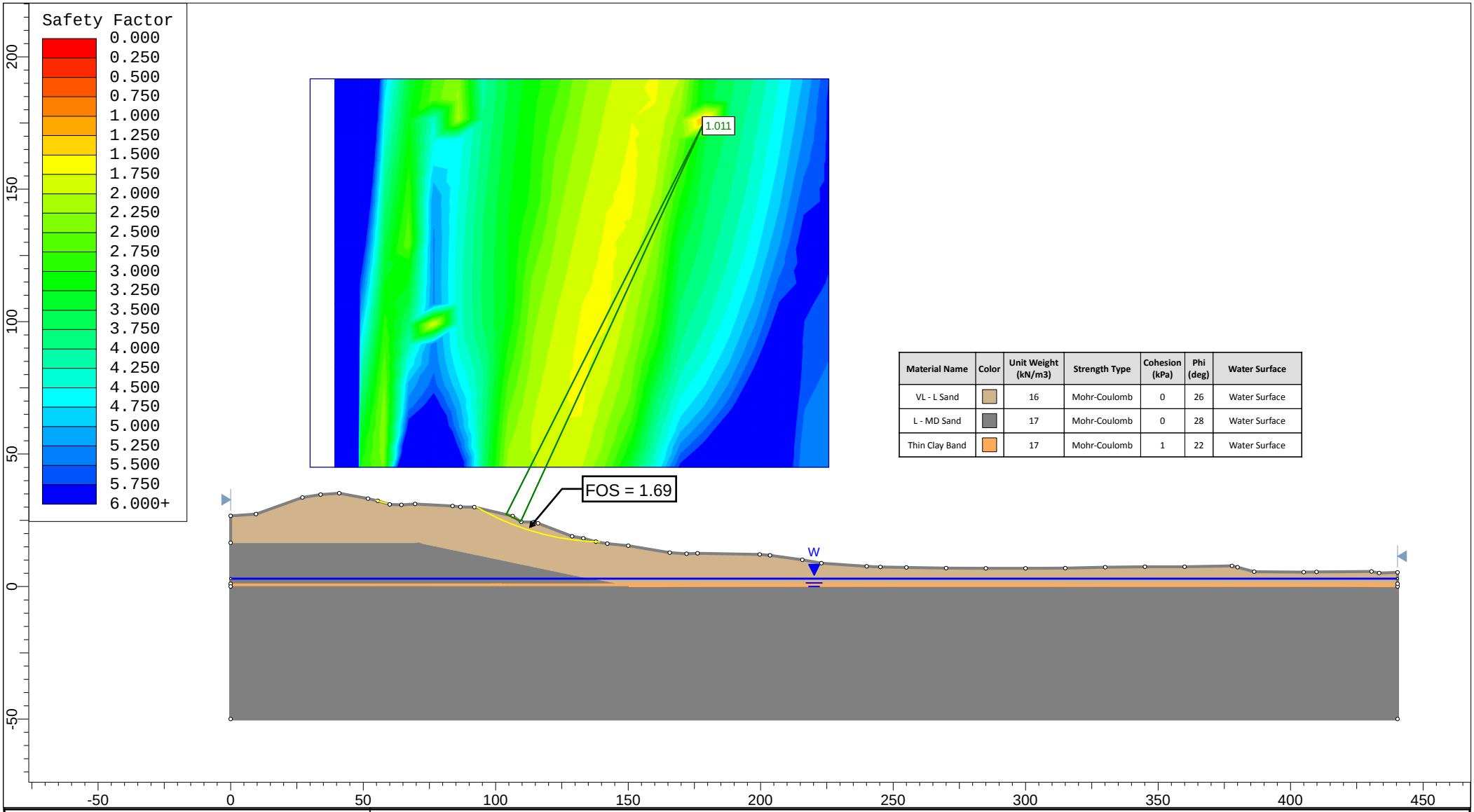
Project No: 140521 Location: 114013

Test Parameter	Method Reference	Units	Sample ID	114013-19	114013-21
			Depth cm	-	-
			LOR	140521-5	140521-6
Dispersion Index	*Loveday & Pyle*	*%*	*na*	1	0

NB: LOR is the Lowest Obtainable Reading.

DOCUMENT END

13 Appendix F – Slide Modelling Results



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface
VL - L Sand		16	Mohr-Coulomb	0	26	Water Surface
L - MD Sand		17	Mohr-Coulomb	0	28	Water Surface
Thin Clay Band		17	Mohr-Coulomb	1	22	Water Surface

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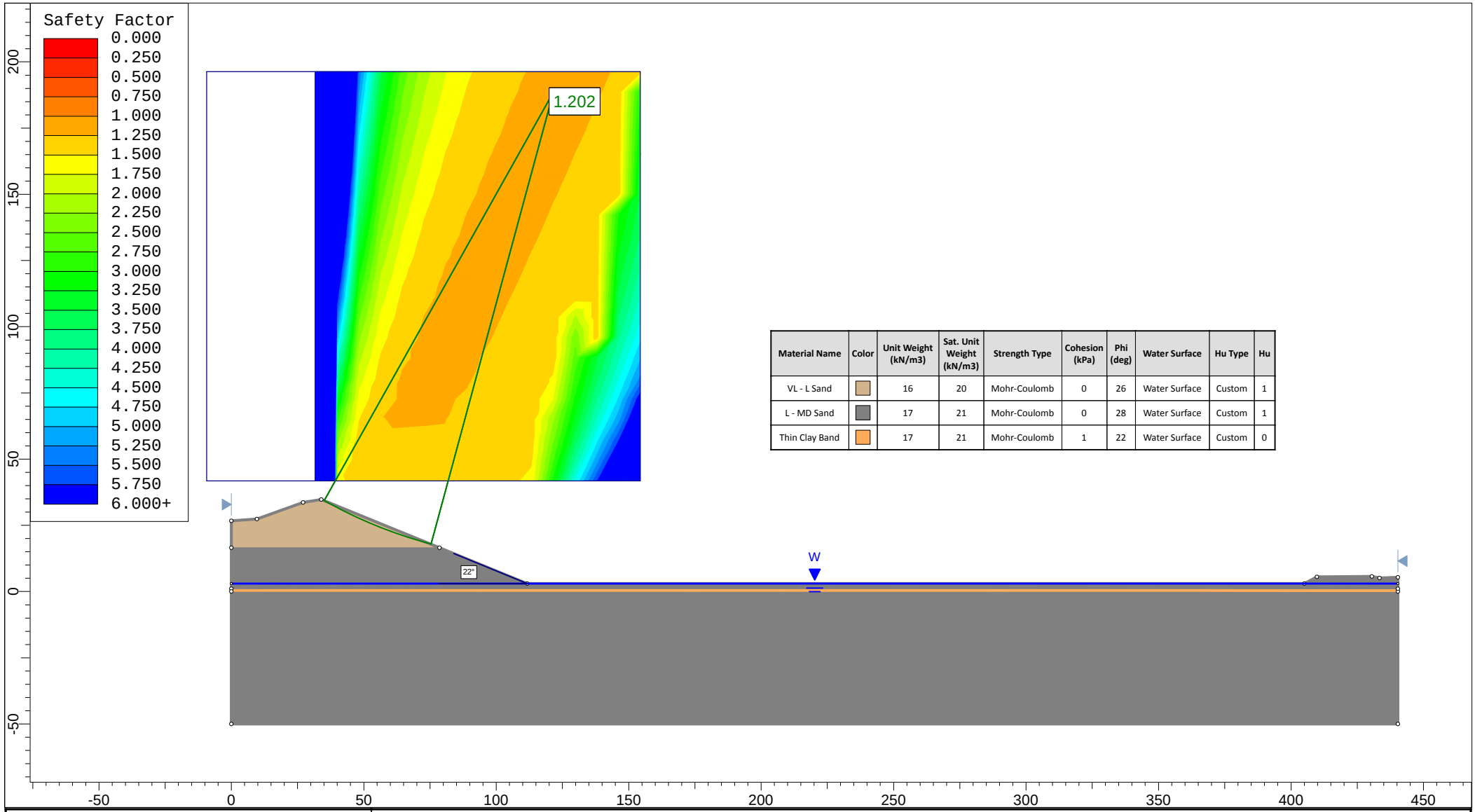
SLIDEINTERPRET 6.029

Project	Proposed Sand Quarry - 51 Nelson Bay Road, Bobs Farm, NSW			
Description	Slide Modelling - Section A-A, Existing Slope Conditions			
Drawn By	AB	*Scale*	1:2000	*Company* Martens & Associates Pty Ltd
Date	28/08/2014			*File Name* P1303897SL02V01.slim



Material Name	Color	Unit Weight (kN/m3)	Sat. Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
VL - L Sand		16	20	Mohr-Coulomb	0	26	Water Surface	Custom	1
L - MD Sand		17	21	Mohr-Coulomb	0	28	Water Surface	Custom	1
Thin Clay Band		17	21	Mohr-Coulomb	1	22	Water Surface	Custom	0

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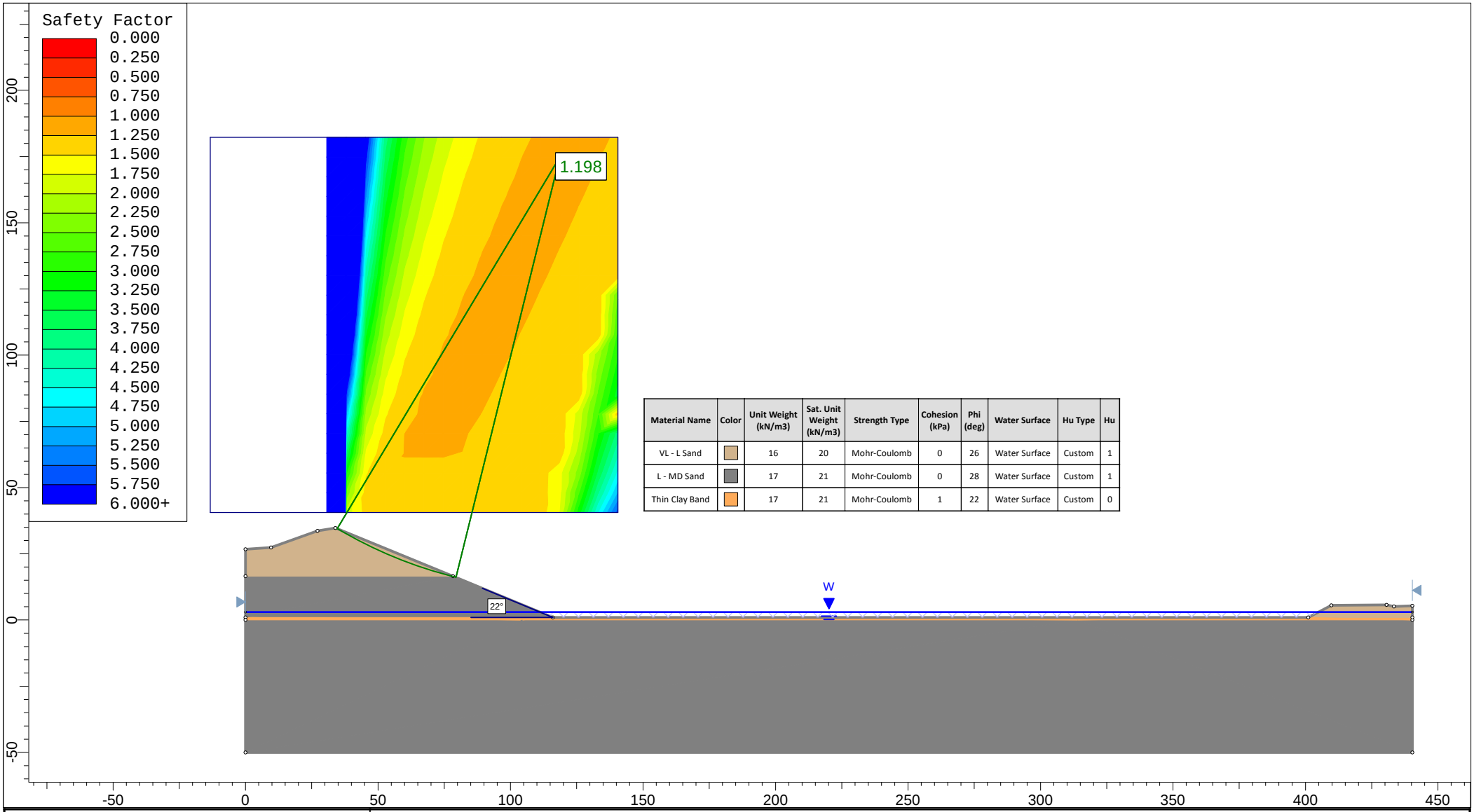
SLIDEINTERPRET 6.029

Project	Proposed Sand Quarry - 51 Nelson Bay Road, Bobs Farm, NSW				
Description	Slide Modelling - Section A-A, Stage 1 (Excavation to 3m AHD)				
Drawn By	AB	*Scale*	1:2000	*Company*	Martens & Associates Pty Ltd
Date	28/08/2014			*File Name*	P1303897SL04V01.slim

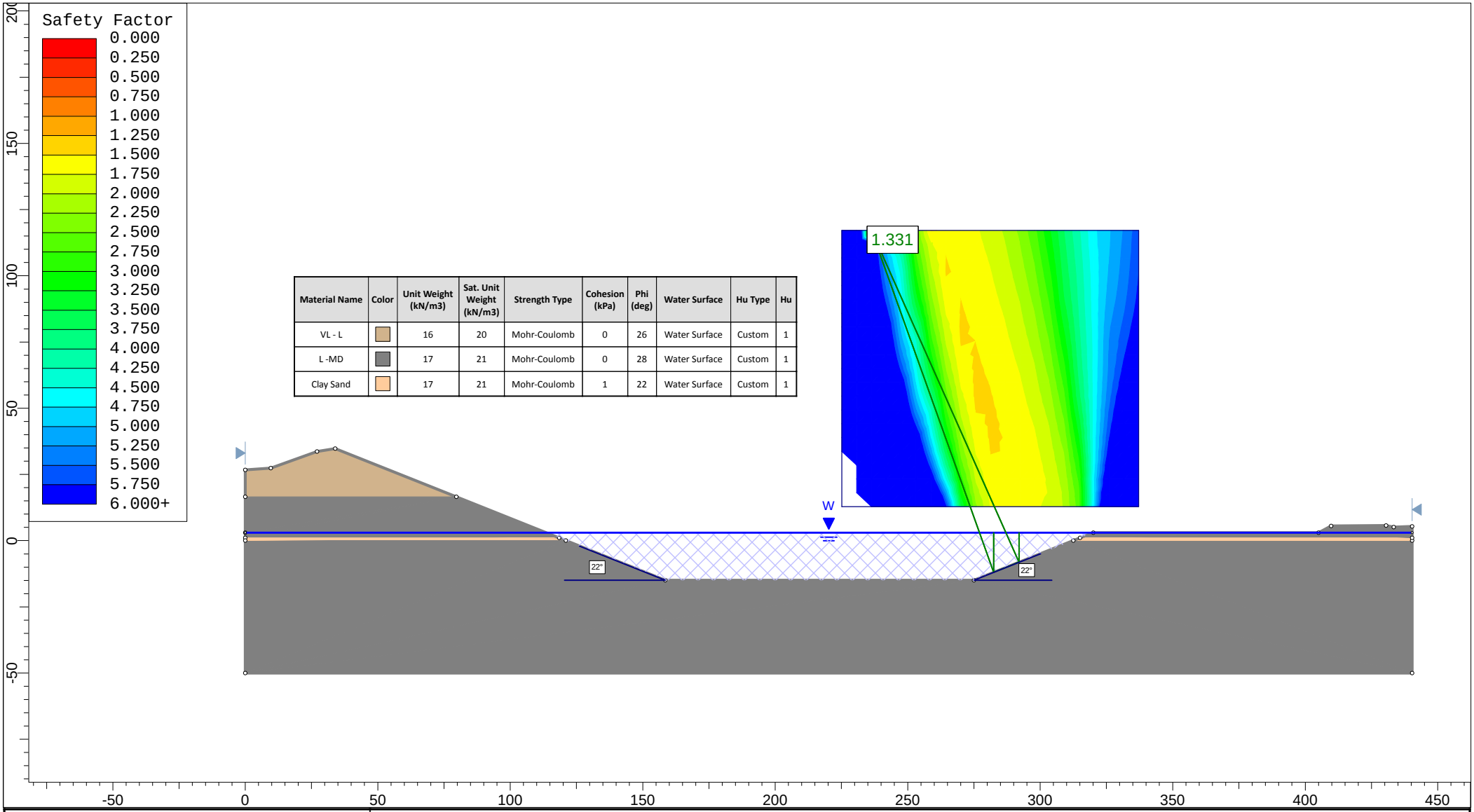


Material Name	Color	Unit Weight (kN/m3)	Sat. Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
VL - L Sand		16	20	Mohr-Coulomb	0	26	Water Surface	Custom	1
L - MD Sand		17	21	Mohr-Coulomb	0	28	Water Surface	Custom	1
Thin Clay Band		17	21	Mohr-Coulomb	1	22	Water Surface	Custom	0

martens consulting engineers

SLIDEINTERPRET 6.029

Project	Proposed Sand Quarry - 51 Nelson Bay Road, Bobs Farm, NSW		
Description	Slide Modelling - Section A-A, Stage 2 (Excavation to 1m AHD)		
Drawn By	AB	*Scale* 1:2000	*Company* Martens & Associates Pty Ltd
Date	28/08/2014		*File Name* P1303897SL07V01.slim



Material Name	Color	Unit Weight (kN/m3)	Sat. Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
VL - L		16	20	Mohr-Coulomb	0	26	Water Surface	Custom	1
L -MD		17	21	Mohr-Coulomb	0	28	Water Surface	Custom	1
Clay Sand		17	21	Mohr-Coulomb	1	22	Water Surface	Custom	1

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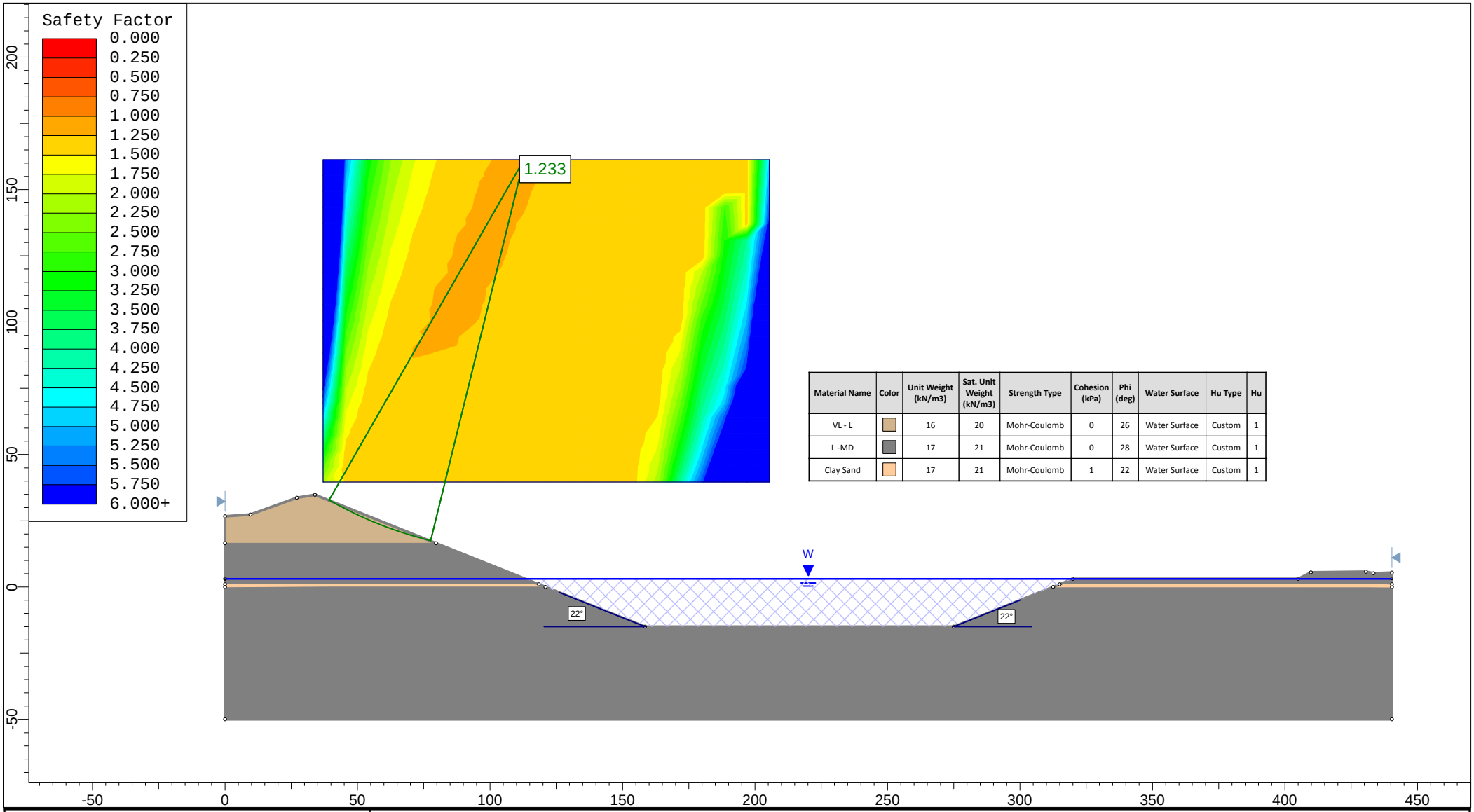
SLIDEINTERPRET 6.029

Project	Proposed Sand Quarry - 51 Nelson Bay Road, Bobs Farm, NSW		
Description	Slide Modelling - Section A-A, Stage 3 (Excavation to -15m AHD)		
Drawn By	AB	*Scale* 1:2000	*Company* Martens & Associates Pty Ltd
Date	28/08/2014		*File Name* P1303897SL18V01.slim



Material Name	Color	Unit Weight (kN/m3)	Sat. Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
VL - L		16	20	Mohr-Coulomb	0	26	Water Surface	Custom	1
L -MD		17	21	Mohr-Coulomb	0	28	Water Surface	Custom	1
Clay Sand		17	21	Mohr-Coulomb	1	22	Water Surface	Custom	1

martens consulting engineers

SLIDEINTERPRET 6.029

Project	Proposed Sand Quarry - 51 Nelson Bay Road, Bobs Farm, NSW		
Description	Slide Modelling - Section A-A, Stage 3 (Excavation to -15m AHD)		
Drawn By	AB	*Scale* 1:2000	*Company* Martens & Associates Pty Ltd
Date	28/08/2014		*File Name* P1303897SL18V01.slim

14 Appendix G – Risk Evaluation Calculations

Landslide Hazard Evaluation - Risk to Life Assessment

Method based on Walker *et al.* in AGS Vol 42 No. 1 March 2007

Method ST-24 Revised 20.02.08

6/37 Leighton Place, Hornsby, NSW 2007, Ph: (02) 9476 9999 Fax: (02) 9476 8767, mail@martens.com.au, www.martens.com.au

PROJECT DETAILS

Project	Geotechnical Assessment			Ref. No.	P1303897
Author	GMT	Reviewed	RE	Created	17.09.14

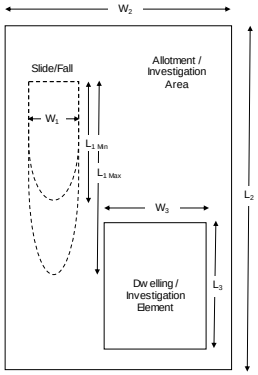
STEP 1 : ENTER SITE AND DESIGN DATA

Hazard Type	**Soil Creep**

$P_{(H)}$	Annual probability of landslide	**0.001**

INDICATIVE VALUE	RECURRENCE INTERVAL	DESCRIPTION	DESCRIPTOR	LEVEL
10^{-1}	10 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	100 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	1000 years	The event could occur under tadverse conditions over the design life.	POSSIBLE	C
10^{-4}	10,000 years	The enent might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	100,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}	1,000,000 years	The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

$P_{(S:H)}$	Probablity of spatial impact impacting building location taking into account travel distance and travel direction	**0.03**



FACTOR	DESCRIPTION	UNITS	VALUE
W_1	Likely slide/fall width	m	**100**
W_2	Width of allotment / investigation area	m	**700**
W_3	Width of dwelling / investigation element	m	**60**
L_{1Min}	Minimum run-out length	m	**1**
L_{1Max}	Maximum run-out length	m	**50**
L_2	Length of allotment / investigation area	m	**700**
L_3	Length of dwelling / investigation element	m	**50**
L_{PMin}	Probability of runout being 0 - 1 m long	(0 - 1)	**0.05**
L_{PMax}	Probability of runout being 0 - 50 m long	(0 - 1)	0.95
W_F	Likelihood of across slope strike on risk element	(0 - 1)	**0.23**
$L_{F Min}$	Likelihood of downslope strike on risk element for minimum run-out distance	(0 - 1)	0.07
$L_{F Max}$	Likelihood of downslope strike on risk element for maximum run-out distance	(0 - 1)	0.14
$L_{F Design}$	Likelihood of downslope strike (integrated) on risk element run-out distance	(0 - 1)	**0.14**

$P_{(T:S)}$	Temporal spatial probability given the spatial impact	**0.35**

FACTOR	DESCRIPTION	UNITS	VALUE
T_1	Percentage of time person(s) are on-site	m	50%
T_2	Percentage of dwelling / element that person(s) occupy	m	70%

$V_{(V:D)}$	Vulnerability of the individual (ie. probability of loss of life given the impact)	**0.05**

CASE	DESCRIPTION	RANGE IN DATA	RECOMMENDED VALUE	COMMENTS
Person in open space	If struck by a rockfall	0.1 - 0.7	0.50	May be injured but unlikely to cause death
	If buried by debris	0.8 - 1.0	1.00	Death by asphyxia almost certain
	If not buried	0.1 - 0.5	0.10	High chance of survival
Person in a vehicle	If vehicle is buried / crushed	0.9 - 1.0	1.00	Death is almost certain
	If the vehicle is damaged only	0.0 - 0.3	0.30	High chance of survival
Persons in building	If the building collapses	0.9 - 1.0	1.00	Death is almost certain
	If the building is inundated with debris and the person is buried	0.8 - 1.0	1.00	Death is highly likely
	If the debris strikes the building only	0.0 - 0.1	0.05	Very high chance of survival

STEP 2 : RISK EVALUATION

$V_{(D:T)}$	Risk (annual probability of loss of life of an individual)	**5.57E-07**
Risk Assessment	**Acceptable risk for loss of life for the person(s). Risk level suitable for new developments.**	

Landslide Hazard Evaluation - Risk to Life Assessment

Method based on Walker *et al.* in AGS Vol 42 No. 1 March 2007

Method ST-24 Revised 20.02.08

6/37 Leighton Place, Hornsby, NSW 2007, Ph: (02) 9476 9999 Fax: (02) 9476 8767, mail@martens.com.au, www.martens.com.au

PROJECT DETAILS

Project	Geotechnical Assessment			Ref. No.	P1404179
Author	GMT	Reviewed	RE	Created	23.05.14

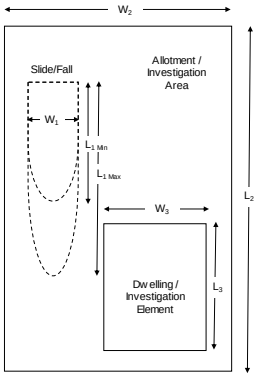
STEP 1 : ENTER SITE AND DESIGN DATA

Hazard Type	**Slide Failure**

$P_{(H)}$	Annual probability of landslide	**0.001**

INDICATIVE VALUE	RECURRENCE INTERVAL	DESCRIPTION	DESCRIPTOR	LEVEL
10^{-1}	10 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	100 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	1000 years	The event could occur under tadverse conditions over the design life.	POSSIBLE	C
10^{-4}	10,000 years	The enent might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	100,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}	1,000,000 years	The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

$P_{(S:H)}$	Probablity of spatial impact impacting building location taking into account travel distance and travel direction	**0.02**



FACTOR	DESCRIPTION	UNITS	VALUE
W_1	Likely slide/fall width	m	**10**
W_2	Width of allotment / investigation area	m	**700**
W_3	Width of dwelling / investigation element	m	**60**
L_{1Min}	Minimum run-out length	m	**1**
L_{1Max}	Maximum run-out length	m	**100**
L_2	Length of allotment / investigation area	m	**700**
L_3	Length of dwelling / investigation element	m	**50**
L_{PMin}	Probability of runout being 0 - 1 m long	(0 - 1)	**0.05**
L_{PMax}	Probability of runout being 0 - 100 m long	(0 - 1)	0.95
W_F	Likelihood of across slope strike on risk element	(0 - 1)	**0.10**
$L_{F\,Min}$	Likelihood of downslope strike on risk element for minimum run-out distance	(0 - 1)	0.07
$L_{F\,Max}$	Likelihood of downslope strike on risk element for maximum run-out distance	(0 - 1)	0.21
$L_{F\,Design}$	Likelihood of downslope strike (integrated) on risk element run-out distance	(0 - 1)	**0.21**

$P_{(T:S)}$	Temporal spatial probability given the spatial impact	**0.35**

FACTOR	DESCRIPTION	UNITS	VALUE
T_1	Percentage of time person(s) are on-site	(0-1)	50%
T_2	Percentage of dwelling / element that person(s) occupy	(0-1)	70%

$V_{(V:D)}$	Vulnerability of the individual (ie. probability of loss of life given the impact)	**0.10**

CASE	DESCRIPTION	RANGE IN DATA	RECOMMENDED VALUE	COMMENTS
Person in open space	If struck by a rockfall	0.1 - 0.7	0.50	May be injured but unlikely to cause death
	If buried by debris	0.8 - 1.0	1.00	Death by asphyxia almost certain
	If not buried	0.1 - 0.5	0.10	High chance of survival
Person in a vehicle	If vehicle is buried / crushed	0.9 - 1.0	1.00	Death is almost certain
	If the vehicle is damaged only	0.0 - 0.3	0.30	High chance of survival
Persons in building	If the building collapses	0.9 - 1.0	1.00	Dealth is almost certain
	If the building is inundated with debris and the person is buried	0.8 - 1.0	1.00	Death is highly likely
	If the debris strikes the building only	0.0 - 0.1	0.05	Very high chance of survival

STEP 2 : RISK EVALUATION

$V_{(D:T)}$	Risk (annual probability of loss of life of an individual)	**7.25E-07**
Risk Assessment	**Acceptable risk for loss of life for the person(s). Risk level suitable for new developments.**	