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ABN 64 002 841 063

Job No: 13787/1
Our Ref: 13787/1-AA
3 August 2016

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Attention: Mr D Hogan

Dear Sir

re: **Proposed Development**
23-27 Warriewood Road, Warriewood
Geotechnical Investigation

This report provides the results of a geotechnical investigation carried out at 23-17 Warriewood Road, Warriewood, hereafter referred to as the site.

We understand that the proposed development at the above site includes the construction of the following:

- A residential aged care facility (RACF) building in the southern portion of the site. This building will have three storeys above the ground and one level of basement car park. The basement excavation will be about 3.0m deep.
- Townhouses, dual occupancies and residential flat buildings to the northern portion of the site. These buildings will have ground floors at about existing ground surface.

A geotechnical investigation is required to assess subsurface conditions across the site in order to provide geotechnical recommendations for the design of basement excavation, retaining structures, floor slabs and footings.

Background Information

Based on our experience at 53 Warriewood Road, Warriewood, the subsurface profile in the western portion of the site (adjacent to the creek) is anticipated to comprise significant thickness of very soft alluvial deposit. However, bedrock may be encountered at shallow depth in the eastern portion.

Review of Geological Map of Sydney (scale 1:100,000) indicates the following:

- The subsurface profile in the eastern portion of the site belongs to the Narrabeen Group comprising interbedded laminite, shale and sandstone with minor clays.
- The subsurface profile in the western portion of the site includes stream alluvium and/or estuarine deposit, comprising silty to peaty quartz sand, silt and clay, ferruginous and humic at places, with shell layers.

Review of the Soil Landscape Map of Sydney (scale 1:100,000) indicates the following:

- The landscape in the eastern portion of the site belongs to Watagan Group, which is characterised by rolling to very steep hills on fine grained Narrabeen Group sediments, with local relief of 60m to 120m, ground slopes in excess of 25%, narrow crests and ridges, steep colluvial side slopes and occasional sandstone boulders and benches. There is likely to be occasional rock outcrops with sandy soils on sandstone and clayey soils on shale. The group is susceptible to mass movement and erosion hazard.
- The landscape in the western portion of the site belongs to Warriewood Group, which is characterised by level to gently undulating swales, depressions and in filled lagoons on Quaternary sand, with local relief of less than 10m, ground slopes of less than 3%, depth to water table of less than 2.0m. Soils in this group comprise sandy humus, sand and peaty, with thickness exceeding 1.5m. This landscape has high watertable and is subjected to flooding.

Review of the Acid Sulphate Soil Risk Map (Edition 2, scale 1:25,000) of Hornsby/Mona Vale prepared by Department of Land and Water Conservation the following:

- There are no known occurrences of acid sulphate soil materials within the soil profiles in most portions of the site and acid sulphate soil materials are not expected in most portions of the site.
- In the western portion of the site, adjacent to Narrabeen Creek, there is low probability of occurrence of acid sulphate soil materials within the soil profile at depths exceeding 3.0m.

Field Work

Field work for the geotechnical investigation was carried out during 13, 15 and 19 July 2016 and consisted of the following:

- A walkover survey to assess general site conditions.
- Review services plans obtained from “Dial Before You Dig” to ascertain the locations of underground services across the site.
- Scanning proposed borehole locations for underground services to ensure that the investigation works would not damage existing underground services. We engaged a specialist services locator for this purpose.
- Drilling eight boreholes (BH1 to BH8) using a truck mounted drilling rig fully equipped for geotechnical investigation. Boreholes were uniformly distributed in accessible portions of the site. Boreholes were initially drilled using V-bit or TC-bit refusal in bedrock at depths of 6.0m to 11.2m from existing ground surface. Then five boreholes were continued into bedrock for depths of about 1.8m to 2.7m using rock coring technique. Approximate borehole locations are indicated on the attached Drawing No 13787/1-AA1. Borehole logs and core photographs along with explanatory notes are also attached.
- Carry out Standard Penetration Tests (SPT) in the boreholes at regular depth intervals to assess the strength characteristics of the sub-surface soils. SPT test results are included in appropriate borehole logs.
- Recover representative soil samples and rock cores from the boreholes for visual classification and laboratory tests.
- Measure depths to groundwater level in boreholes, if encountered.

Field work was supervised by a team of two Field Engineers from this company, who were responsible for nominating the borehole locations, supervising SPT tests, sampling and preparation of field logs.

Site Conditions

The site is of irregular shape measuring approximately 2.533ha in plan area. The following observations were made during field work:

- The site is bound by Warriewood Road, Warriewood to the east, Narrabeen Creek to the west, a vacant residential lot to the north and Macpherson Street to the south.
- The site is vacant and grass covered.
- The natural ground surface across the site dips from the east towards the west at about 2 to 5 degrees. However, the buildings for the propose development will be located at least 50.0m away from the Narrabeen Creek, where ground surface is dipping at about 4 to 5 degrees.

Sub-surface profiles encountered in the boreholes are detailed in the attached borehole logs and summarised below in Table 1.

Table 1 – Sub-surface Profiles at Borehole Locations

Borehole No	Ground Surface RL (m, AHD)	Termination Depth* (m)	Depth Range for Topsoil/Fill (m)	Depth Range for Alluvium (m)	Depth to Bedrock (m)	Depth to Groundwater (m)
BH1	3.2	11.9	0.0-0.3	0.0-9.5	9.5	4.3
BH2	8.1	7.8	0.0-0.4	0.4-6.0	6.0	4.5
BH3	4.6	10.3	0.0-0.2	0.2-10.3	10.3	7.9
BH4	4.0	8.9	0.0-0.3	0.3-7.0	7.0	>8.9
BH5	12.0	11.7	0.0-0.2	0.2-7.0	7.0	>11.7
BH6	8.8	11.9	0.0-0.5	0.5-6.6	6.6	4.4
BH7	6.5	14.4	0.0-0.3	0.3-7.2	7.2	4.4
BH8	5.7	8.9	0.0-0.3	0.3-7.0	7.0	4.5

RL are Approximate only.

Table 1 indicates that the sub-surface profile across the site comprises a sequence of topsoil/fill and alluvial soils underlain by bedrock. The thickness of topsoil/fill varies from about 0.2m to 0.5m and the depth to bedrock varies from about 6.0m to 10.3m from existing ground surface.

Topsoil/fill included sandy silt of low plasticity and fine to medium grained silty sand with some roots. Alluvial soils included layers of fine to medium grained sand, clayey sand and silty sand and low to high plasticity silty clay and sandy clay with ironstone. It is possible that a layer of clayey soil overlying bedrock in some borehole locations was residual soil not alluvium. Bedrock to borehole termination depth was predominantly sandstone but localised claystone was also encountered.

Groundwater level was encountered in all boreholes except two boreholes BH4 and BH5 at depths ranging from 4.3m to 7.9m from existing ground surface. No groundwater level was encountered in borehole BH4 and BH5 up to their termination depths of 8.9m and 11.7m respectively. Therefore, we anticipate the depth to groundwater level across the building site to be more than 4.0m from existing ground surface. It should however be noted that the depth to groundwater level could be affected by rainfall and other factors not evident during investigation.

Laboratory Testing

Representative soil samples recovered from the boreholes were tested in the NATA accredited laboratory of SGS Environmental Services to determine the chemical properties to assess the following:

- Salinity of soil in terms of Electrical Conductivity (EC)
- Aggressivity of soil in terms of pH, chloride, sulphate and resistivity
- Acid sulphate soils in terms of of **pH_{KCl}, pH_{ox}**(pH after oxidation), **TPA** (Total Potential Acidity), **TAA** (Total Actual Acidity), **TSA** (Total Sulphidic Acidity), **S_{POS}%** (Percent Peroxide Oxidisable Sulfur) and **S_{cr}** (Chromium Reducible Sulphur).

Detailed laboratory test results are attached and summaries are presented in the following Tables 2 to 4:

Table 2 – Results of Electrical Conductivity Tests

Borehole No	Depth (m)	EC (µS/cm)		Borehole No	Depth (m)	EC (µS/cm)
BH1	0.5-0.95	37		BH6	0.5-0.95	220
BH1	2.0-2.45	61		BH6	1.5-1.95	140
BH1	3.5-3.95	49		BH6	3.0-3.45	76
BH1	5.0-5.45	85		BH6	4.5-4.95	94
BH1	6.5-6.95	170		BH6	6.0-6.45	120
BH1	8.0-8.45	180		BH6	7.5-7.95	85
BH4	1.0-1.45	74		BH8	3.0-3.5	47
BH4	3.0-3.45	65		BH8	5.0-5.5	47
BH4	5.0-5.45	160		BH8	8.9-9.0	100
BH4	6.5-6.95	86				

Table 3 – Results of Soil Aggressivity Tests

Borehole No	Depth (m)	pH	Chloride (mg/kg)	Sulphate (mg/kg)	Resistivity (ohm-cm)
BH1	0.5-0.95	6.7	5.9	20	17000
BH1	2.0-2.45	4.6	6.0	46	14000
BH1	3.5-3.95	4.6	7.5	50	15000
BH1	5.0-5.45	4.9	15	87	8100
BH1	6.5-6.95	4.6	110	100	3700
BH1	8.0-8.45	4.8	130	89	4000
BH6	1.5-1.95	4.8	61	100	5000
BH6	3.0-3.45	4.9	21	100	8200
BH6	4.5-4.95	4.9	19	100	6900
BH6	6.0-6.45	4.7	22	140	6000
BH6	7.5-7.95	5.1	24	89	7800
BH8	3.0-3.5	5.1	2.5	46	18000
BH8	5.0-5.5	5.1	7.7	48	17000
BH8	8.9-9.0	5.0	25	120	6900

Table 4 – Results of Acid Sulphate Soil Tests

Borehole No	Depth (m)	pH_{KCl}	pH_{ox}	TPA (pH6.5)	TAA (pH6.5)	TSA (pH6.5)	S_{POS} (% w/w)	Scr (% w/w)
BH2	2.0-2.45	4.0	4.5	65	65	<5	<0.005	<0.005
BH3	0.5-0.95	5.9	6.0	<5	6	<5	<0.005	<0.005
BH3	2.5-2.95	4.0	5.1	57	57	<5	<0.005	<0.005
BH3	5.5-5.95	3.8	4.9	87	82	<5	<0.005	<0.005
BH3	8.0-8.45	3.8	5.1	90	87	<5	<0.005	<0.005
BH5	7.0-7.5	3.8	5.0	112	102	10	<0.005	<0.005

Notes
pH_{KCl} = pH of filtered 1:20, 1M K_{Cl} extract, overnight shake
pH_{ox} = pH of filtered 1:20, 1M K_{Cl} after peroxide digestion
TPA = Total Potential Acidity (mol H^+/tonne)
TAA = Total Actual Acidity (mol H^+/tonne)
TSA = Total Sulphidic Acidity (mol H^+/tonne)
S_{POS} = Peroxide Oxidisable Sulphur (%w/w)
S_{cr} = Chromium Reducible Sulphur (% w/w)
Limit of Reporting for TAA, TPA and TSA is 5 moles H^+/tonne, and for S_{POS} is 0.005% w/w.

Rock cores obtained from selected boreholes were photographed and tested at regular depth intervals for determination of Point Load Strength Index (I_{s50}). The point load strength indices for the rock cores and the assessed rock strengths, in accordance with Australian Standard AS1726-1993 (Reference 1), are summarised in the following Table 5.

Table 5 – Results of Point Load Strength Index Tests

Borehole No	Depth (m)	Diametral $I_{s(50)}$ (MPa)	Axial $I_{s(50)}$ (MPa)	Assessed Diametral Strength	Assessed Axial Strength
BH1	9.55	0.61	1.33	Medium	High
BH1	10.35	0.23	0.56	Low	Medium
BH1	11.20	0.91	1.03	Medium	High
BH1	11.85	0.07	0.59	Very Low	Medium
BH2	6.10	0.75	1.60	Medium	High
BH2	7.35	0.11	0.10	Low	Very Low
BH4	7.27	0.79	1.53	Medium	High
BH4	7.70	0.11	0.04	Low	Very Low
BH4	8.50	0.21	0.25	Low	Low
BH4	8.85	1.02	1.00	High	High
BH6	10.40	0.13	0.14	Low	Low
BH6	11.70	0.20	1.19	Low	High
BH7	11.90	1.78	1.60	High	High
BH7	12.80	1.47	1.21	High	High
BH7	13.60	0.53	0.83	Medium	Medium

It should however be noted that Point Load Strength tests could only be carried out on intact (stronger) portions of rock cores. Therefore, strength assessments presented in Table 5 indicate the upper limits of rock strengths.

Based on rock strengths (Table 5) and rock discontinuities shown in the borehole logs, bedrock from the proposed development site is classified for foundation design in accordance with Pells et al (Reference 2) in the following Table 6.

Table 6 – Rock Classification for Foundation Design

Assessed Rock Class	Depth Range in BH1* (m)	Depth Range in BH2* (m)	Depth Range in BH4* (m)	Depth Range in BH6* (m)	Depth Range in BH7* (m)
Sandstone - Class V	NE	6.0-7.6	7.0-8.0	6.6-10.5	7.2->11.5
Sandstone - Class IV	NE	7.6->7.8	NE	10.5-11.5	NE
Sandstone – Class III	>9.5	NE	>8.0	>11.5	NE

* Approximate only from existing ground surface
NE=Not Encountered

Table 6 indicates that the rock classification for bedrock across the site vary significantly both in the plan and depth.

DISCUSSION AND RECOMMENDATIONS

Soil Salinity

Salinity refers to the presence of excess salt in the environment, either in soil or water. Salinity is a serious problem for any development due to the many environmental, economic and social impacts.

Soil salinity is generally assessed by measuring Electrical Conductivity (EC) of a soil sample made up of 1:5 soil water suspension. Thus, determined Electrical Conductivity (EC) is multiplied by a factor varying from 6 to 23, based on the texture of the soil sample, to obtain Corrected Electrical Conductivity designated as ECe (Reference 3). Alternatively, ECe may be directly measured in soil saturation extracts. Soils are classified as saline if ECe of the saturated extracts exceed 4.0dS/m.

The criteria for assessment of soil salinity classes are shown in the following Table 7 (Reference 3):

Table 7 –Criteria for Soil Salinity Classification

Classification	EC_e (dS/m)	Comments
Non-saline	<2	Salinity effects mostly negligible
Slightly saline	2 – 4	Yields of very sensitive crops may be affected
Moderately saline	4 – 8	Yields of many crops affected
Very saline	8 – 16	Only tolerant crops yield satisfactorily
Highly saline	>16	Only a few tolerant crops yield satisfactorily

Electrical Conductivity (EC) values for 19 representative soil samples are summarised in Table 2. For sandy soils encountered across the site multiplying factors of 12 to 14 are considered appropriate. But for clayey soils multiplying factors of 8 to 10 are considered appropriate. Even if multiplying factor is 14, estimates of ECe values for representative samples vary from about 0.5dS/m to 3.1dS/m.

Therefore, it is our assessment that the soils likely to be disturbed or excavated during proposed development works are non-saline. That also means that the excavation and disturbance of the soils during proposed development works can be carried out without a specific saline soil management plan.

Soil Aggressivity

Aqueous solution of chlorides causes corrosion of iron and steel, including steel reinforcements in concrete. The aggressivity classifications of soil and groundwater applicable to iron and steel, in accordance with Australian Standard AS2159 (Reference 4), are given below in Table 8.

Table 8 – Soil Aggressivity Classification for Steel/Iron

Chloride		pH	Resistivity (ohm cm)	Soil Condition A*	Soil Condition B#
In Soil (ppm)	In Water (ppm)				
<5000	<1000	>5.0	>5000	Non-aggressive	Non-aggressive
5000-20000	1000-10000	4.0-5.0	2000-5000	Mild	Non-aggressive
20000-50000	10000-20000	3.0-4.0	1000-2000	Moderate	Mild
>50000	>20000	<3.0	<1000	Severe	Moderate

*Soil Condition A = high permeability soils (e.g. sands and gravels) which are below groundwater
#Soil Condition B = low permeability soils (e.g. silts and clays) and all soils above groundwater

The aggressivity classifications of soil and groundwater applicable to concrete, in accordance with Reference 4 are given below in Table 9.

Table 9 – Soil Aggressivity Classification for Concrete

Sulphate expressed as SO_4		pH	Chloride in Water (ppm)	Soil Condition A	Soil Condition B
In Soil (ppm)	In Groundwater (ppm)				
<5000	<1000	>5.5	<6000	Mild	Non-aggressive
5000-10000	1000-3000	4.5-5.5	6000-12000	Moderate	Mild
10000-20000	3000-1000	4.0-4.5	12000-30000	Severe	Moderate
>20000	>10000	<4.0	>30000	Very Severe	Severe

Approximately 100ppm of SO_4 = 80ppm of SO_3

Results of aggressivity tests on 14 representative soil samples are summarised in Table 3. The soils likely to be encountered during proposed development works are assessed to be predominantly clayey with low permeability. But sandy soils with high permeability are also present. Therefore, results of aggressivity tests indicate the following:

- The pH value of soils vary from 4.6 to 6.7, indicating that the site is non-aggressive to mildly moderately aggressive to steel/iron but mildly to moderately aggressive to concrete.
- Chloride contents in soils vary from 2.5 to 130.0ppm, indicating the site is non-aggressive to steel but mildly aggressive to concrete.
- Sulphate contents in soils vary from 420.0 to 140.0 ppm, indicating the site is mildly to moderately aggressive to concrete.
- Resistivity of soil varies from 3700.0 to 18000 ohm-cm, indicating the site is non-aggressive to mildly moderately aggressive to steel/iron.

Based on the laboratory test results and the assumption that soils are predominantly sandy, the site is assessed to be mildly aggressive towards steel/iron and moderately aggressive towards concrete. Therefore, we recommend use of construction materials, such as concrete and steel that are appropriate to assessed aggressivity.

Acid Sulphate Soil Assessment

Review of existing information and site assessment indicated the following:

- The Acid Sulphate Soil Risk Map of Hornsby/Mona Vale indicates there are no known occurrences of acid sulphate soil materials in most portions of the site. However, there is a low probability of occurrence of acid sulphate soil materials in the western portion of the site adjacent to the Narrabeen Creek.

- Buildings for the proposed development will be constructed at least 50.0m away from the Narrabeen Creek (buffer zone), where ground surface elevation is at 5.0m AHD or higher. The ground surface within the proposed building area is dipping gently (2 to 3 degrees) towards the west. Therefore, ground surface elevation and geomorphology of the site indicate that acid sulphate or potentially acid sulphate soils are unlikely to be encountered across the site.
- The sub-surface profile across the site comprises a sequence of topsoil/fill and alluvial soil underlain by sandstone. Topsoil/fill as well as alluvial soils likely to be disturbed or excavated during construction of the proposed residence could be acid sulphate or potentially acid sulphate soils.
- Groundwater level is likely to be deeper than the base of proposed excavation. Although the level of groundwater might fluctuate due to variations in rainfall and/or other factors not evident during drilling, it is unlikely that proposed development works will lower the groundwater level to expose the acid sulphate or potentially acid sulphate soils to atmosphere.

The above assessments based on review of available information indicate acid sulphate or potentially acid sulphate soils are unlikely to be encountered at the proposed development site. Despite that representative soil samples obtained from various depths were tested for acid sulphate or potentially acid sulphate soils. The laboratory test results summarised in Table 4 indicate the following:

- The pH_{kcl} (field pH) values are in range of 3.8 to 5.9, indicating actual acid sulphate soils are absent at the site, but does not give an indication whether potential acid sulphate soils are present or not.
- The pH_{ox} values (pH after oxidation) of samples are in range of 4.5 to 6.0. The pH_{ox} values of all samples are higher than the pH_{kcl} values, indicating that oxidation of soils is unlikely to produce any acid.
- Peroxide Oxidisable Sulphur content in the soil samples is lower than 0.03% and hence oxidation of soils is unlikely to produce any significant acid.
- Chromium Reducible Sulphur content in the soil samples is lower than 0.03% and hence oxidation of soils is unlikely to produce any significant acid.

Assessments of laboratory test results indicate soils across the site are unlikely to be acid sulphate or potentially acid sulphate soils.

Acid sulphate soils are a problem because they produce significant acid (sulphuric acid) by oxidation when exposed to oxygen, which might occur during excavation or disturbance of soils containing iron sulphides/oxidisable sulphur. Lowering the groundwater level might also encourage oxidation.

The New South Wales Acid Sulphate Soils Management Advisory Committee (Reference 5) recommends “Action Criteria” (Table 10) based on results of acid sulphate soils analysis for three broad texture categories. Works in soils that exceed these “Action Criteria” must be carried out in accordance with an approved Acid Sulphate Soils Management Plan.

Table 10 – Action Criteria for Acid Sulphate Soils

Type of Material		**Action Criteria 1-1000 tonnes of soil is disturbed**		**Action Criteria More than 1000 tonnes of soil is disturbed**	
Texture Range	**Approximate Clay Content <0.002mm** (%)	**Sulphur Trail** % S oxidisable (S_{TOS} or S_{POS})	**Acid Sulphate Trail** mol H^+/tonne (TPA or TSA)	**Sulphur Trail** % S oxidisable (S_{TOS} or S_{POS})	**Acid Sulphate Trail** mol H^+/tonne (TPA or TSA)
Coarse Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium Texture Sandy loams to light clays	5-40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≥40	0.10	62	0.03	18

The borehole logs indicate both clayey and sandy soils likely to be disturbed or excavated during the proposed development. Therefore, appropriate texture is assessed to be "Fine to Medium".

Laboratory test results presented in Table 4 shows that the oxidisable sulphur (S_{POS}) for all samples are less than instrument detectable limit of 0.005%. Likewise, Total Sulphidic Acidity (TSA) for all samples is less than 18.0mol H^+/tonne. In fact five of six samples show TSA value of lower than instrument detectable limit of 5.0mol H^+/tonne. Therefore, even if volume of soils to be disturbed or excavated during the proposed development works is more than 1000 tonnes, the Action Criteria for both Sulphur Trail and Acid Trail presented in Table 10 show that the excavations and disturbance of soils during the proposed development works may be carried out without an approved "Acid Sulphate Soils Management Plan".

Excavation Condition

It is anticipated that the proposed development across the site will involve up to about 3.0m deep basement excavation. Therefore, materials to be excavated are anticipated to comprise topsoil, fill and alluvial soils. No rock excavation is anticipated. It is our assessment that excavation of topsoil, fill and alluvial soils can be achieved using conventional earthmoving equipment such as excavators and dozers.

Observation during borehole drilling indicated that the depth to groundwater level is likely to be in range of 4.3m to 7.9m from existing ground surface. Although fluctuations in the level of groundwater and/or seepage might occur due to variations in rainfall and/or other factors not observed during field work day, it is our assessment that the proposed basement excavation to depth of about 3.0m is unlikely to encounter significant groundwater inflow. Minor groundwater inflow, if any, could be managed by a conventional sump and pump method. However, we suggest that a specialist contractor is engaged to design an appropriate dewatering system if significant groundwater inflow is encountered during basement excavation.

Fill Placement

We anticipate site preparation for the proposed development works will involve removal of weak alluvial soils and replacement with controlled fill. The following procedures are recommended for placement of controlled fill, where required.

- Strip topsoil and existing fill materials and stockpile separately for possible future uses or dispose off the site. Topsoils may be used in landscaping and fill materials may be selectively used in controlled fill.
- Undertake proof rolling (using an 8 to 10 tonnes roller) of the exposed alluvial soils to detect potentially weak spots (ground heave). Excavate areas of localised heaving to depth of about 300mm and replace with crushed sandstone, compacted as described below.
- Undertake proof rolling of soft spots backfilled with crushed sandstone, as described above. If the backfilled area shows movement during further proof rolling, this office should be contacted for further recommendations. The additional works may include removal of additional alluvial soils or construction of a Geogrid reinforced bridging layer.
- Place controlled fill over compacted surface of alluvial soil or Geogrid reinforced bridging layer. The controlled fill should comprise at least 0.5m thick crushed sandstone layer overlain by crushed sandstone and/or a mixture of crushed sandstone and alluvial soils obtained from excavations within the site. Particle size of crushed sandstone should not exceed 75mm.
- Controlled fill should be placed in horizontal layers of 200mm to 250mm maximum loose thickness and compacted to a Minimum Dry Density Ratio (MDDR) of 98% Standard at moisture content within 2% of Optimum Moisture Content (OMC) for cohesive soils or Minimum Density Index of 75% for sandy soils.
- Fill placement should be supervised to ensure that material quality, layer thickness, testing frequency and compaction criteria conform to the specifications. We recommend "Level 1" supervision, in accordance with Australian Standard AS3798- (Reference 6). It should be noted that a Geotechnical Inspection and Testing Authority will generally provide certification on quality of compacted fill only if Level 1 supervision and testing is carried out.

Batter Slopes and Retaining Structures

It is anticipated that the proposed development works will involve up to about 3.0m deep excavation. The excavation will occur within alluvial soils. Some minor fill placement might also be required. Cut and fill slopes during and after development works should be battered for stability or retained by engineered retaining structures. If battering is the preferred option, we recommended the following batter slopes.

- Batter slope for short term stability = 1 vertical to 2 horizontal
- Batter slope for long term stability = 1 vertical to 4 horizontal

Surface protection of the batter slopes can be provided by shotcreting. It is also recommended that batter slopes are provided with adequate surface and sub-surface drainage and the crest of the batter slope is at least 1.5m away from the site boundaries and existing structure, if any.

As the materials in the excavation faces are anticipated to comprise predominantly sandy soils, it is unlikely that steep slopes could be maintained in these materials. This is especially the case if groundwater is encountered during basement excavation. Therefore, excavation faces may preferably be retained by engineered retaining structures. Appropriate retaining structures for the proposed excavation would comprise contiguous bored pier walls installed before excavation is commenced or cantilever walls or gravity walls installed after excavation is completed. Secant pile walls may be required if groundwater level is shallower than the base of excavation unless a pumping system is installed to maintain the groundwater level below the base of excavation permanently. The pressure distribution on such walls is assumed to be triangular in shape and estimated as follows:

$$p_h = \gamma k H$$

If the retaining walls are anchored or strutted, the active pressure distribution on such retaining structures is assumed to be rectangular and estimated as follows:

$$p_h = 0.3\gamma H$$

Where,

p_h = Horizontal active pressure (kN/m^2)
γ = Total density of materials to be retained (say 18.0kN/m^3)
k = Coefficient of earth pressure (k_a or k_o)
H = Retained height (m)

Distribution of passive pressure, if retaining walls are embedded below the base of excavation, may also be assumed triangular and estimated as follows:

$$p_p = \gamma_1 k_p h$$

Where,

p_p = Horizontal passive pressure (kN/m^2)
γ_1 = Total density of materials below base of excavation (say 18.0kN/m^3)
k_p = Coefficient of passive earth pressure
h = Wall embedment depth below base of excavation (m)

For design of flexible retaining structures, where some lateral movement is acceptable, an active earth pressure coefficient (k_a=0.45) is recommended. If it is critical to limit the horizontal deformation of a retaining structure, use of an earth pressure coefficient at rest (k_0=0.60) should be considered. To estimate passive resistance, we recommend use of k_p= 2.8. These coefficients are based on the assumption that ground level behind the retaining structure is horizontal and the retained material is effectively drained. Additional earth pressures resulting from surcharge loads (existing structures, traffic etc) and groundwater pressure should also be considered in designing the retaining structures.

The design of any retaining structure should also be checked for bearing capacity, overturning, sliding and overall stability of the slope.

Floor Slabs and Footings

Floor slabs for the proposed buildings may be designed as suspended slabs supported by footings founded in appropriate foundation materials or ground bearing slabs bearing on controlled fill placed in accordance with the recommendation presented in this report.

For design of floor slabs bearing on controlled fill, we recommend a Modulus of Subgrade Reaction Value of 15kPa/mm.

Exact loadings from the proposed structures are not known at this stage. However, we anticipate appropriate footings for the proposed buildings would comprise; (1) shallow footings (pad or strip footings) founded on controlled fill or alluvial soils at depths of about 0.5m to 1.5m from the existing ground surface, (2) shallow footings founded at the base of about 3.0m deep basement excavation or (3) Deep footings (screw piles, bored piers, grout injected piles etc) founded in alluvial soils at depths exceeding 5.0m from existing ground surface or bedrock. Screw piles or grout injected piles would be preferable if footings are founded at depths lower than groundwater level. Deep footings may also be desirable if footings are required to withstand lateral and uplift loads. The recommended allowable bearing pressures for design of shallow and deep footings are presented in Table 11:

Table 11 – Recommended Allowable Bearing Pressures

Founding Materials	Founding Depth from Ground Surface* (m)	Allowable End Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)
Controlled Fill/ Alluvial Soils	0.5-1.5	100.0	Ignore
Alluvial Soils	3.0-5.0	200.0	Ignore
Alluvial Soils	5.0-11.0	350.0	5.0
Sandstone V	6.0-10.0	900.0	50.0
Sandstone IV or better	>10.0	1200.0	100.0

*Approximate only.

Allowable shaft adhesion values presented in Table 11 are for compressive loads. For uplift loads, allowable shaft adhesion values may be assumed to be halves of those presented in Table 11.

The depths to alluvial soils and bedrock sandstone with recommended allowable bearing pressures are expected to vary across the site. The ranges of founding depths provided in Table 11 were based on measurements at borehole locations and should be considered an indicative only. Therefore, founding level at a specific location will have to be confirmed by an experienced Geotechnical Engineer on the basis of assessment made during footing excavation or pier hole drilling. The engineer should ensure that the design strength of soil and rock is achieved.

Design of footings (both shallow and deep) should be based on allowable bearing pressures for the foundation materials and acceptable total and differential footing settlements. For footings founded in controlled fill and alluvial soils, total settlement is anticipated to be 2.5% of minimum footing dimension or pier diameter. However, for deep footings founded in bedrock, total settlement is estimated to be about 1.0% of footing diameter. The differential settlements for both shallow and deep footings are estimated to be about halves of the estimated total settlements.

General

Assessments and recommendations presented in this report are based on site observation and information from only eight boreholes distributed across the site. Although we believe that the sub-surface profile presented in this report is indicative of the general profile across the site, it is possible that the sub-surface profile across the site could differ from those encountered in boreholes. Likewise, comments on depth to groundwater level are based observation during field work. Therefore, we recommend that this company is contacted for further advice if actual site conditions encountered during construction differ from those presented in this report.

If you have any questions, please do not hesitate to contact the undersigned.

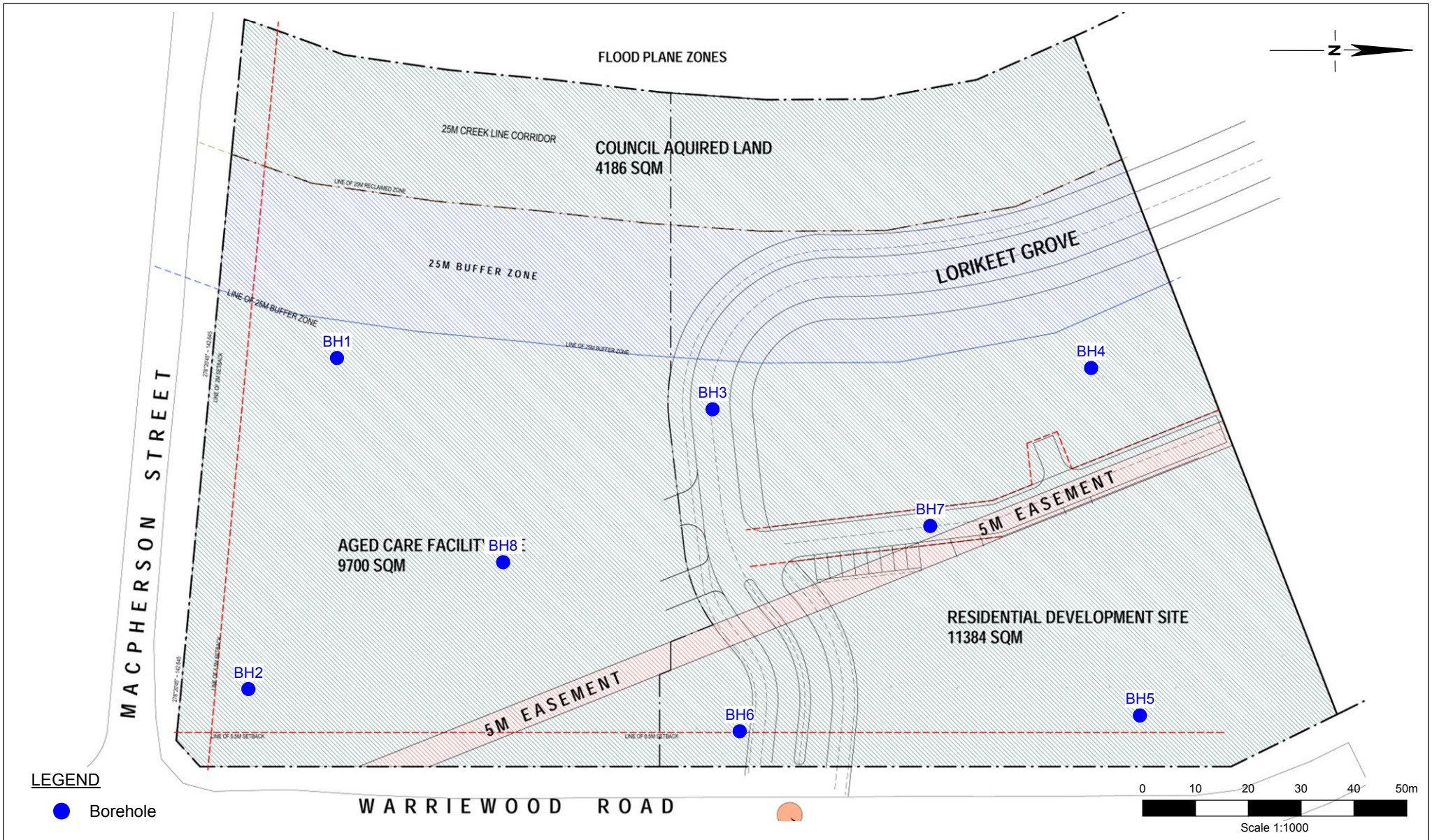
Yours faithfully
GEOTECHNIQUE PTY LTD

INDRA JWORCHAN
Principal Geotechnical Engineer

Attached Drawing No 13787/1-AA1 – Borehole Location Plan
Borehole Logs & Explanatory Notes
Laboratory Test Results

References

1. *Australian Standard, Geotechnical Site Investigation, AS1726-1993.*
2. *Pells, P J N, Mostyn, E and Walker, B F, Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics Journal, Dec 1998.*
3. *Lillicrap, A and McGhie, S., Site Investigation for Urban Salinity, Department of Land and Water Conservation, 2002.*
4. *Standard Australia- AS2159-1995, Piling – Design and Installation, 1995.*
5. *New South Wales, Acid sulphate Soil Management Advisory Committee, 1988 – Acid sulphate Soil Manual.*
6. *Australian Standard AS3798-2007, Guidelines on Earthworks for Commercial and Residential Developments, 2007.*



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NOTES

1. Site features are indicative and are not to scale.
2. This drawing has been produced using a base plan provided by others to which additional information e.g test pits, borehole locations or notes have been added. Some or all of the plan may not be relevant at the time of producing this drawing

J + G Knowles and Associates Pty Ltd
Proposed Residential Aged Care Facility
23-27 Warriewood Road
Warriewood

Borehole Locations

Drawing No: 13787/1-AA1
Job No: 13787/1
Drawn By: MH
Date: 26 July 2016
Checked By: IJ

File No: 13787-1
Layers: 0, AA1

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 1
Date : 13/07/2016
Logged/Checked by: SM

drill model and mounting : Hydro-Powered Scout,Truck Mount **slope :** **deg.** **R.L. surface :** 3.2

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
V-Bit	▼					0			TOPSOIL/FILL: Sandy Silt, brown				Brick pieces
				DS	N=7 4,4,3			SP	SAND, fine to medium grained, pale grey	M	MD		Alluvium
						1		CI	Sandy CLAY, medium plasticity, yellow-red-grey	M≥PL	St		
				DS	N=10 3,4,6	2		CL	Silty CLAY, low plasticity, red-brown, yellow-brown, grey	M≥PL	St		
						3		SC	Clayey SAND, fine to medium grained, grey, red	M	MD		
				DS	N=11 4,6,5	4		SM	Silty SAND, fine to medium grained, grey	W	MD		
				DS	N=12 6,5,7	5		SC	Clayey SAND, fine to medium grained, grey	W	MD		
				DS	N=29 5,11,18	6		CL-CI	Sandy CLAY, low to medium plasticity, red, yellow, grey, ironstone pieces	M≥PL	VSt		Ironstone with minor cementation
						7			Transitioning to low plasticity, harder, more red				Increase in ironstone content
				DS	N=48 10,24,24	8							
						9							
									Refer to cored borehole				

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engineering log
cored borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 1
Date : 13/07/2016
Logged/Checked by : SM

drill model and mounting : Hydro-Powered Scout,Truck **slope :** **deg.** **R.L. surface :** 3.2
core size: **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Commenced coring at 9.5m					
		10		SANDSTONE, medium to coarse grained, grey-red	DW	M-H			9.8m: Jo,Pl,sn 9.9m: Jo,Pl,Ro,sn
					SW	H			10.4m: Jo,55°,Pl,Ro
					DW	M			10.6m: Bp,5°,Pl,Ro 10.7m: Jo,Un,Ro
		11			SW	M-H			10.9m: Jo,75°,Pl,Ro,sn 11.0m: Bp,Pl,Sl
					DW	M			
				CLAYSTONE, low plasticity, grey					
				SANDSTONE, fine to medium grained, grey	F	H-VH			
		12		Borehole No.1 terminated at 11.9m					
		13							
		14							
		15							
		16							
		17							
		18							
		19							

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Job No 13787/1 BH1 Started Coring at 9.5m

BH1 terminated at 11.9m

IJ.mh/03.08.2016

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 2
Date : 13/07/2016
Logged/Checked by: SM

drill model and mounting : Hydro-Powered Scout,Truck Mount **slope :** **deg.** **R.L. surface :** 8.1

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
V-Bit	▼					0			TOPSOIL/FILL: Sandy Silt, brown	M			
				DS	N=2 1,1,1	1		SM	Silty SAND, fine grained, brown	W	VL		Alluvium
				DS	N=14 5,6,8	2		CI-CH	Sandy CLAY, medium to high plasticity, red, grey transitioning to a clayey sand and more grey in colour	M≥PL	F-St		
				DS	N=19 4,8,11	3 4 5		SW	SAND, fine to medium grained, grey	M	MD		
						6 7 8 9			Refer to cored borehole				

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engineering log
cored borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 2
Date : 13/07/2016
Logged/Checked by : SM

drill model and mounting : Hydra Powered Scout, truck **slope :** **deg.** **R.L. surface :** 8.1

core size: 50mm **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
		6		Commenced coring at 6.0m					
				CLAYSTONE, grey-red, with siltstone bands	EW	L			6.1m: Jo,Pl,Sl 6.2m: Jo,Cu,Sl
		7							Bp,Pl,Sm 7.1m: Jo,50°,Pl,Sm,sn 7.5m: Jo,Pl,Sm,sn 7.6m: Jo,Pl,Sm,sn
				Borehole No. 2 terminated at 7.8m					
		8							
		9							
		10							
		11							
		12							
		13							
		14							
		15							

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Job No 13787/1 BH2 Started Coring at 6.0m

6.0m

7.0m

7.8m

BH2 terminated at 7.8m

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 3
Date : 15/07/2016
Logged/Checked by: AJP

drill model and mounting : Hydro-Powered Scout,Truck Mount **slope :** **deg.** **R.L. surface :** 4.6

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
V-Bit	▼					0			TOPSOIL: Silty Sand, medium grained, dark-brown, with root fibres				
								SP	Silty SAND, medium grained, pale brown	M	MD		Alluvium
				DS	N=9 2,4,5	1		CL	Sandy CLAY, low plasticity, orange-brown and grey mottled Becoming red-brown and grey mottled	M≤PL	St		
				DS	N=13 4,6,7	2		CL	Sandy CLAY, low plasticity, orange-brown, becoming grey, with ironstone bands	M≤PL	VSt		
				DS	N=14 4,6,8	3							
						4							
						5							
						6							
						7				M>PL	VSt		
				DS	N=19 6,9,10	8			Becoming red-brown mottled grey, with ironstone bands				
						9							

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 3
Date : 15/07/2016
Logged/Checked by: AJP

drill model and mounting : Hydro-Powered Scout,Truck Mount **slope :** **deg.** **R.L. surface :** 4.6

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						10							
									SANDSTONE, red-brown and grey, very low strength, extremely weathered				Bedrock
						11			Borehole No. 3 terminated at 10.9m due to refusal in sandstone bedrock				
						12							
						13							
						14							
						15							
						16							
						17							
						18							
						19							

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 4
Date : 15/07/2016
Logged/Checked by: AJP

drill model and mounting : Hydro-Powered Scout,Truck Mount **slope :** **deg.** **R.L. surface :** 4.0

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
V-Bit						0			TOPSOIL: Silty Sand, fine to medium grained, dark brown, with root fibres				
								SP	Silty SAND, medium grained, pale brown	M-W	MD		Alluvium
								CL	Sandy CLAY, low plasticity, orange-brown and grey mottled	M≤PL	VSt		
				DS	N=11 3,5,6	1							
									Becoming red-brown and grey mottled				
						2							
				DS	N=16 5,7,9	3			Presence of ironstone bands				
						4							
								CI-CH	Silty CLAY, medium to high plasticity, grey, with ironstone bands	M≤PL	VSt		
				DS	N=20 5,8,12	5							
TC-Bit								CL	Sandy CLAY, low plasticity, grey, with ironstone bands				5.8-6.2m: Ironstone band approximately 400mm thick
				DS		6							
						7			Refer to cored borehole				
						8							
						9							

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engineering log
cored borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 4
Date : 15/07/2016
Logged/Checked by : AJP

drill model and mounting : Hydra Powered Scout, truck **slope :** **deg.** **R.L. surface :** 4.0
core size: 50mm **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
		7		Commenced coring at 7.0m					
				SANDSTONE, medium to coarse grained, red-brown and grey					7.1m: Bp,Pl,Ro,sn 7.2m: Jo,Un,Ro,sn 7.25m: Jo,5°,Pl,Ro,sn 7.3m: Jo,5mm,Ro,sn 7.45m: Fr,90°,5mm,Ro,sn
		8							
									8.6m: Jo,Pl,Ro,sn 8.75m: Jo,Pl,Ro,sn 8.9m: Jo,Pl,Ro,sn
		9		Borehole No. 4 terminated at 8.95m					
		10							
		11							
		12							
		13							
		14							
		15							
		16							

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Job No 13787/1 BH4 Started Coring at 7.0m

7.0m

8.0m

8.95m

BH4 terminated at 8.95m

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 5
Date : 15/07/2016
Logged/Checked by: AJP

drill model and mounting : Hydro-Powered Scout,Truck Mount **slope :** **deg.** **R.L. surface :** 12.0

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
V-Bit						0			TOPSOIL: Silty Sand, fine to medium grained, dark brown, with root fibres				
								SP	Silty SAND, fine to medium grained, grey	M	MD		Alluvium
								CL	Silty CLAY, low plasticity, yellow-brown and grey mottled	M≤PL	St		
				DS		1			Becoming red-brown mottled yellow-brown				
				DS	N=17 4,7,10	2				M≤PL	VSt		
				DS		3			Becoming red-brown mottled grey				
				DS	N=16 5,7,9	5			Becoming grey, with ironstone bands				
				DS		7							
						8							
						9							

GEOTECHNIQUE
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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 5
Date : 15/07/2016
Logged/Checked by: AJP

drill model and mounting : Hydro-Powered Scout,Truck Mount **slope :** **deg.** **R.L. surface :** 12.0

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						10							
						11							
TC-Bit									SANDSTONE, medium to coarse grained, red-brown and grey, extremely low to low strength, extremely to distinctly weathered				Bedrock
									Borehole No. 5 terminated at 11.7m due to refusal				
						12							
						13							
						14							
						15							
						16							
						17							
						18							
						19							

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 6
Date : 19/07/2016
Logged/Checked by: SM

drill model and mounting : Geoprobe 6600 **slope :** **deg.** **R.L. surface :** 8.8

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
TC-Bit	▼					0			FILL: Silty Sand, fine to medium grained, brown, with brick pieces	M	VL		
								SM	Silty SAND, fine grained, grey	M	L		Alluvium
				DS				CI	Sandy CLAY, medium plasticity, red-brown, yellow-brown	M≥PL	F		
						1							
				DS	N=12 4,5,7				Becoming red-brown	M<PL	VSt		
						2							
									Introduction of ironstone bands				
				DS	N=16 6,9,7	3							
									Becoming more grey				
						4							
				DS	N=21 6,8,13				Becoming more sandy	M>PL	VSt-H		Extremely weathered sandstone?
						5							
									Becoming red				Residual?
				DS	N=23 5,9,14	6							
									SANDSTONE, fine to medium grained, grey, extremely weathered				Bedrock
				DS	N=20 5,9,11	7							
						8							
						9							
									Refer to cored borehole				

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engineering log
cored borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 6
Date : 19/07/2016
Logged/Checked by : SM

drill model and mounting : Geoprobe 6600 **slope :** **deg.** **R.L. surface :** 8.8

core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	DEFECT DETAILS defect spacing (mm) 2000 1000 500 300 100 50	DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Commenced coring at 9.3m CORE LOSS					
		10		CLAYSTONE, grey, red, with siltstone bands	EW	L			10.23m: Cs,2mm,Pl,Sl 10.75m: Cs,5mm,Pl,Sl
		11		SANDSTONE, fine to medium grained, grey-red	SW	M-H			11.16m: Bp,Ir,Ro,sn 11.45m: Jo,Ir,Ro,sn 11.67m: Jo,5°,Pl,Ro
		12		Borehole No. 6 terminated at 11.9m					
		13							
		14							
		15							
		16							
		17							
		18							

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Job No 13787/1 BH6 Started Coring at 9.3m

9.0m	9.3m	Core Loss
10.0m	Core Loss	
11.0m		11.9m

BH6 terminated at 11.9m

IJ.mh/03.08.2016

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 7
Date : 19/07/2016
Logged/Checked by: SM

drill model and mounting : Geoprobe 6600 **slope :** **deg.** **R.L. surface :** 6.5

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
TC-Bit	▼					0			FILL: Silty Sand, fine grained, brown, with brick pieces	M	VL		
				DS	N=6 2,3,3			SM	Silty SAND, fine grained, grey	M	VS		Alluvium
						1		CI	Sandy CLAY, medium plasticity, grey-red	M≤PL	VSt		
				DS	N=13 3,6,7								
						2			Becoming red				
				DS	N=18 6,7,11	3			Becoming grey, increase in sand content				
				DS	N=21 6,8,13	4							
						5				M>PL	H		
				DS	N=24 6,10,14	6			Introduction of ironstone bands				
				DS	N=24 6,9,15	7			SANDSTONE, fine to medium grained, grey, extremely weathered, with ironstone bands				Bedrock
						8							
						9							

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 7
Date : 19/07/2016
Logged/Checked by: SM

drill model and mounting : Geoprobe 6600 **slope :** **deg.** **R.L. surface :** 6.5

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						10							
						11							
						12			Refer to cored borehole				
						13							
						14							
						15							
						16							
						17							
						18							
						19							

GEOTECHNIQUE
PTY LTD

engineering log
cored borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 7
Date : 19/07/2016
Logged/Checked by : SM

drill model and mounting : Geoprobe 6600 **slope :** **deg.** **R.L. surface :** 6.5
core size: NMLC **bearing :** **deg.** **datum :** AHD

barrel lift	water loss/level	depth of R.L. in meters	graphic log	CORE DESCRIPTION rock type, grain characteristics, colour, structure, minor components.	weathering	strength	point load index strength $I_S(50)$ EL VL L M H VH	defect spacing (mm) 2000 1000 500 300 100 50	DEFECT DETAILS DESCRIPTION type, inclination, thickness, planarity, roughness, coating. Specific / General
				Commenced coring at 11.7m					
		12		SANDSTONE, medium grained, red-grey, with ironstaining	DW	VL			
					Fr	H-VH			12.2m: Jo,80°,Pl,Sl
					DW	VL			
					SW	L			12.7m: Jo,80°,Pl,Sl
						H			12.8m: Jo,Pl,Ro,sn
		13			EW	EL			12.84m: Jo,50°,Pl,Ro,sn
					SW	H			13.18m: Ds,3mm,Pl,Sl 13.2m: Bp,Pl,Sl 13.31m: Jo,75°,Pl,Ro,sn
					EW	VL			13.5m: Is,10mm,Pl,Sl
		14							14.25m: Jo,80°,Pl,Ro,sn
				Borehole No. 7 terminated at 14.4m					
		15							
		16							
		17							
		18							
		19							
		20							
		21							

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Job No 13787/1 BH7 Started Coring at 11.7m

BH7 terminated at 14.4m

IJ.mh/03.08.2016

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engineering log - borehole

Client : J & G Knowles & Associates Pty Ltd
Project : Aged Care Facility
Location : 23-27 Warriewood Road, Warriewood

Job No. : 13787/1
Borehole No. : 8
Date : 19/07/2016
Logged/Checked by: SM

drill model and mounting : Geoprobe 6600 **slope :** **deg.** **R.L. surface :** 5.7

hole diameter : 125 **mm** **bearing :** **deg.** **datum :** AHD

method	groundwater	env samples	PID reading (ppm)	geo samples	field test	depth or R.L. in meters	graphic log	classification symbol	MATERIAL DESCRIPTION soil type, plasticity or particle characteristic, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa	Remarks and additional observations
						0			FILL: Silty Sand, fine to medium grained, brown, with brick pieces	M	VL		
								SM	Silty SAND, fine to medium grained, grey	M	VS		Alluvium
								CI	Sandy CLAY, medium plasticity, grey-red	M≥PL	F		
						1							
						2							
									Becoming red	M<PL	VSt		
				DS		3							
						4				M>PL	H		
								SP	Silty Clayey SAND, fine to medium grained, grey	M	VL		
				DS		5							
						6				W	D		
TC-Bit						7			SANDSTONE, fine to medium grained, grey-red, extremely weathered, with ironstone bands				Bedrock
						8							
				DS		9			Borehole No. 8 terminated at 8.9m				

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Fill / Topsoil
	Sand
	Sandy Clay medium plasticity
	Silty Clay low plasticity
	Clayey Sand
	Silty Sand
	Sandy Clay low to medium plasticity
	Sandy Clay medium to high plasticity
	Topsoil
	Sandy Clay low plasticity
	Sandstone
	Silty Clay medium to high plasticity
	Fill
	Silty Clayey Sand

Symbol	Description
	Claystone
	Claystone / Mudstone
	Core Loss
Misc. Symbols	
	Point Load Strength
Descriptions of various line types (soli	
	Profile change
	Gradual profile change

Notes:

1. Exploratory borings were drilled between 19/07/2016 and 19/07/2016 using a 50, 100 and 125mm diameter continuous flight power auger.

2. These logs are subject to the limitations, conclusions and recommendations in this report.

3. Results of tests conducted on samples recovered are reported on the logs.

Log Symbols & Abbreviations (Non-cored Borehole Log)

Log Column	Symbol/Value		Description
Drilling Method	V-bit TC-bit RR DB BB		Hardened steel 'V' shaped bit attached to auger Tungsten Carbide bit attached to auger Tricone (Rock Roller) bit Drag bit Blade bit
Groundwater	Dry 		Groundwater not encountered to the drilled or auger refusal depth Groundwater level at depths shown on log Groundwater seepage at depths shown on log
Environment Sample	GP G P		Glass bottle and plastic bag sample over depths shown on log Glass bottle sample over depths shown on log Plastic bag sample over depths shown on log
PID Reading	100		PID reading in ppm
Geotechnical Sample	DS DB U_{50}		Disturbed Small bag sample over depths shown on log Disturbed Bulk sample over depths shown on log Undisturbed 50mm tube sample over depths shown on log
Field Test	N=10 3,5,5 N=R 10,15/100		Standard Penetration Test (SPT) 'N' value. Individual numbers indicate blows per 150mm penetration. 'R' represents refusal to penetration in hard/very dense soils or in cobbles or boulders. The first number represents10 blows for 150mm penetration whereas the second number represents 15 blows for 100mm penetration where SPT met refusal
	DCP/PSP	5 6 R/10	Dynamic Cone Penetration (DCP) or Perth Sand Penetrometer (PSP). Each number represents blows per 100mm penetration. 'R/10' represents refusal after 10mm penetration in hard/very dense soils or in gravels or boulders.
Classification	GP GW GM GC SP SW SM SC ML MI MH CL CI CH		Poorly Graded GRAVEL Well graded GRAVEL Silty GRAVEL Clayey GRAVEL Poorly graded SAND Well graded SAND Silty SAND Clayey SAND SILT / Sandy SILT / clayey SILT, low plasticity SILT / Sandy SILT / clayey SILT, medium plasticity SILT / Sandy SILT / clayey SILT, high plasticity CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, low plasticity CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, medium plasticity CLAY / Silty CLAY / Sandy CLAY / Gravelly CLAY, high plasticity
Moisture Condition Cohesive soils Cohesionless soils	 M<PL M=PL M>PL D M W		 Moisture content less than Plastic Limit Moisture content equal to Plastic Limit Moisture content to be greater than Plastic Limit Dry - Runs freely through hand Moist - Tends to cohere Wet - Tends to cohere

Consistency Cohesive soils	Term	Undrained shear strength, C_u (kPa)	Hand Penetrometer (Qu)
VS	Very Soft	≤12	<25
S	Soft	>12 ≤25	25 – 50
F	Firm	>25 ≤50	50 – 100
St	Stiff	>50 ≤100	100 – 200
VSt	Very Stiff	>100 ≤200	200 – 400
H	Hard	>200	>400

Density Index Cohesionless soils	Term	Density Index, I_D (%)	SPT 'N' (blows/300mm)
VL	Very Loose	≤15	≤5
L	Loose	>15 ≤35	>5 ≤10
M	Medium Dense	>35 ≤65	>10 ≤30
D	Dense	>65 ≤85	>30 ≤50
VD	Very Dense	>85	>50

Hand Penetrometer	100 200	Unconfined compressive strength (q_u) in kPa determined using pocket penetrometer, at depths shown on log
Remarks	 Residual Alluvium Colluvial Aeolian Marine	Geological origin of soils Residual soils above bedrock River deposited Alluvial soils Gravity deposited Colluvial soils Wind deposited Aeolian soils Marine Soils

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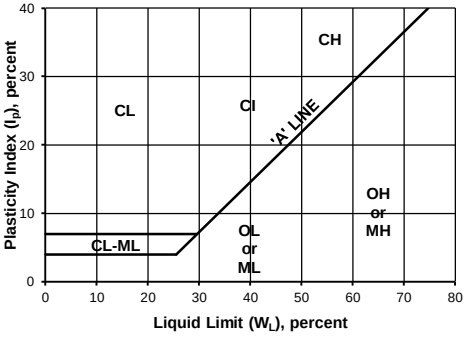
AS1726 – Unified Soil Classification System

Major Divisions		Particle size (mm)	Group Symbol	Typical Names	Field Identifications Sand and Gravels			Laboratory classification				
	BOULDERS	200						% (2) < 0.075mm	Plasticity of Fine Fraction	$C_u = D_{60}/D_{10}$	$C_c = (D_{30})^2/(D_{10}D_{60})$	Notes
	COBBLES	63										
COARSE GRAINED SOILS (more than half of material less 63mm is larger than 0.075mm)	GRAVELS (more than half of coarse fraction is larger than 2.36mm)	Coarse 20	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			0-5	-	>4	between 1 and 3	1. Identify lines by the method given for fine grained soils 2. Borderline classifications occur when the percentage of fines (fraction smaller than 0.075mm size) is greater than 5% and less than 12%. Borderline classifications require the use of dual symbols e.g. SP-SM, GW-GC
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			0-5	-	Fails to comply with above		
		Medium 6	GM	Silty gravels, gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			12-50	Below 'A' line or I_p<4	-	-	
		Fine 2.36	GC	Clayey gravels, gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength			12-50	Above 'A' line or I_p>7	-	-	
	SANDS (more than half of coarse fraction is smaller than 2.36mm)	Coarse 0.6	SW	Well-graded sands, gravelly sands, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength			0-5	-	>6	between 1 and 3	
		Medium 0.2	SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength			0-5	-	Fails to comply with above		
		Fine 0.075	SM	Silty sands, sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength			12-50	Below 'A' line or I_p<4	-	-	
			SC	Clayey sand, sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength			12-50	Above 'A' line of I_p>7	-	-	
FINE GRAINED SOILS (more than half of material less than 63mm is smaller than 0.075mm)					**Dry Strength**	**Dilatancy**	**Toughness**					
	SILTS & CLAYS (liquid limit < 50%)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	None to low	Quick to slow	None	More than 50% passing 0.075mm	Below 'A' line			
			CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	None to very slow	Medium		Above 'A' line			
			OL	Organic silts and organic silty clays of low plasticity	Low to medium	Slow	Low		Below 'A' line			
	SILTS & CLAYS (liquid limit > 50%)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Low to medium	Slow to none	Low to medium		Below 'A' line			
			CH	Inorganic clays of medium to high plasticity, fat clays	High to very high	None	High		Above 'A' line			
			OH	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Low to medium		Below 'A' line			
	HIGHLY ORGANIC SOILS		Pt	Peat and highly organic soils	Identified by colour, odour, spongy feel and generally by fibrous texture			Effervesces with H_2O_2				

Use the gradation of material passing 63mm for classification of fractions according to the criteria given in 'Major Divisions'

Log Symbols & Abbreviations (Cored Borehole Log)

Log Column	Symbol	Description
Core Size		Nominal Core Size (mm)
	NQ	47
	NMLC	52
	HQ	63
Water Loss	◀	Complete water loss
	◁	Partial water loss
Weathering	FR	Fresh — Rock shows no sign of decomposition or staining
	SW	Slightly Weathered — Rock is slightly discoloured but shows little or no change of strength from fresh rock
	DW	Distinctly Weathered — Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased by deposition of weathering products in pores
	EW	Extremely Weathered — Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrate or can be remoulded, in water
	RS	Residual Soil — Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but soil has not been significantly transported
Strength		Term — Point Load Strength Index (I_{s50}, MPa)
	EL	Extremely Low — ≤0.03
	VL	Very Low — >0.03 ≤0.1
	L	Low — >0.1 ≤0.3
	M	Medium — >0.3 ≤1
	H	High — >1 ≤3
	VH	Very High — >3 ≤10
	EH	Extremely High — >10
Defect Spacing		Description — Spacing (mm)
		Extremely closely spaced — <20
		Very closely spaced — 20 to 60
		Closely spaced — 60 to 200
		Medium spaced — 200 to 600
		Widely spaced — 600 to 2000
		Very widely spaced — 2000 to 6000
		Extremely widely spaced — >6000
Defect Description		
Type	Bp	Bedding parting
	Fp	Foliation parting
	Jo	Joint
	Sh	Sheared zone
	Cs	Crushed seam
	Ds	Decomposed seam
	Is	Infilled seam
Macro-surface geometry	St	Stepped
	Cu	Curved
	Un	Undulating
	Ir	Irregular
	Pl	Planar
Micro-surface geometry	Ro	Rough
	Sm	Smooth
	Sl	Slickensided
Coating or infilling	cn	clean
	sn	stained
	vn	veneer
	cg	coating

AS1726 – Identification of Sedimentary Rocks for Engineering Purposes

Grain Size mm		Bedded rocks (mostly sedimentary)									
More than 20	20	Grain Size Description				At least 50% of grains are of carbonate				At least 50% of grains are of fine-grained volcanic rock	
	6	RUDACEOUS		CONGLOMERATE Rounded boulders, cobbles and gravel cemented in a finer matrix		LIMESTONE and DOLOMITE (undifferentiated)		Calcirudite		Fragments of volcanic ejecta in a finer matrix	SALINE ROCKS
	2			Breccia Irregular rock fragments in a finer matrix						Rounded grains AGGLOMERATE Angular grains VOLCANIC BRECCIA	Halite Anhydrite
	0.6	ARENACEOUS	Coarse	SANDSTONE Angular or rounded grains, commonly cemented by clay, calcite or iron minerals				Calcarenite		Cemented volcanic ash	Gypsum
	0.2		Medium	Quartzite Quartz grains and siliceous cement						TUFF	
	0.06		Fine	Arkose Many feldspar grains Greywacke Many rock chips							
	0.002	ARGILLACEOUS		MUDSTONE	SILTSTONE Mostly silt	Calcareous Mudstone		Calcisiltite	CHALK	Fine-grained TUFF	
	Less than 0.002			SHALE Fissile	CLAYSTONE Mostly clay			Calcilutite		Very fine-grained TUFF	
Amorphous or crypto-crystalline				Flint: occurs as hands of nodules in the chalk Chert: occurs as nodules and beds in limestone and calcareous sandstone							COAL LIGNITE
				Granular cemented – except amorphous rocks							
				SILICEOUS		CALCAREOUS				SILICEOUS	CARBONACEOUS
				SEDIMENTARY ROCKS Granular cemented rocks vary greatly in strength, some sandstones are stronger than many Igneous rocks. Bedding may not show in hand specimens and is best seen in outcrop. Only sedimentary rocks, and some metamorphic rocks derived from them, contain fossils Calcareous rocks contain calcite (calcium carbonate) which effervesces with dilute hydrochloric acid						

AS1726 – Identification of Metamorphic and Igneous Rocks for Engineering Purposes

Obviously foliated rocks (mostly metamorphic)		Rocks with massive structure and crystalline texture (mostly igneous)						Grain size (mm)
Grain size description			Grain size description	Pegmatite			Pyrosenite	More than 20
		MARBLE						20
COARSE	GNEISS Well developed but often widely spaced foliation sometimes with schistose bands	QUARTZITE	COARSE	GRANITE	Diorite	GABBRO	Peridorite	6
	Migmatite Irregularly foliated: mixed schists and gneisses	Granulite HORNFELS		These rocks are sometimes phorphyritic and are then described, for example, as porphyritic granite				2
MEDIUM	SCHIST Well developed undulose foliation; generally much mica	Amphibolite	MEDIUM	Micorgranite	Microdiorite	Dolerite		0.6
		Serpentine		These rocks are sometimes phorphyritic and are then described as porphyries				0.2
								0.06
FINE	PHYLLITE Slightly undulose foliation; sometimes 'spotted'		FINE	RHYOLITE	ANDESITE	BASALT		0.002
	SLATE Well developed plane cleavage (foliation)			These rocks are sometimes phorphyritic and are then described as porphyries				Less than 0.002
	Mylonite Found in fault zones, mainly in igneous and metamorphic areas			Obsidian	Volcanic glass			Amorphous or cryptocrystalline
CRYSTALLINE				Pale<----------->Dark				
SILICEOUS		Mainly SILICEOUS		ACID Much quartz	INTERMEDIATE Some quartz	BASIC Little or no quartz	ULTRA BASIC	
METAMORPHIC ROCKS Most metamorphic rocks are distinguished by foliation which may impart fissility. Foliation in gneisses is best observed in outcrop. Non-foliated metamorphics are difficult to recognize except by association. Any rock baked by contact metamorphism is described as 'hornfels' and is generally somewhat stronger than the parent rock Most fresh metamorphic rocks are strong although perhaps fissile			IGNEOUS ROCKS Composed of closely interlocking mineral grains. Strong when fresh; not porous Mode of occurrence : 1 Batholith; 2 Laccoliths; 3 Sills; 4 Dykes; 5 Lava Flows; 6 Veins					

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

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Project	**13787-1 23-27 Warriewood rd Warriewood**
Order Number	**SE154900**
Samples	6

LABORATORY DETAILS

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SGS Reference	**CE122159 R0**
Date Received	21 Jul 2016
Date Reported	27 Jul 2016

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(3146)

SIGNATORIES

Anthony Nilsson
Operations Manager

Jon Dicker
Manager Northern QLD

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	CE122159.001 Soil 18 Jul 2016 BH2 2.0-2.45	CE122159.002 Soil 18 Jul 2016 BH3 0.5-0.95	CE122159.003 Soil 18 Jul 2016 BH3 2.5-2.95	CE122159.004 Soil 18 Jul 2016 BH3 5.5-5.95
Chromium Reducible Sulphur (CRS) Method: AN217 Tested: 26/7/2016							
Chromium Reducible Sulphur (Scr)	%	0.005		<0.005	<0.005	<0.005	<0.005
Chromium Reducible Sulphur (Scr)	moles H+/T	5		<5	<5	<5	<5
Moisture Content Method: AN002 Tested: 21/7/2016							
% Moisture	%w/w	0.5		**14**	**16**	**14**	**14**
TAA (Titratable Actual Acidity) Method: AN219 Tested: 26/7/2016							
pH KCl	pH Units	-		**4.0**	**5.9**	**4.0**	**3.8**
Titratable Actual Acidity	kg H2SO4/T	0.25		**3.2**	**0.31**	**2.8**	**4.0**
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5		**65**	**6**	**57**	**82**
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01		**0.10**	**0.01**	**0.09**	**0.13**
Sulphur (SKCl)	%w/w	0.005		**0.027**	<0.005	**0.013**	**0.020**
Calcium (CaKCl)	%w/w	0.005		**0.020**	**0.13**	**0.007**	<0.005
Magnesium (MgKCl)	%w/w	0.005		**0.023**	**0.024**	**0.024**	**0.021**
TPA (Titratable Peroxide Acidity) Method: AN218 Tested: 26/7/2016							
Peroxide pH (pH Ox)	pH Units	-		**4.5**	**6.0**	**5.1**	**4.9**
TPA as kg H_2SO_4/tonne	kg H2SO4/T	0.25		**3.2**	<0.25	**2.8**	**4.3**
TPA as moles H+/tonne	moles H+/T	5		**65**	<5	**57**	**87**
TPA as S % W/W	%w/w S	0.01		**0.10**	<0.01	**0.09**	**0.14**
Titratable Sulfidic Acidity as moles H+/tonne	moles H+/T	5		<5	<5	<5	<5
Titratable Sulfidic Acidity as kg H_2SO_4/tonne	kg H2SO4/T	0.25		<0.25	<0.25	<0.25	<0.25
Titratable Sulfidic Acidity as S % W/W	%w/w S	0.01		<0.01	<0.01	<0.01	<0.01
ANCE as % $CaCO_3$	% CaCO3	0.01		<0.01	<0.01	<0.01	<0.01
ANCE as moles H+/tonne	moles H+/T	5		<5	<5	<5	<5
ANCE as S % W/W	%w/w S	0.01		<0.01	<0.01	<0.01	<0.01
Peroxide Oxidisable Sulphur (Spos)	%w/w	0.005		<0.005	<0.005	<0.005	<0.005
Peroxide Oxidisable Sulphur as moles H+/tonne	moles H+/T	5		<5	<5	<5	<5
Sulphur (Sp)	%w/w	0.005		**0.028**	<0.005	**0.014**	**0.023**
Calcium (Cap)	%w/w	0.005		**0.018**	**0.12**	**0.008**	<0.005
Reacted Calcium (CaA)	%w/w	0.005		<0.005	<0.005	<0.005	<0.005
Reacted Calcium (CaA)	moles H+/T	5		<5	<5	<5	<5
Magnesium (Mgp)	%w/w	0.005		**0.023**	**0.023**	**0.022**	**0.022**
Reacted Magnesium (MgA)	%w/w	0.005		<0.005	<0.005	<0.005	<0.005
Reacted Magnesium (MgA)	moles H+/T	5		<5	<5	<5	<5
Net Acid Soluble Sulphur as % w/w	%w/w	0.005		**0.072**	-	**0.020**	**0.008**
Net Acid Soluble Sulphur as moles H+/tonne	moles H+/T	5		**45**	-	**13**	**5**

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	CE122159.001 Soil 18 Jul 2016 BH2 2.0-2.45	CE122159.002 Soil 18 Jul 2016 BH3 0.5-0.95	CE122159.003 Soil 18 Jul 2016 BH3 2.5-2.95	CE122159.004 Soil 18 Jul 2016 BH3 5.5-5.95
HCl Extractable S, Ca and Mg in Soil ICP OES Method: AN014 Tested: 27/7/2016							
Acid Soluble Sulphur (SHCl)	%w/w	0.005		**0.099**	-	**0.033**	**0.029**
SPOCAS Net Acidity Calculations Method: AN220 Tested: 27/7/2016							
s-Net Acidity	%w/w S	0.01		**0.16**	**0.01**	**0.11**	**0.14**
a-Net Acidity	moles H+/T	5		**99**	**7**	**68**	**88**
Liming Rate	kg CaCO3/T	0.1		**7.4**	NA	**5.1**	**6.6**
Verification s-Net Acidity	%w/w S	-20		**0.00**	**0.00**	**0.00**	**0.00**
a-Net Acidity without ANCE	moles H+/T	5		**99**	**7**	**68**	**88**
Liming Rate without ANCE	kg CaCO3/T	0.1		**7.4**	NA	**5.1**	**6.6**

Parameter	Units	LOR	Sample Number: CE122159.005 Sample Matrix: Soil Sample Date: 18 Jul 2016 Sample Name: BH3 8.0-8.45	Sample Number: CE122159.006 Sample Matrix: Soil Sample Date: 18 Jul 2016 Sample Name: BH5 7.0-7.5
Chromium Reducible Sulphur (CRS) Method: AN217 Tested: 26/7/2016				
Chromium Reducible Sulphur (Scr)	%	0.005	<0.005	<0.005
Chromium Reducible Sulphur (Scr)	moles H+/T	5	<5	<5
Moisture Content Method: AN002 Tested: 21/7/2016				
% Moisture	%w/w	0.5	**15**	**14**
TAA (Titratable Actual Acidity) Method: AN219 Tested: 26/7/2016				
pH KCl	pH Units	-	**3.8**	**3.8**
Titratable Actual Acidity	kg H2SO4/T	0.25	**4.3**	**5.0**
Titratable Actual Acidity (TAA) moles H+/tonne	moles H+/T	5	**87**	**102**
Titratable Actual Acidity (TAA) S%w/w	%w/w S	0.01	**0.14**	**0.16**
Sulphur (SKCl)	%w/w	0.005	**0.013**	**0.016**
Calcium (CaKCl)	%w/w	0.005	<0.005	<0.005
Magnesium (MgKCl)	%w/w	0.005	**0.021**	**0.020**
TPA (Titratable Peroxide Acidity) Method: AN218 Tested: 26/7/2016				
Peroxide pH (pH Ox)	pH Units	-	**5.1**	**5.0**
TPA as kg H_2SO_4/tonne	kg H2SO4/T	0.25	**4.4**	**5.5**
TPA as moles H+/tonne	moles H+/T	5	**90**	**112**
TPA as S % W/W	%w/w S	0.01	**0.14**	**0.18**
Titratable Sulfidic Acidity as moles H+/tonne	moles H+/T	5	<5	**10**
Titratable Sulfidic Acidity as kg H_2SO_4/tonne	kg H2SO4/T	0.25	<0.25	**0.49**
Titratable Sulfidic Acidity as S % W/W	%w/w S	0.01	<0.01	**0.02**
ANCE as % $CaCO_3$	% CaCO3	0.01	<0.01	<0.01
ANCE as moles H+/tonne	moles H+/T	5	<5	<5
ANCE as S % W/W	%w/w S	0.01	<0.01	<0.01
Peroxide Oxidisable Sulphur (Spos)	%w/w	0.005	<0.005	<0.005
Peroxide Oxidisable Sulphur as moles H+/tonne	moles H+/T	5	<5	<5
Sulphur (Sp)	%w/w	0.005	**0.013**	**0.020**
Calcium (Cap)	%w/w	0.005	<0.005	<0.005
Reacted Calcium (CaA)	%w/w	0.005	<0.005	<0.005
Reacted Calcium (CaA)	moles H+/T	5	<5	<5
Magnesium (Mgp)	%w/w	0.005	**0.020**	**0.019**
Reacted Magnesium (MgA)	%w/w	0.005	<0.005	<0.005
Reacted Magnesium (MgA)	moles H+/T	5	<5	<5
Net Acid Soluble Sulphur as % w/w	%w/w	0.005	<0.005	**0.007**
Net Acid Soluble Sulphur as moles H+/tonne	moles H+/T	5	<5	<5

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	CE122159.005 Soil 18 Jul 2016 BH3 8.0-8.45	CE122159.006 Soil 18 Jul 2016 BH5 7.0-7.5
HCl Extractable S, Ca and Mg in Soil ICP OES Method: AN014 Tested: 27/7/2016					
Acid Soluble Sulphur (SHCl)	%w/w	0.005		**0.016**	**0.023**
SPOCAS Net Acidity Calculations Method: AN220 Tested: 27/7/2016					
s-Net Acidity	%w/w S	0.01		**0.14**	**0.17**
a-Net Acidity	moles H+/T	5		**89**	**110**
Liming Rate	kg CaCO3/T	0.1		**6.7**	**8.1**
Verification s-Net Acidity	%w/w S	-20		**0.00**	**0.00**
a-Net Acidity without ANCE	moles H+/T	5		**89**	**110**
Liming Rate without ANCE	kg CaCO3/T	0.1		**6.7**	**8.1**

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage*. Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Chromium Reducible Sulphur (CRS) **Method: ME-(AU)-[ENV]AN217**

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Chromium Reducible Sulphur (Scr)	LB038118	%	0.005	<0.005	0%	89%
Chromium Reducible Sulphur (Scr)	LB038118	moles H+/T	5	<5		

TAA (Titratable Actual Acidity) **Method: ME-(AU)-[ENV]AN219**

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH KCl	LB038117	pH Units	-	5.9	0 - 2%	101%
Titratable Actual Acidity	LB038117	kg H2SO4/T	0.25	<0.25	0 - 4%	NA
Titratable Actual Acidity (TAA) moles H+/tonne	LB038117	moles H+/T	5	<5	0 - 4%	92%
Titratable Actual Acidity (TAA) S%w/w	LB038117	%w/w S	0.01	<0.01	0 - 4%	92%
Sulphur (SKCl)	LB038117	%w/w	0.005	<0.005	5 - 12%	87%
Calcium (CaKCl)	LB038117	%w/w	0.005	<0.005	1 - 6%	99%
Magnesium (MgKCl)	LB038117	%w/w	0.005	<0.005	0 - 3%	92%

TPA (Titratable Peroxide Acidity) **Method: ME-(AU)-[ENV]AN218**

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Peroxide pH (pH Ox)	LB038116	pH Units	-	6.3	0 - 2%	100%
TPA as kg H_2SO_4/tonne	LB038116	kg H2SO4/T	0.25	<0.25	0 - 4%	99%
TPA as moles H+/tonne	LB038116	moles H+/T	5	<5	0 - 4%	99%
TPA as S % W/W	LB038116	%w/w S	0.01	<0.01	0 - 4%	99%
ANCE as % $CaCO_3$	LB038116	% CaCO3	0.01	<0.01	0%	
ANCE as moles H+/tonne	LB038116	moles H+/T	5	<5	0%	
ANCE as S % W/W	LB038116	%w/w S	0.01	<0.01	0%	
Sulphur (Sp)	LB038116	%w/w	0.005	<0.005	4 - 6%	102%
Calcium (Cap)	LB038116	%w/w	0.005	<0.005	0 - 3%	115%
Magnesium (Mgp)	LB038116	%w/w	0.005	<0.005	0 - 5%	107%

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN014	This method is for the determination of soluble sulfate (SO4-S) by extraction with hydrochloric acid. Sulphides should not react and would normally be expelled. Sulfur is determined by ICP.
AN217	Dried pulped sample is mixed with acid and chromium metal in a rapid distillation unit to produce hydrogen sulfide (H2S) which is collected and titrated with iodine (I2(aq)) to measure SCR.
AN218	Soil samples are subjected to extreme oxidising conditions using hydrogen peroxide. Continuous application of heat and peroxide ensure all sulfide is converted to sulfuric acid. Excess peroxide is broken down by a copper catalyst prior to titration for acidity. Calcium, magnesium, and sulfur are determined by ICP-OES. Also included is a carbonate modification step which, depending on pH after the initial oxidation, gives a measure of ANC.
AN219	Dried pulped sample is extracted for 4 hours in a 1 M KCl solution. The ratio of sample to solution is 1:40. The extract is titrated for acidity. Calcium, magnesium, and sulfur are determined by ICP-AES.
AN220	SPOCAS Suite: Scheme for the calculation of net acidities and liming rates using a Fineness Factor of 1.5.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

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Project	**13787-1 23-27 Warriewood Road Warriewood**
Order Number	(Not specified)
Samples	19

LABORATORY DETAILS

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SGS Reference	**SE155019 R0**
Date Received	20/7/2016
Date Reported	29/7/2016

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

Dong Liang
Metals/Inorganics Team Leader

Ly Kim Ha
Organic Section Head

Conductivity and TDS by Calculation - Soil [AN106] Tested: 28/7/2016

PARAMETER	UOM	LOR	BH1 0.5-0.95 SOIL - 18/7/2016 SE155019.001	BH1 2.0-2.45 SOIL - 18/7/2016 SE155019.002	BH1 3.5-3.95 SOIL - 18/7/2016 SE155019.003	BH1 5.0-5.45 SOIL - 18/7/2016 SE155019.004	BH1 6.5-6.95 SOIL - 18/7/2016 SE155019.005
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	37	61	49	85	170

PARAMETER	UOM	LOR	BH1 8.0-8.45 SOIL - 18/7/2016 SE155019.006	BH4 1.0-1.45 SOIL - 18/7/2016 SE155019.007	BH4 3.0-3.45 SOIL - 18/7/2016 SE155019.008	BH4 5.0-5.45 SOIL - 18/7/2016 SE155019.009	BH4 6.5-6.95 SOIL - 18/7/2016 SE155019.010
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	180	74	65	160	86

PARAMETER	UOM	LOR	BH6 0.5-0.95 SOIL - 18/7/2016 SE155019.011	BH6 1.5-1.95 SOIL - 18/7/2016 SE155019.012	BH6 3.0-3.45 SOIL - 18/7/2016 SE155019.013	BH6 4.5-4.95 SOIL - 18/7/2016 SE155019.014	BH6 6.0-6.45 SOIL - 18/7/2016 SE155019.015
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	220	140	76	94	120

PARAMETER	UOM	LOR	BH6 7.5-7.95 SOIL - 18/7/2016 SE155019.016	BH8 3.0-3.5 SOIL - 18/7/2016 SE155019.017	BH8 5.0-5.5 SOIL - 18/7/2016 SE155019.018	BH8 8.9-9.0 SOIL - 18/7/2016 SE155019.019
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	85	47	47	100

pH in soil (1:2) [AN101] Tested: 28/7/2016

PARAMETER	UOM	LOR	BH1 0.5-0.95 SOIL - 18/7/2016 SE155019.001	BH1 2.0-2.45 SOIL - 18/7/2016 SE155019.002	BH1 3.5-3.95 SOIL - 18/7/2016 SE155019.003	BH1 5.0-5.45 SOIL - 18/7/2016 SE155019.004	BH1 6.5-6.95 SOIL - 18/7/2016 SE155019.005
pH (1:2)	pH Units	-	6.7	4.6	4.6	4.9	4.6

PARAMETER	UOM	LOR	BH1 8.0-8.45 SOIL - 18/7/2016 SE155019.006	BH6 1.5-1.95 SOIL - 18/7/2016 SE155019.012	BH6 3.0-3.45 SOIL - 18/7/2016 SE155019.013	BH6 4.5-4.95 SOIL - 18/7/2016 SE155019.014	BH6 6.0-6.45 SOIL - 18/7/2016 SE155019.015
pH (1:2)	pH Units	-	4.8	4.8	4.9	4.9	4.7

PARAMETER	UOM	LOR	BH6 7.5-7.95 SOIL - 18/7/2016 SE155019.016	BH8 3.0-3.5 SOIL - 18/7/2016 SE155019.017	BH8 5.0-5.5 SOIL - 18/7/2016 SE155019.018	BH8 8.9-9.0 SOIL - 18/7/2016 SE155019.019
pH (1:2)	pH Units	-	5.1	5.1	5.1	5.0

Conductivity (1:2) in soil [AN106] Tested: 28/7/2016

PARAMETER	UOM	LOR	BH1 0.5-0.95 SOIL - 18/7/2016 SE155019.001	BH1 2.0-2.45 SOIL - 18/7/2016 SE155019.002	BH1 3.5-3.95 SOIL - 18/7/2016 SE155019.003	BH1 5.0-5.45 SOIL - 18/7/2016 SE155019.004	BH1 6.5-6.95 SOIL - 18/7/2016 SE155019.005
Conductivity (1:2) @25 C*	µS/cm	1	60	73	68	120	270
Resistivity (1:2)*	ohm cm	-	17000	14000	15000	8100	3700

PARAMETER	UOM	LOR	BH1 8.0-8.45 SOIL - 18/7/2016 SE155019.006	BH6 1.5-1.95 SOIL - 18/7/2016 SE155019.012	BH6 3.0-3.45 SOIL - 18/7/2016 SE155019.013	BH6 4.5-4.95 SOIL - 18/7/2016 SE155019.014	BH6 6.0-6.45 SOIL - 18/7/2016 SE155019.015
Conductivity (1:2) @25 C*	µS/cm	1	250	200	120	150	170
Resistivity (1:2)*	ohm cm	-	4000	5000	8200	6900	6000

PARAMETER	UOM	LOR	BH6 7.5-7.95 SOIL - 18/7/2016 SE155019.016	BH8 3.0-3.5 SOIL - 18/7/2016 SE155019.017	BH8 5.0-5.5 SOIL - 18/7/2016 SE155019.018	BH8 8.9-9.0 SOIL - 18/7/2016 SE155019.019
Conductivity (1:2) @25 C*	µS/cm	1	130	56	58	140
Resistivity (1:2)*	ohm cm	-	7800	18000	17000	6900

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography [AN245] Tested: 26/7/2016

PARAMETER	UOM	LOR	BH1 0.5-0.95 SOIL - 18/7/2016 SE155019.001	BH1 2.0-2.45 SOIL - 18/7/2016 SE155019.002	BH1 3.5-3.95 SOIL - 18/7/2016 SE155019.003	BH1 5.0-5.45 SOIL - 18/7/2016 SE155019.004	BH1 6.5-6.95 SOIL - 18/7/2016 SE155019.005
Chloride	mg/kg	0.25	5.9	6.0	7.5	15	110
Sulphate	mg/kg	0.5	20	46	50	87	100

PARAMETER	UOM	LOR	BH1 8.0-8.45 SOIL - 18/7/2016 SE155019.006	BH6 1.5-1.95 SOIL - 18/7/2016 SE155019.012	BH6 3.0-3.45 SOIL - 18/7/2016 SE155019.013	BH6 4.5-4.95 SOIL - 18/7/2016 SE155019.014	BH6 6.0-6.45 SOIL - 18/7/2016 SE155019.015
Chloride	mg/kg	0.25	130	61	21	19	22
Sulphate	mg/kg	0.5	89	100	100	100	140

PARAMETER	UOM	LOR	BH6 7.5-7.95 SOIL - 18/7/2016 SE155019.016	BH8 3.0-3.5 SOIL - 18/7/2016 SE155019.017	BH8 5.0-5.5 SOIL - 18/7/2016 SE155019.018	BH8 8.9-9.0 SOIL - 18/7/2016 SE155019.019
Chloride	mg/kg	0.25	24	2.5	7.7	25
Sulphate	mg/kg	0.5	89	46	48	120

Moisture Content [AN002] Tested: 26/7/2016

PARAMETER	UOM	LOR	BH1 0.5-0.95 SOIL - 18/7/2016 SE155019.001	BH1 2.0-2.45 SOIL - 18/7/2016 SE155019.002	BH1 3.5-3.95 SOIL - 18/7/2016 SE155019.003	BH1 5.0-5.45 SOIL - 18/7/2016 SE155019.004	BH1 6.5-6.95 SOIL - 18/7/2016 SE155019.005
% Moisture	%w/w	0.5	11.4	17.9	15.0	16.9	20.1

PARAMETER	UOM	LOR	BH1 8.0-8.45 SOIL - 18/7/2016 SE155019.006	BH4 1.0-1.45 SOIL - 18/7/2016 SE155019.007	BH4 3.0-3.45 SOIL - 18/7/2016 SE155019.008	BH4 5.0-5.45 SOIL - 18/7/2016 SE155019.009	BH4 6.5-6.95 SOIL - 18/7/2016 SE155019.010
% Moisture	%w/w	0.5	22.2	14.2	16.2	17.0	9.7

PARAMETER	UOM	LOR	BH6 0.5-0.95 SOIL - 18/7/2016 SE155019.011	BH6 1.5-1.95 SOIL - 18/7/2016 SE155019.012	BH6 3.0-3.45 SOIL - 18/7/2016 SE155019.013	BH6 4.5-4.95 SOIL - 18/7/2016 SE155019.014	BH6 6.0-6.45 SOIL - 18/7/2016 SE155019.015
% Moisture	%w/w	0.5	18.6	14.7	17.9	14.7	14.8

PARAMETER	UOM	LOR	BH6 7.5-7.95 SOIL - 18/7/2016 SE155019.016	BH8 3.0-3.5 SOIL - 18/7/2016 SE155019.017	BH8 5.0-5.5 SOIL - 18/7/2016 SE155019.018	BH8 8.9-9.0 SOIL - 18/7/2016 SE155019.019
% Moisture	%w/w	0.5	15.7	15.3	16.8	18.8

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:2 and the pH determined and reported on the extract after 1 hour extraction (pH 1:2) or after 1 hour extraction and overnight aging (pH (1:2) aged). Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN106	Resistivity of the extract is reported on the extract basis and is the reciprocal of conductivity. Salinity and TDS can be calculated from the extract conductivity and is reported back to the soil basis.
AN245	Anions by Ion Chromatography: A water sample or extract is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

STATEMENT OF QA/QC PERFORMANCE

SE155019 R0

CLIENT DETAILS

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Order Number	(Not specified)
Samples	19

LABORATORY DETAILS

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SGS Reference	**SE155019 R0**
Date Received	20 Jul 2016
Date Reported	29 Jul 2016

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met with the exception of the following:

Extraction Date	Conductivity (1:2) in soil	14 items
	Conductivity and TDS by Calculation - Soil	19 items
	pH in soil (1:2)	14 items
	Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography	14 items
Analysis Date	Conductivity (1:2) in soil	14 items
	Conductivity and TDS by Calculation - Soil	19 items

SAMPLE SUMMARY

Sample counts by matrix	19 Soils	Type of documentation received	COC
Date documentation received	22/7/16 @ 11.27am	Samples received in good order	Yes
Samples received without headspace	N/A	Sample temperature upon receipt	16.8°C
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	None	Samples clearly labelled	Yes
Complete documentation received	Yes		

HOLDING TIME SUMMARY

SE155019 R0

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS “Field Sampling Guide for Containers and Holding Time” (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Conductivity (1:2) in soil

Method: ME-(AU)-[ENV]AN106

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH1 0.5-0.95	SE155019.001	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 2.0-2.45	SE155019.002	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 3.5-3.95	SE155019.003	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 5.0-5.45	SE155019.004	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 6.5-6.95	SE155019.005	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 8.0-8.45	SE155019.006	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 1.5-1.95	SE155019.012	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 3.0-3.45	SE155019.013	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 4.5-4.95	SE155019.014	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 6.0-6.45	SE155019.015	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 7.5-7.95	SE155019.016	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH8 3.0-3.5	SE155019.017	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH8 5.0-5.5	SE155019.018	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH8 8.9-9.0	SE155019.019	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†

Conductivity and TDS by Calculation - Soil

Method: ME-(AU)-[ENV]AN106

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH1 0.5-0.95	SE155019.001	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 2.0-2.45	SE155019.002	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 3.5-3.95	SE155019.003	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 5.0-5.45	SE155019.004	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 6.5-6.95	SE155019.005	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH1 8.0-8.45	SE155019.006	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH4 1.0-1.45	SE155019.007	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH4 3.0-3.45	SE155019.008	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH4 5.0-5.45	SE155019.009	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH4 6.5-6.95	SE155019.010	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 0.5-0.95	SE155019.011	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 1.5-1.95	SE155019.012	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 3.0-3.45	SE155019.013	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 4.5-4.95	SE155019.014	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 6.0-6.45	SE155019.015	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH6 7.5-7.95	SE155019.016	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH8 3.0-3.5	SE155019.017	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH8 5.0-5.5	SE155019.018	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†
BH8 8.9-9.0	SE155019.019	LB106404	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	25 Jul 2016	29 Jul 2016†

Moisture Content

Method: ME-(AU)-[ENV]AN002

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH1 0.5-0.95	SE155019.001	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH1 2.0-2.45	SE155019.002	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH1 3.5-3.95	SE155019.003	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH1 5.0-5.45	SE155019.004	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH1 6.5-6.95	SE155019.005	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH1 8.0-8.45	SE155019.006	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH4 1.0-1.45	SE155019.007	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH4 3.0-3.45	SE155019.008	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH4 5.0-5.45	SE155019.009	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH4 6.5-6.95	SE155019.010	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH6 0.5-0.95	SE155019.011	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH6 1.5-1.95	SE155019.012	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH6 3.0-3.45	SE155019.013	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH6 4.5-4.95	SE155019.014	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH6 6.0-6.45	SE155019.015	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH6 7.5-7.95	SE155019.016	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH8 3.0-3.5	SE155019.017	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH8 5.0-5.5	SE155019.018	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016
BH8 8.9-9.0	SE155019.019	LB106180	18 Jul 2016	20 Jul 2016	01 Aug 2016	26 Jul 2016	31 Jul 2016	29 Jul 2016

pH in soil (1:2)

Method: ME-(AU)-[ENV]AN101

Sample Name	Sample No.	QC Ref

HOLDING TIME SUMMARY

SE155019 R0

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS “Field Sampling Guide for Containers and Holding Time” (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

pH in soil (1:2) (continued)

Method: ME-(AU)-[ENV]AN101

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH1 0.5-0.95	SE155019.001	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH1 2.0-2.45	SE155019.002	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH1 3.5-3.95	SE155019.003	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH1 5.0-5.45	SE155019.004	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH1 6.5-6.95	SE155019.005	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH1 8.0-8.45	SE155019.006	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH6 1.5-1.95	SE155019.012	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH6 3.0-3.45	SE155019.013	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH6 4.5-4.95	SE155019.014	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH6 6.0-6.45	SE155019.015	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH6 7.5-7.95	SE155019.016	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH8 3.0-3.5	SE155019.017	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH8 5.0-5.5	SE155019.018	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016
BH8 8.9-9.0	SE155019.019	LB106415	18 Jul 2016	20 Jul 2016	25 Jul 2016	28 Jul 2016†	29 Jul 2016	29 Jul 2016

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH1 0.5-0.95	SE155019.001	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH1 2.0-2.45	SE155019.002	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH1 3.5-3.95	SE155019.003	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH1 5.0-5.45	SE155019.004	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH1 6.5-6.95	SE155019.005	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH1 8.0-8.45	SE155019.006	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH6 1.5-1.95	SE155019.012	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH6 3.0-3.45	SE155019.013	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH6 4.5-4.95	SE155019.014	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH6 6.0-6.45	SE155019.015	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH6 7.5-7.95	SE155019.016	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH8 3.0-3.5	SE155019.017	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH8 5.0-5.5	SE155019.018	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016
BH8 8.9-9.0	SE155019.019	LB106253	18 Jul 2016	20 Jul 2016	25 Jul 2016	26 Jul 2016†	23 Aug 2016	29 Jul 2016

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No surrogates were required for this job.

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Conductivity (1:2) in soil

Method: ME-(AU)-[ENV]AN106

Sample Number	Parameter	Units	LOR	Result
LB106415.001	Conductivity (1:2) @25 C*	µS/cm	1	<1

Conductivity and TDS by Calculation - Soil

Method: ME-(AU)-[ENV]AN106

Sample Number	Parameter	Units	LOR

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Conductivity (1:2) in soil

Method: ME-(AU)-[ENV]AN106

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE155019.006	LB106415.010	Conductivity (1:2) @25 C*	µS/cm	1	250	249	31	1
		Resistivity (1:2)*	ohm cm	-	4000	)16.06425702E	15	1
SE155019.019	LB106415.020	Conductivity (1:2) @25 C*	µS/cm	1	140	150	31	3
		Resistivity (1:2)*	ohm cm	-	6900	6700	15	3

Conductivity and TDS by Calculation - Soil

Method: ME-(AU)-[ENV]AN106

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE155019.009	LB106404.014	Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	160	53.285256222	31	5
SE155019.019	LB106404.025	Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	100	03.590276243	32	2

Moisture Content

Method: ME-(AU)-[ENV]AN002

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE155019.009	LB106180.011	% Moisture	%w/w	0.5	17.0	17.8	36	5
SE155019.019	LB106180.022	% Moisture	%w/w	0.5	18.8	18.7	35	1
SE155053.010	LB106180.033	% Moisture	%w/w	0.5	9.79443772679	.5872170439	40	2
SE155053.025	LB106180.044	% Moisture	%w/w	0.5	10.2230483271	9.4311377245	40	8
SE155053.027	LB106180.046	% Moisture	%w/w	0.5	0	0	200	0

pH in soil (1:2)

Method: ME-(AU)-[ENV]AN101

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE155019.006	LB106415.010	pH (1:2)	pH Units	-	4.8	4.78	32	0
SE155019.019	LB106415.020	pH (1:2)	pH Units	-	5.0	5.0	32	1

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE155019.006	LB106253.009	Chloride	mg/kg	0.25	130	35.8623968561	30	4
		Sulphate	mg/kg	0.5	89	96.1598428290	32	8
SE155019.019	LB106253.018	Chloride	mg/kg	0.25	25	24.6655248618	31	2
		Sulphate	mg/kg	0.5	120	19.5822099447	32	2

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Conductivity (1:2) in soil

Method: ME-(AU)-[ENV]AN106

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB106415.002	Conductivity (1:2) @25 C*	µS/cm	1	300	303	85 - 115	100

Conductivity and TDS by Calculation - Soil

Method: ME-(AU)-[ENV]AN106

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB106404.002	Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	NA	303	85 - 115	100

pH in soil (1:2)

Method: ME-(AU)-[ENV]AN101

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB106415.003	pH (1:2)	pH Units	-	7.4	7.415	98 - 102	99

Soluble Anions in Soil from 1:2 DI Extract by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB106253.002	Chloride	mg/kg	0.25	NA	40	70 - 130	92
	Sulphate	mg/kg	0.5	NA	40	70 - 130	96

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spikes were required for this job.

MATRIX SPIKE DUPLICATES

SE155019 R0

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover tthe performance of this service.
-	Sample not analysed for this analyte.

IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

source: MLX_EHS_OFFICE_X585_20160722134339.pdf page: 33 SGS Ref: SE155019_COC

... 22/7/16 @ 11.27 a

GEOTECHNIQUE PTY LTD

Laboratory Test Request / Chain of Custody Record

Lemko Place
PENRITH NSW 2750

P O Box 880
PENRITH NSW 2751

Tel: (02) 4722 2700
Fax: (02) 4722 6161
email: info@geotech.com.au

Page 1

TO:	SGS ENVIRONMENTAL SERVICES UNIT 16 33 MADDOX STREET ALEXANDRIA NSW 2015	Sampling By: AP	Job No: 13787/1
			Project: Proposed Residential Aged Care Facility
PH:	02 8594 0400	FAX: 02 8594 0499	
ATTN:	Ms Emily Yin	Project Manager: IJ	Location: 23-27 Warriewood Road, Warriewood

Sampling details | **Results required by:**

#	Location	Depth (m)	Soil	Water	EC(1:5)	Aggressivity							Notes	Keep Sample
1	BH1	0.5-0.95	DSP		✓	✓							Aggressivity test includes pH	
2		2.0-2.45	DSP		✓	✓							chloride, sulphate and resistivity	
3		3.5-3.95	DSP		✓	✓								
4		5.0-5.45	DSP		✓	✓								
5		6.5-6.95	DSP		✓	✓								
6		8.0-8.45	DSP		✓	✓								
	BH2	0.5-0.95	DSP											
		2.0-2.45	DSP											
		5.0-5.45	DSP											
	BH3	0.5-0.95	DSP											
		2.5-2.95	DSP											
		5.5-5.95	DSP											
		8.0-8.5	DSP											
7	BH4	1.0-1.45	DSP		✓									
8		3.0-3.45	DSP		✓									
9		5.0-5.45	DSP		✓									
10		6.5-6.95	DSP		✓									

SGS Alexandria Environmental
SE155019 COC
Received: 20-Jul-2016

Relinquished by			Received by		
Name	Signature	Date	Name	Signature	
Indra Jworchan		18-Jul-16	Harish	HG	20/7 2pm

Legend:

WG	USG	Undisturbed soil sample (glass	DSP	Disturbed soil sample (small plastic bag)	* Purge & Trap
WP	DSG	Disturbed soil sample (glass ja	✓	Test required	# Geotechnique Screen

Form No 4.7F2-5 SGS

GEOTECHNIQUE PTY LTD

Laboratory Test Request / Chain of Custody Record

Lemko Place
PENRITH NSW 2750

P O Box 880
PENRITH NSW 2751

Tel: (02) 4722 2700
Fax: (02) 4722 6161
email: info@geotech.com.au

TO:	SGS ENVIRONMENTAL SERVICES UNIT 16 33 MADDOX STREET ALEXANDRIA NSW 2015	Sampling By:	AP
		Job No:	13787/1
		Project:	Proposed Residential Aged Care Facility
PH:	02 8594 0400	FAX:	02 8594 0499
ATTN:	Ms Emily Yin	Project Manager:	IJ
		Location:	23-27 Warriewood Road, Warriewood

Sampling details				Results required by:									
Location	Depth (m)	Soil	Water	EC(1:5)	Aggressivity							Notes	Keep Sample
BH5	1.0-1.45	DSP										Aggressivity test includes pH	
	2.5-2.95	DSP										chloride, sulphate and resistivity	
	3.5-4.0	DSP											
	5.0-5.45	DSP											
	7.0-7.5	DSP											
11 BH6	0.5-0.95	DSP		✓									
12	1.5-1.95	DSP		✓	✓								
13	3.0-3.45	DSP		✓	✓								
14	4.5-4.95	DSP		✓	✓								
15	6.0-6.45	DSP		✓	✓								
16	7.5-7.95	DSP		✓	✓								
BH7	0.5-1.0	DSP											
	1.5-1.95	DSP											
	3.0-3.45	DSP											
	4.5-4.95	DSP											
	6.0-6.45	DSP											
	7.5-7.95	DSP											

Relinquished by			Received by		
Name	Signature	Date	Name	Signature	
Indra Jworchan		18-Jul-16	Hamish	HS	20/7 8pm

Legend:

WG	USG	Undisturbed soil sample (glass	DSP	Disturbed soil sample (small plastic bag)	* Purge & Trap
WP	DSG	Disturbed soil sample (glass ja	✓	Test required	# Geotechnique Screen

GEOTECHNIQUE PTY LTD

Laboratory Test Request / Chain of Custody Record

Lemko Place
PENRITH NSW 2750

P O Box 880
PENRITH NSW 2751

Tel: (02) 4722 2700
Fax: (02) 4722 6161
email: info@geotech.com.au

TO:	**SGS ENVIRONMENTAL SERVICES** **UNIT 16** **33 MADDOX STREET** **ALEXANDRIA NSW 2015**	**Sampling By:** AP	**Job No:** 13787/1
			Project: Proposed Residential Aged Care Facility
PH:	**02 8594 0400** **FAX:** **02 8594 0499**	**Project Manager:** IJ	**Location:** 23-27 Warriewood Road, Warriewood
ATTN:	**Ms Emily Yin**		

	Sampling details				Results required by:								
	Location	**Depth (m)**	**Soil**	**Water**	**EC(1:5)**	**Aggresivity**						**Notes**	**Keep Sample**
17	BH8	3.0-3.5	DSP		✓	✓						Aggressivity test includes pH	
18		5.0-5.5	DSP		✓	✓						chloride, sulphate and resistivity	
19		8.9-9.0	DSP		✓	✓							

Relinquished by			Received by		
Name	Signature	Date	Name	Signature	
Indra Jworchan		18-Jul-16	Hamish	HS	20/7 2pm

Legend:

WG	USG	Undisturbed soil sample (glass	DSP	Disturbed soil sample (small plastic bag)	* Purge & Trap
WP	DSG	Disturbed soil sample (glass ja	✓	Test required	# Geotechnique Screen

SAMPLE RECEIPT ADVICE

SE155019

CLIENT DETAILS

Contact	Indra Jworchan
Client	Geotechnique
Address	P.O. Box 880 NSW 2751
Telephone	02 4722 2700
Facsimile	02 4722 6161
Email	indra.jworchan@geotech.com.au
Project	**13787-1 23-27 Warriewood Road Warriewood**
Order Number	(Not specified)
Samples	19

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
Samples Received	Wed 20/7/2016
Report Due	Fri 29/7/2016
SGS Reference	**SE155019**

SUBMISSION DETAILS

This is to confirm that 19 samples were received on Wednesday 20/7/2016. Results are expected to be ready by Friday 29/7/2016. Please quote SGS reference SE155019 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Sample counts by matrix	19 Soils	Type of documentation received	COC
Date documentation received	22/7/16 @ 11.27am	Samples received in good order	Yes
Samples received without headspace	N/A	Sample temperature upon receipt	16.8°C
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	None	Samples clearly labelled	Yes
Complete documentation received	Yes		

Unless otherwise instructed, water and bulk samples will be held for one month from date of report, and soil samples will be held for two months.

COMMENTS

18 soil samples, which were not marked for analyses on the COC, have been placed on hold.

SAMPLE RECEIPT ADVICE

SE155019

CLIENT DETAILS

Client Geotechnique

Project 13787-1 23-27 Warriewood Road Warriewood

SUMMARY OF ANALYSIS

No.	Sample ID	Conductivity (1:2) in soil	Conductivity and TDS by Calculation - Soil	Moisture Content	pH in soil (1:2)	Soluble Anions in Soil from 1:2 DI Extract by Ion
001	BH1 0.5-0.95	2	1	1	1	2
002	BH1 2.0-2.45	2	1	1	1	2
003	BH1 3.5-3.95	2	1	1	1	2
004	BH1 5.0-5.45	2	1	1	1	2
005	BH1 6.5-6.95	2	1	1	1	2
006	BH1 8.0-8.45	2	1	1	1	2
007	BH4 1.0-1.45	-	1	1	-	-
008	BH4 3.0-3.45	-	1	1	-	-
009	BH4 5.0-5.45	-	1	1	-	-
010	BH4 6.5-6.95	-	1	1	-	-
011	BH6 0.5-0.95	-	1	1	-	-
012	BH6 1.5-1.95	2	1	1	1	2
013	BH6 3.0-3.45	2	1	1	1	2
014	BH6 4.5-4.95	2	1	1	1	2
015	BH6 6.0-6.45	2	1	1	1	2
016	BH6 7.5-7.95	2	1	1	1	2
017	BH8 3.0-3.5	2	1	1	1	2
018	BH8 5.0-5.5	2	1	1	1	2
019	BH8 8.9-9.0	2	1	1	1	2

The above table represents SGS' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .