Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Preliminary Acid Sulfate Soil Investigation

Great Keppel Island Revitalisation Plan

Prepared for
GKI Resorts Pty Ltd

Project 74586.00
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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		31/08/2011
Reviewer		31/08/2011

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Report on Preliminary Acid Sulfate Soil Investigation
Great Keppel Island Resort Revitalisation Plan

1. Introduction

Douglas Partners Pty Ltd (DP) was commissioned by GKI Resort Pty Ltd (GKI Resort) to conduct a preliminary acid sulfate soil (ASS) assessment within the proposed footprint of works for the Great Keppel Island (GKI) Resort Revitalisation Plan (the "Project").

It is understood that revitalisation will include demolition of the existing resort, as well as construction of new resort facilities, a golf course and a marina. This assessment has been requested as part of the Environmental Impact Statement (EIS) for the proposed development. It comprised a desktop review of the potential for ASS to exist on the island, as well as preliminary soil sampling, field screening and laboratory analysis.

1.1 Objective

The objective of this investigation was to identify the potential for ASS to be present at the site. This report describes data and comments on subsurface conditions and provides an assessment of the presence or otherwise of ASS. No previous ASS investigations are known to have been carried out on Great Keppel Island.

This assessment has been conducted with reference to the requirements of the terms of reference (TOR) issued for development of the EIS (Coordinator-General 2011: Section 3.2.5; and GBRMPA 2011: Section 5). It included a desktop assessment, drilling of eight bores with a hand auger, soil sampling, preliminary screening, laboratory testing, and ASS assessment.

1.2 Reference Guidelines

This investigation was conducted with reference to QASSIT (1998), SPP 2/02 (2002) and its accompanying Guideline 2/02, as well as QASSMAC (1999).

2. Site Information

Great Keppel Island is the largest island in the Keppel group of islands, and is located approximately 19 km east of Yeppoon off the Central Queensland coastline. It is located within the Mackay/ Capricorn region of the Great Barrier Reef Marine Park.

A former resort is located on a dune sand deposit on the south-western end of the island, inland from Fisherman's Beach. Residential houses, a holiday village, and the Keppel Haven Resort are also located on this dune sand deposit between Fisherman's Beach and Putney Beach, further to the north.

2.1 Site Description

The "site" considered in this investigation is limited to the areas of proposed disturbance for Project related activities. According to the proposed development plans provided by GKI Resorts (dated October 2010), three regions of the island will require disturbance as follows (as shown on Drawing 1):

Precinct 1: Proposed marina precinct, northern section of Putney Beach and off-shore area
Precinct 2: Proposed Fisherman's Beach precinct, footprint of existing resort, air strip, and vegetated areas east of the airstrip
Precinct 3: Proposed Clam Bay precinct, north of Clam Bay from the eastern base of Mount Wyndham and Wyndham Cove north to the historical Homestead, and east to the base of the mountain

2.2 Local Geology and Acid Sulfate Soil Conditions

According to the Queensland Department of Natural Resources, Mines and Water (2006) geological map for the Rockhampton region, the island is primarily underlain by the Carboniferous aged Shoalwater Formation comprising metamorphic quartzose and lithic sandstones, with minor mudstone and schist. In three separate areas of the island this Carboniferous sequence is overlain by thin veneers of Quaternary deposits. The western areas of the island adjacent to Fisherman's Beach and Putney Beach are mapped as coastal sand beach ridges.

No documented information was available with regards to the ASS conditions on Great Keppel Island.

2.3 Topography

The topography of Great Keppel Island is relatively steep and is dominated by two southeast to northwest trending ridges with a maximum elevation of approximately 175 m AHD (Drawing 1). A flat to undulating topography is present in the dune sand areas in the northeast and southwest regions of the island. The topography becomes slightly undulating on the eastern side towards Wreck Bay.

Topography in Precinct 1 is relatively flat along the beach front. Elevations range from less than 0 m AHD to 3-4 m AHD in the southern section of Precinct 1. A ridge exists beyond the beach along the north-eastern boundary of Precinct 1 that extends to approximately 25-30 m AHD.

Elevations in Precinct 2 range from approximately 3-4 m AHD in the western section near Fisherman's Beach to 45-50 m AHD on the ridges in the eastern sections before sloping down towards Long Beach.

Precinct 3 is relatively steep. It slopes from approximately 12 m AHD at the north-western end to approximately 65 m AHD at the south-eastern end near Clam Bay.

3. Acid Sulfate Soil Risk Areas

Disturbance of land with a surface elevation at or below 5 m AHD via excavation of at least 100 m^3 or filling of at least 500 m^3 triggers an ASS assessment (SPP Guideline 2/02, 2002: 3). An ASS assessment would also be triggered where the surface elevation is between 5 m AHD and 20 m AHD and an excavation of at least 100 m^3 is to occur below 5 m AHD.

On this basis and in accordance with SPP Guideline 2/02 (2002), an initial desktop review of the proposed development precincts was conducted to identify any areas at risk of containing ASS. At the time of this investigation, it was not expected that deep excavations would be required (i.e. from 20 m AHD to depths less than 5 m AHD) and only minimal excavation would be required below 5 m AHD. Therefore, only the areas identified as having an elevation of less than 5 m AHD were considered as potential ASS risk areas for the Project. ASS risk areas were identified only within Precincts 1 and 2 of the proposed development (Drawing 2).

Sections of Precinct 1 with a surface elevation less than 5 m AHD consisted primarily of rock outcrops and beach sand (Drawing 2). Although this was identified as a potential ASS risk area, observations noted during the site inspection (Section 4.1) did not indicate potential for ASS. It was therefore considered highly unlikely that ASS would be present in Precinct 1 and that soil sampling and laboratory testing was not warranted.

Approximately 12.145 ha (121,450 m^2) of land in the western section of Precinct 2 lies at elevations less than 5 m AHD (Drawing 2). At the time of this preliminary investigation, detailed excavation plans were not available for the Project. However, it is expected that the requirement for extensive demolition and construction of new resort buildings would result in soil disturbance in low-lying areas that would trigger an ASS assessment under SPP 2/02 (2002).

Precinct 3, the proposed golf course precinct, has a topographic elevation ranging from approximately 12 m AHD in the northwest to 65 m AHD in the southeast near Clam Bay (Drawing 1). As Precinct 3 lies above the ASS trigger elevation of 5 m AHD and the golf course development is not intended to include deep excavations (>5 m), an ASS investigation under SPP Guideline 2/02 (2002) is not required for this precinct.

This preliminary assessment was focussed on the portion of Precinct 2 with an elevation less than 5 m AHD (Drawing 2).

4. Field Investigations

Field investigations were carried out by DP Engineers, Chris Bell and Karen Hager, on 23 November 2010. Investigations comprised the following activities:

- An inspection of accessible sections of the proposed precincts of development.
- Augering of eight boreholes with a 90 mm hand auger to depths between 1 m and 1.2 m below ground level for ASS sampling (Boreholes HA12-HA16, HA18-HA20, Drawing 3).
- Collection of soil samples from each borehole location at 0.25 m depth intervals.

4.1 Site Inspections

Inspections of the accessible portions of the proposed development precincts were carried out prior to drilling and sample collection. Soil and water characteristics were visually assessed with reference to typical ASS indicators and are summarised in Table 1. See also attached site photographs.

Table 1: Summary of field observations – typical indicators of ASS

Typical Indicators of Actual ASS	Presence of Indicators		
	Precinct 1	Precinct 2	Precinct 3
Soil Characteristics			
pH_F ≤4	NA	×	NA
Corroded shells	×	×	×
Jarosite horizons/ staining	×	×	×
Iron oxide mottling/staining	×	×	×
Sulfurous (H_2S gas) odours	×	×	×
Pale to dark steely blue-grey colour, possibly greenish	×	×	×
Soil cracking	×	×	×
Water Characteristics			
Water pH<5.5 in adjacent waterways	NA	NA	NA
Unusually clear or milky blue-green drain water	×	NA	NA
Extensive iron stains on water surface	×	NA	NA
Iron stained water	×	NA	NA
Ochre deposits	×	×	×
Orange scum on banks	×	×	×
Oily film of bacteria	×	×	×
Fish diseases/ kills	NA	NA	NA
Landscape Characteristics			
Dead, dying or stunted vegetation*	✓	×	×
Scalded or bare low-lying areas*	×	×	×
Corrosion of concrete and/or steel structures*	NA	NA	NA
Subsidence	NA	NA	NA
Acid tolerant vegetation	×	×	×
Typical Indicators of Potential ASS			
Soil Characteristics			
Waterlogged soils	×	×	×
pH_F>4	NA	✓	NA
pH_{FOX}<3	NA	×	NA
Large change in pH (ΔpH) and strong reaction to peroxide	NA	×	NA
Presence of shell	×	×	×
Sulfurous (H_2S gas) odours	×	×	×
Water Characteristics			
Water pH usually neutral in adjacent waterways	✓	NA	NA
Landscape Characteristics			
Water logging tolerant vegetation	×	×	×
Anaerobic tolerant vegetation	×	×	×

Notes

*	May also be due to excessive salinity or salinity in combination with actual ASS
×	Indicator not observed
✓	Indicator was observed in at least one location
NA	Not applicable due to non-presence of indicative substance

In summary, no significant indicators for the presence of ASS were observed during inspections of the three precincts proposed for development.

4.2 Soil Sampling

Soil sampling was carried out with reference to standard operating procedures described in DP's Field Procedures Manual to ensure the samples are representative and to maintain their integrity. All samples were recorded on DP chain of custody sheets, and the general sampling procedure comprised:

- Grab sampling by the sampler wearing disposable gloves that were changed prior to the collection of each sample;
- Transfer of samples into air-tight, zip-locked plastic bags, and sealing immediately;
- Chilling of samples with ice in insulated containers;
- Labelling of sample containers with individual and unique identification, including project number and sample location;
- Temporary storage of samples in a designated freezer; and
- Placement of the samples into ice-containing, insulated and sealed containers for transport to the laboratory.

Borehole locations were determined based on a judgemental sampling strategy according to site accessibility. Actual test locations were recorded using a Garmin hand held GPS accurate in position to approximately 5 m. Borehole locations are indicated on Drawing 3. Co-ordinates for each borehole were referenced to GDA 94 datum and are included on the borehole reports in Appendix B.

4.3 Sampling Intensity

Only a preliminary assessment with the objective of identifying the presence/absence of ASS in the selected portions of Precinct 2 was considered feasible to satisfy the TOR (Coordinator-General 2010: Section 3.2.5, GBRMPA 2010: Section 5) at this stage of the Project. A more extensive ASS assessment would be dependent on the proposed development, excavation locations, and volumes of soil requiring disturbance. If ASS indicators are identified and the preliminary ASS investigation confirmed the presence of actual or potential ASS, then a more extensive ASS assessment would be required in accordance with QASSIT (1998).

According to QASSIT (1998), a minimum of two boreholes per hectare is recommended for the ASS component of most Queensland EIS for sites with an area greater than 4 ha. Eight boreholes were assessed in the 12.145 ha portion of Precinct 2 with elevations less than 5 m AHD during field investigations. Although it does not comply with the QASSIT (1998) guidelines, this sampling intensity is considered sufficient for a preliminary assessment for submission to local Council where no indications of ASS are present.

4.4 Ground Conditions

Subsurface ground conditions comprised **silty sand** and **sand** to the limit of the current investigation. Each borehole location was lithologically logged and the soil profiles encountered and sampled are described on the borehole reports in Appendix B. No free groundwater was observed during drilling or sampling. Soil types encountered during this ASS assessment are in broad agreement with the mapped geology (Section 2.2).

5. Sample Analysis

5.1 Sample Integrity

Sample integrity was maintained by keeping all samples in sealed containers and in ice-cooled, insulated eskies immediately after sampling. Samples were frozen overnight and sent to Australian Laboratory Services Pty Ltd (ALS), at 32 Shand Street, Stafford, Brisbane with ice present under strict chain of custody procedures on departure from the island. ALS are accredited by the National Association of Testing Authorities (NATA).

Samples were all received by the laboratory in good condition, in the correct containers without headspace, and within recommended holding times. It is considered that the integrity of samples was preserved during temporary storage and transportation to the laboratory. Chain of custody and sample receipt documentation is attached with the laboratory reports in Appendix C.

5.2 ASS Analysis Results

A total of 40 samples were screened by measurement of pH after the addition of distilled water (pH_F) and peroxide (pH_{FOX}). Eight of these soil samples were selected for Chromium Suite analysis based on the field screening results and with reference to SPP Guideline 2/02 (2002).

Field screening and chemical laboratory tests for ASS were carried out with reference to QASSIT (1998), Dear *et al* (2002), and Ahern *et al* (2004). Results of the screening tests and the Chromium Suite test results are summarised in Table 2.

Table 2: Summary of Acid Sulfate Soil Laboratory Results

Depth (m BGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results (%S)							
		pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pHKCl (pH units)	Chromium Reducible Sulfur, SCR	Tritratable Actual Acidity, TAA		Sulfur in KCl extract, SKCl	Retained Acidity (NASS)	Acid Neutralising Capacity, ANC	Net Acidity
								mol H^+/t	% pyrite S				
Bore Number 12													
0.00	Sand	7.1	5.0	2.1	1	-	-	-	-	-	-	-	-
0.25	Sand	7.1	4.8	2.3	1	-	-	-	-	-	-	-	-
0.50	Sand	6.9	5.0	1.9	1	-	-	-	-	-	-	-	-
0.75	Sand	6.7	4.9	1.8	1	-	-	-	-	-	-	-	-
1.00	Sand	9.1	6.3	2.8	1	9.60	0.012	<2	<0.02	-	-	1.3	<0.02
Bore Number 13													
0.00	Silty Sand	7.1	5.0	2.1	1	-	-	-	-	-	-	-	-
0.25	Silty Sand	5.6	3.5	2.1	1	4.30	<0.005	44	0.07	<0.02	0.02	-	0.09
0.50	Silty Sand	6.4	4.7	1.7	1	-	-	-	-	-	-	-	-
0.75	Sand	6.3	4.6	1.7	1	-	-	-	-	-	-	-	-
1.00	Sand	6.4	4.7	1.7	1	-	-	-	-	-	-	-	-
Bore Number 14													
0.00	Sand	7.9	5.4	2.5	1	-	-	-	-	-	-	-	-
0.25	Sand	7.9	5.5	2.4	1	-	-	-	-	-	-	-	-
0.50	Sand	7.8	5.3	2.5	1	-	-	-	-	-	-	-	-
0.75	Sand	8.2	5.6	2.6	1	8.70	<0.005	<2	<0.02	-	-	<0.01	<0.02
1.00	Sand	9.2	6.4	2.8	1	-	-	-	-	-	-	-	-
Bore Number 15													
0.00	Sand	7.8	5.5	2.3	1	-	-	-	-	-	-	-	-
0.25	Sand	8.1	5.6	2.5	1	-	-	-	-	-	-	-	-
0.50	Sand	9.1	6.0	3.1	1	8.40	<0.005	<2	<0.02	-	-	<0.01	<0.02
0.75	Sand	8.4	5.5	2.9	1	-	-	-	-	-	-	-	-
1.00	Sand	8.5	5.8	2.7	1	-	-	-	-	-	-	-	-

Table continued on next page

Table 2 (cont.): Summary of Acid Sulfate Soil Laboratory Results

Depth (m BGL)	Lithology	Field Screening Test Results				Chromium Suite Test Results (%S)							
		pH_F	pH_{FOX}	ΔpH	Reaction Intensity (1,2,3,4)*	pHKCl (pH units)	Chromium Reducible Sulfur, SCR	Tritratable Actual Acidity, TAA		Sulfur in KCl extract, SKCl	Retained Acidity (NASS)	Acid Neutralising Capacity, ANC	Net Acidity
								mol H^+/t	% pyrite S				
Bore Number 16													
0.00	Sand	7.2	5.1	2.1	1	-	-	-	-	-	-	-	-
0.25	Sand	6.1	5.8	0.3	1	-	-	-	-	-	-	-	-
0.50	Sand	6.5	4.8	1.7	1	-	-	-	-	-	-	-	-
0.75	Sand	6.7	4.8	1.9	1	-	-	-	-	-	-	-	-
1.00	Sand	6.7	4.8	1.9	1	6.40	<0.005	<2	<0.02	-	-	-	<0.02
Bore Number 18													
0.00	Sand	7.6	5.5	2.1	1	-	-	-	-	-	-	-	-
0.25	Sand	7.3	5.3	2.0	1	-	-	-	-	-	-	-	-
0.50	Sand	7.1	5.2	1.9	1	-	-	-	-	-	-	-	-
0.75	Sand	8.0	5.1	2.9	1	6.40	<0.005	<2	<0.02	-	-	-	<0.02
1.00	Sand	9.0	6.3	2.7	1	-	-	-	-	-	-	-	-
Bore Number 19													
0.00	Sand	8.6	6.2	2.4	1	-	-	-	-	-	-	-	-
0.25	Sand	7.8	5.7	2.1	1	-	-	-	-	-	-	-	-
0.50	Sand	7.7	5.3	2.4	1	6.50	<0.005	<2	<0.02	-	-	<0.01	<0.02
0.75	Sand	8.9	6.2	2.7	1	-	-	-	-	-	-	-	-
1.00	Sand	9.1	6.5	2.6	1	-	-	-	-	-	-	-	-
Bore Number 20													
0.00	Sand	6.8	5.0	1.8	1	-	-	-	-	-	-	-	-
0.25	Sand	6.4	5.0	1.4	1	-	-	-	-	-	-	-	-
0.50	Sand	6.1	4.5	1.6	1	-	-	-	-	-	-	-	-
0.75	Sand	6.6	4.8	1.8	1	-	-	-	-	-	-	-	-
1.00	Sand	6.6	4.8	1.8	1	5.80	<0.005	<2	<0.02	-	-	-	<0.02

Notes	
mBGL	metres below ground level
-	Not tested
*	Reaction Intensity: 1 = no reaction, 2 = mild reaction, 3 = vigorous reaction, 4 = violent reaction
Yellow	cells indicate a net acidity greater than or equal to the guideline level of 0.03% S

6. Discussion

6.1 Screening Test Results

Assessment of screening test results (pH_F and pH_{FOX}) and their indications of actual or potential ASS was based on QASSIT (1998) and can be described as follows (Table 2).

- The **field pH test (pH_F)** measures the existing acidity of the soil and is used to help identify whether actual ASS is present. If pH_F is less than 4, it is considered that either actual ASS is present or soils contain a high organic content. A pH_F is between 4 and 5 indicates acidic soils. All samples reported a pH_F greater than or equal to 5.6 with a median value of 7.3, which indicates that actual ASS is not present.

- The **field peroxide test (pH_{FOX})** is used to indicate the presence of iron sulfides, i.e. the potential for acid release, or potential ASS. All pH_{FOX} results were greater than 4.6, with a median value of 5.3. Borehole 13 was the only exception at 0.25 m depth with a pH_{FOX} of 3.5. This indicates that the presence of potential ASS is unlikely.

- The **change in pH (ΔpH)** is also used as an indicator of potential ASS. Generally, the greater the ΔpH, the more likelihood there is of potential ASS being present. A pH_{FOX} value at least one unit below pH_F may also indicate potential ASS. Calculated ΔpH values varied between 0.3 and 3.1 with a median value of 2.1.

- The **strength of reaction** with peroxide is rated between 1 and 4, where 1 represents no reaction, and 4 represents a violent reaction. This is a useful indicator that must be considered in conjunction with other field test results (pH_F, pH_{FOX}, ΔpH). All samples reported no reaction (i.e. 1).

On the basis of the qualitative screening results, the likelihood of actual and/or potential ASS is considered to be low. **Chromium suite laboratory analysis** was conducted on selected samples to confirm this (Table 2). Results can be interpreted as follows:

- The majority of samples returned chromium reducible sulfur (S_{CR}) values less than the laboratory's limit of reporting (LOR) of 0.005% Sulfur. Borehole 12 was the only exception at 1 m depth with a SCR of 0.012. Therefore it is considered that negligible amounts of sulfides were identified.

- Only one sample (Borehole 13 at 0.25 m depth) reported a Titratable Actual Acidity (TAA) above the LOR. This result of 44 mol H^+/t with an equivalent sulfidic-TAA of 0.07 % Sulfur indicates naturally acidic material was present within this sample and does not indicate the presence of ASS.

7. Conclusions and Recommendations

Based on the results of this investigation, the following conclusions have been made:

- No indications of actual or potential acid sulfate soils were identified within Precinct 2 of the proposed Project (Drawing 1) during this investigation.
- ASS management is not considered necessary within the three precincts assessed.

8. References

Ahern CR, Ahern MR, and Powell B (1998) *QASSIT Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in QLD 1998,* Revision 4.0. Queensland Acid Sulfate Soil Investigation Team (QASSIT), Department of Natural Resources, RSC, Indooroopilly.

Ahern CR, Sullivan LA, and McElnea AE (2004) *Acid Sulfate Soils, Laboratory Methods Guidelines*, Version 2.1, Department of Natural Resources and Mines joint project, Indooroopilly.

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Dear SE, Moore NG, Dobos SK, Watling KM, and Ahern CR (2002) Soil Management Guidelines. In *Queensland Acid Sulfate Soil Technical Manual*. Version 3.8. Department of Natural Resources and Mines, Indooroopilly.

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Queensland Department of Natural Resources, Mines and Water (2006) *Australia 1:100,000 Geological Series, Rockhampton, Queensland, Sheet 9051*. Brisbane.

State Planning Policy (SPP) 2/02 (2002) *Planning and Managing Development Involving Acid Sulfate Soils*. Brisbane.

State Planning Policy (SPP) Guideline 2/02 (2002) *Planning and Managing Development Involving Acid Sulfate Soils*. Version 2. Brisbane.

9. Limitations of this Report

DP has preformed investigation and consulting services for this project in accordance with current professional and industry standards for environmental site assessments. DP's assessment is necessarily based on the results of limited site investigations and upon the restricted program of surface and subsurface sample screening and chemical testing. Neither DP, nor any other reputable consultant, can provide unqualified warranties, nor does DP assume any liability for site conditions not observed, or inaccessible during the time of the investigations.

Despite all reasonable care and diligence, the ground conditions encountered and concentrations of analytes measured may not be representative of conditions between the locations sampled and investigated. In addition, site characteristics may change at any time in response to variations in natural conditions, chemical reactions and other events, e.g. groundwater movement. These changes may occur after DP's investigations and assessment.

The investigation addresses the likelihood of the presence of acid sulfate soils within the substrate. As a result, certain environmental characteristics at the site may not be revealed, inter alia these may include background levels of toxins in the substrate including soils, rock, water and biomass in the site.

No site investigations can be thorough enough to provide absolute confirmation of the presence or absence of acid sulfate soils. Similarly the level of testing cannot be considered to unequivocally characterise the degree or extent of acid sulfate soils on the site. In addition regulatory or guideline criteria for the evaluation of environmental soil and groundwater quality are frequently being reviewed and thresholds which are considered acceptable now may in the future be considered to exceed or meet acceptance criteria.

This report and associated documentation and the information herein have been prepared solely for the use of GKI Resort Pty Ltd, and any reliance assumed by other parties on this report shall be at such parties' own risk. Local Council, State and Federal government departments may also use the report solely to review the assessment of acid sulfate soils at the site. Any ensuring liability resulting from use of the report by other parties cannot be transferred to DP.

Douglas Partners Pty Ltd

Photo 1: Northern end of Precinct 1 (Putney Beach) – view towards the south

Photo 2: Northern end of Precinct 1 (Putney Beach) – view towards the east

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs** **Preliminary ASS Assessment** **GKI Resort Revitalisation Plan**	PROJECT: 74586.00 PLATE No: 1 REV: 2
	CLIENT: GKI Resort Pty Ltd	DATE: August 2011

Photo 3: Creek outlet onto Putney Beach (Precinct 1) – view towards the north. Vegetation considered to be affected by excess salinity.

Photo 4: Borehole HA 12 in Precinct 2 – view towards the northwest.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	74586.00
	Preliminary ASS Assessment	PLATE No:	2
	GKI Resort Revitalisation Plan	REV:	2
	CLIENT: GKI Resort Pty Ltd	DATE:	August 2011

Photo 5: Drilling of borehole HA 14 in low-lying portion of Precinct 2 – view towards the northwest.

Photo 6: General view of low-lying areas of Precinct 2 – view from Fisherman's Beach to the east.

Douglas Partners Geotechnics / Environment / Groundwater	**Site Photographs**	PROJECT:	74586.00
	Preliminary ASS Assessment	PLATE No:	3
	GKI Resort Revitalisation Plan	REV:	2
	CLIENT: GKI Resort Pty Ltd	DATE:	August 2011

Drawings

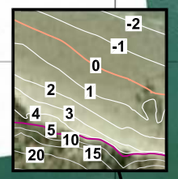
Drawing 1 – Proposed Development Precincts
Drawing 2 – Acid Sulfate Soil Risk Areas
Drawing 3 – Acid Sulfate Soil Bore Locations

77434750

288000 288750 289500 290250 291000 291750 292500 293250 294000 294750

7437750 7437000 7436250 7435500 7434750 7434000 7433250

Precinct 1 - Proposed Marina Precinct
Precinct 2 - Proposed Fisherman's Beach Precinct
Precinct 3 - Proposed Clam Bay Precinct



SVENDSENS BEACH
WRECK BEACH
Wreck Bay
LEEKE'S BEACH
Precinct 1
PUTNEY BEACH
Precinct 2
Precinct 3
FISHERMAN'S BEACH
RED BEACH
Clam Bay
WYNDHAM COVE
LONG BEACH
MONKEY BEACH
MONKEY POINT
LITTLE MONKEY POINT

Notes:-

1. Plan adapted from drawings provided by GKI Resort Pty Ltd.
2. Proposed development areas as specified by GKI Resort Pty Ltd (October 2010).
3. Topographic Contours shown in meters Australian Height Datum (AHD) at 5m intervals.

0 200 400 600 800
SCALE 1: 20,000 (A3)

Douglas Partners
Geotechnics | Environment | Groundwater

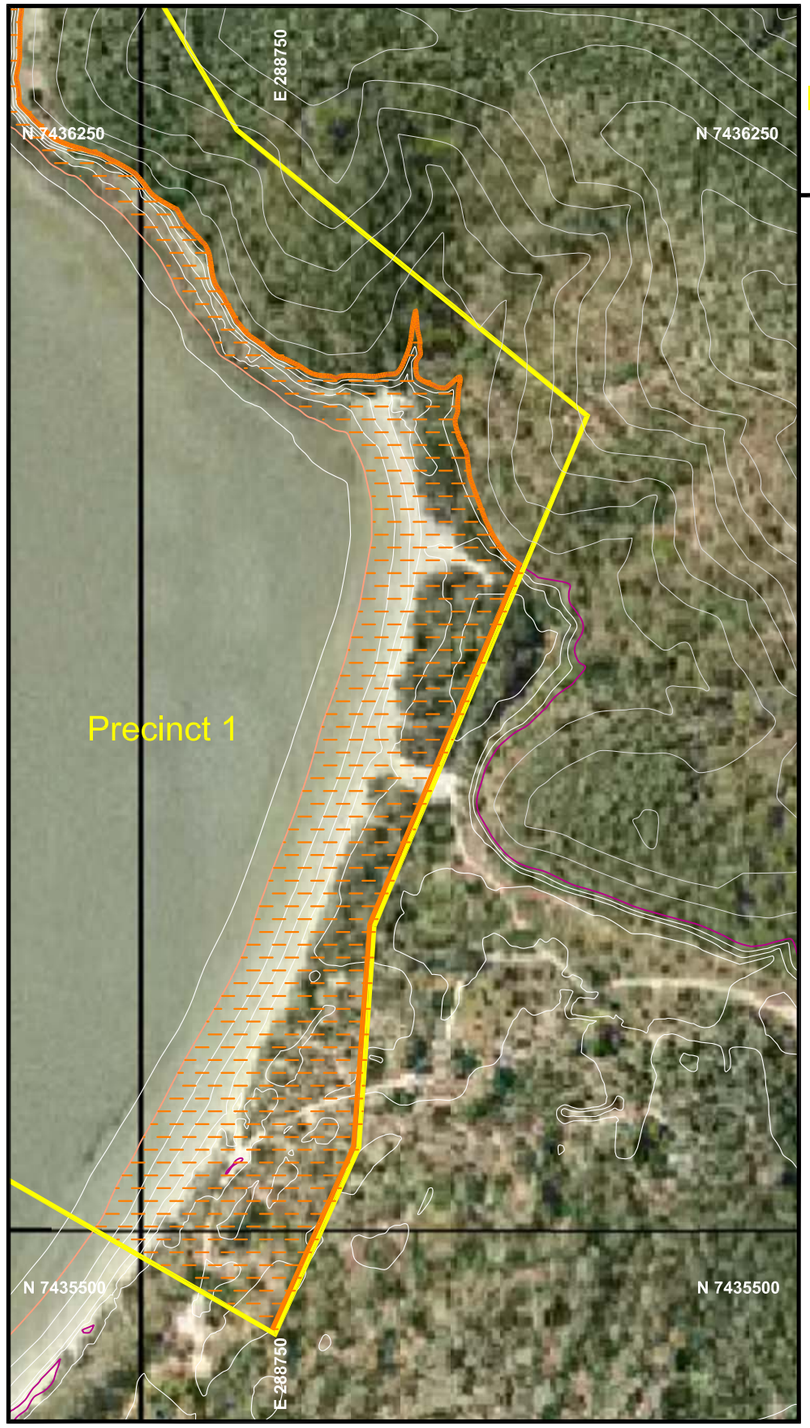
CLIENT: GKI Resort Pty Ltd		
OFFICE: Brisbane	DRAWN BY: JT	
SCALE: As shown	DATE: 31 August 2011	

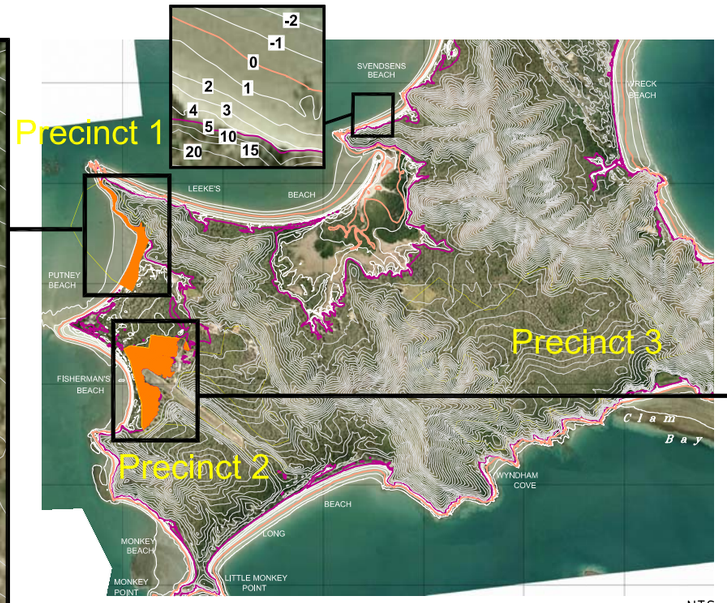
TITLE: **Proposed Areas of Development And Topography**
Preliminary Acid Sulfate Soil Assessment
Great Keppel Island Resort Revitalisation Plan

N

PROJECT No:	74586.00
DRAWING No:	1
REVISION:	2

P:\Groundwater Projects\74586.00 Great Keppel Island EIS\Drawings\ASS Drawings\Rev-02\Drawing 1.dwg





NTS

Acid Sulfate Soil Risk Areas

Precinct 1 - Proposed Marina Precinct
Precinct 2 - Proposed Fisherman's Beach Precinct
Precinct 3 - Proposed Clam Bay Precinct

Notes:-

1. Plan adapted from drawings provided by GKI Resort Pty Ltd.
2. Proposed development areas as specified by GKI Resort Pty Ltd (October 2010).
3. Topographic Contours shown in meters Australian Height Datum (AHD) at 5m intervals.

0 50 100 150
SCALE 1: 4,000 (A3)

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: GKI Resort Pty Ltd		TITLE: **Acid Sulfate Soil Risk Areas** **Preliminary Acid Sulfate Soil Assessment** **Great Keppel Island Resort Revitalisation Plan**
OFFICE: Brisbane	DRAWN BY: JT	
SCALE: 1:4,000(A3)	DATE: 31 August 2011	

N

PROJECT No: 74586.00
DRAWING No: 2
REVISION: 2

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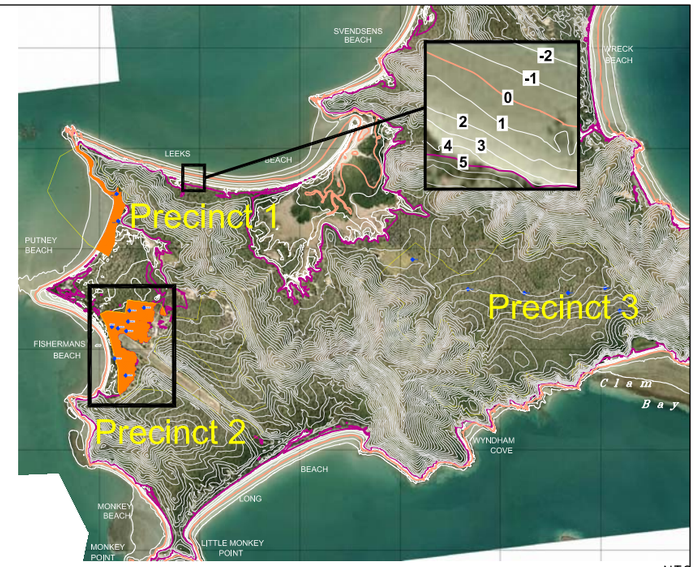

NTS

Legend:-

Test Bore Location And Number

Acid Sulfate Soil Risk Areas

Precinct 1 - Proposed Marina Precinct
Precinct 2 - Proposed Fisherman's Beach Precinct
Precinct 3 - Proposed Clam Bay Precinct

Notes:-

1. Plan adapted from drawings provided by GKI Resort Pty Ltd.
2. Proposed development areas as specified by GKI Resort Pty Ltd (October 2010).
3. Test Locations are approximate only and are shown with reference to existing and/or proposed site features.
4. Topographic Contours shown in meters Australian Height Datum (AHD) at 5m intervals.

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: GKI Resort Pty Ltd	
OFFICE: Brisbane	DRAWN BY: JT
SCALE: 1:4,000(A3)	DATE: 31 August 2011

TITLE: **Acid Sulfate Soil Bore Locations**
Preliminary Acid Sulfate Soil Assessment
Great Keppel Island Resort Revitalisation Plan

N

PROJECT No:	74586.00
DRAWING No:	3
REVISION:	2

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Appendix A

Notes about this Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Borehole Reports

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

BOREHOLE LOG

CLIENT: Tower Holdings Pty Ltd
PROJECT: Geotechnical and Groundwater Investigation (EIS)
LOCATION: Great Keppel Island

SURFACE LEVEL: --
EASTING: 288952
NORTHING: 7434885
DIP/AZIMUTH: -90°/--

BORE No: HA12
PROJECT No: 74586
DATE:
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SAND - estimated very loose, dark brown, fine to medium grained sand, moist, trace of silt and rootlets			0.0		ASS samples taken from 0m to 1m depth at 0.25m intervals		
					0.2				
	0.3	SAND - estimated very loose, light brown, fine to medium grained sand, moist, trace of silt		B					
					0.5				
	1 1.0	Bore discontinued at 1.0m							1

5 10 15 20

RIG: n/a **DRILLER:** CRB/KH **LOGGED:** CRB/KH **SURVEY DATUM:** MGA94 Zone 56K

TYPE OF BORING: 100mm diameter hand auger **CASING:** NIL

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3

☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tower Holdings Pty Ltd
PROJECT: Geotechnical and Groundwater Investigation (EIS)
LOCATION: Great Keppel Island

SURFACE LEVEL: --
EASTING: 288966
NORTHING: 7434957
DIP/AZIMUTH: -90°/--

BORE No: HA13
PROJECT No: 74586
DATE:
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SILTY SAND - estimated very loose, dark brown, silty fine to medium grained sand, moist, trace of rootlets			0.0		ASS samples taken from 0m to 1m depth at 0.25m intervals		
	0.15	SILTY SAND - estimated very loose, light brown,silty fine to medium grained sand, moist		B	0.2				
					0.5				
	0.6	SAND - estimated very loose, light grey, fine to medium grained sand, moist, trace of silt							
1	1.0	Bore discontinued at 1.0m							1

RIG: n/a **DRILLER:** CRB/KH **LOGGED:** CRB/KH **SURVEY DATUM:** MGA94 Zone 56K

TYPE OF BORING: 100mm diameter hand auger **CASING:** NIL

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3

☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tower Holdings Pty Ltd
PROJECT: Geotechnical and Groundwater Investigation (EIS)
LOCATION: Great Keppel Island

SURFACE LEVEL: --
EASTING: 288889
NORTHING: 7434906
DIP/AZIMUTH: -90°/--

BORE No: HA14
PROJECT No: 74586
DATE:
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.0	SAND - estimated very loose, dark brown, fine to medium grained sand, moist, trace of silt and rootlets					ASS samples taken from 0m to 1m depth at 0.25m intervals		
	0.1	SAND - estimated very loose, orange-brown, fine to medium grained sand, moist, trace of silt							
	0.35	SAND - estimated very loose, light-brown, fine to medium grained sand, moist, trace of silt - grading wet							
-1	1.0	Bore discontinued at 1.0m							1

5 10 15 20

RIG: n/a
DRILLER: CRB/KH
LOGGED: CRB/KH
SURVEY DATUM: MGA94 Zone 56K

TYPE OF BORING: 100mm diameter hand auger
CASING: NIL

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tower Holdings Pty Ltd
PROJECT: Geotechnical and Groundwater Investigation (EIS)
LOCATION: Great Keppel Island

SURFACE LEVEL: --
EASTING: 288865
NORTHING: 7434680
DIP/AZIMUTH: -90°/--

BORE No: HA15
PROJECT No: 74586
DATE:
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SAND - estimated very loose, dark brown, fine to medium grained sand, moist, some silt, trace of rootlets			0.0		ASS samples taken from 0m to 1m depth at 0.25m intervals		
	0.2	SAND - estimated very loose, light-brown, fine to medium grained sand, moist		B	0.2				
	1				0.5				1
	1.1	Bore discontinued at 1.1m							

RIG: n/a **DRILLER:** CRB/KH **LOGGED:** CRB/KH **SURVEY DATUM:** MGA94 Zone 56K
TYPE OF BORING: 100mm diameter hand auger **CASING:** NIL
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tower Holdings Pty Ltd
PROJECT: Geotechnical and Groundwater Investigation (EIS)
LOCATION: Great Keppel Island

SURFACE LEVEL: --
EASTING: 288948
NORTHING: 7434553
DIP/AZIMUTH: -90°/--

BORE No: HA16
PROJECT No: 74586
DATE:
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
	0.0	SAND - estimated very loose, dark brown, fine to medium grained sand, moist, trace of silt and rootlets					ASS samples taken from 0m to 1m depth at 0.25m intervals		
	0.15	SAND - estimated very loose, light grey-brown, fine to medium grained sand, moist							
	1								1
	1.1	Bore discontinued at 1.1m							

RIG: n/a **DRILLER:** CRB/KH **LOGGED:** CRB/KH **SURVEY DATUM:** MGA94 Zone 56K

TYPE OF BORING: 100mm diameter hand auger **CASING:** NIL

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3

☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tower Holdings Pty Ltd
PROJECT: Geotechnical and Groundwater Investigation (EIS)
LOCATION: Great Keppel Island

SURFACE LEVEL: --
EASTING: 288844
NORTHING: 7434917
DIP/AZIMUTH: -90°/--

BORE No: HA18
PROJECT No: 74586
DATE:
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.0	SAND - estimated very loose, brown, fine to medium grained sand, moist, trace of silt					ASS samples taken from 0m to 1m depth at 0.25m intervals		
	0.3	SAND - estimated very loose, light brown, fine to medium grained sand, moist							
	1.0	Bore discontinued at 1.0m							

Dynamic Penetrometer Test (blows per mm): 5, 10, 15, 20; 1

RIG: n/a
DRILLER: CRB/KH
LOGGED: CRB/KH
SURVEY DATUM: MGA94 Zone 56K
TYPE OF BORING: 100mm diameter hand auger
CASING: NIL
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tower Holdings Pty Ltd
PROJECT: Geotechnical and Groundwater Investigation (EIS)
LOCATION: Great Keppel Island

SURFACE LEVEL: --
EASTING: 288976
NORTHING: 7435039
DIP/AZIMUTH: -90°/--

BORE No: HA19
PROJECT No: 74586
DATE:
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
		SAND - estimated very loose, orange-brown, fine to medium grained sand, moist, trace of silt			0.0		ASS samples taken from 0m to 1m depth at 0.25m intervals		
				B	0.2				
					0.5				
	1 1.0	Bore discontinued at 1.0m							1

Dynamic Penetrometer Test (blows per mm): 5 10 15 20

RIG: n/a **DRILLER:** CRB/KH **LOGGED:** CRB/KH **SURVEY DATUM:** MGA94 Zone 56K
TYPE OF BORING: 100mm diameter hand auger **CASING:** NIL
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ Sand Penetrometer AS1289.6.3.3
☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tower Holdings Pty Ltd
PROJECT: Geotechnical and Groundwater Investigation (EIS)
LOCATION: Great Keppel Island

SURFACE LEVEL: --
EASTING: 289085
NORTHING: 7435060
DIP/AZIMUTH: -90°/--

BORE No: HA20
PROJECT No: 74586
DATE:
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.0	SAND - estimated very loose, light grey, fine to medium grained sand, moist, trace of silt					ASS samples taken from 0m to 1m depth at 0.25m intervals		
	1 1.0	Bore discontinued at 1.0m							1

5 10 15 20

RIG: n/a **DRILLER:** CRB/KH **LOGGED:** CRB/KH **SURVEY DATUM:** MGA94 Zone 56K

TYPE OF BORING: 100mm diameter hand auger **CASING:** NIL

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

☐ Sand Penetrometer AS1289.6.3.3

☐ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	⧗	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix C

Laboratory Reports and Chain of Custody Documentation

ALS Batch EB1021528

Chain of Custody

URGENT

From: Douglas Partners Pty Ltd.
439 Montague Rd, West End Qld 4101
Project: 74586.00, GKI EIS.
Sampler: Karen Hager 0417 544 122. or. 32378913.
Results required by: Friday. 3/12/2010.
Send results to: karen.hager@douglaspartners.com.au
Send invoice to: brisbane@douglaspartners.com.au

Lab ID	Sample ID.	Matrix	Date sampled.	Analyses. pH$_F$ + pH$_{FOX}$ (non-NATA)
1	HA12-0.0	S bag	24/11/10	X
2	HA12-0.25	S "	"	X
3	HA12-0.5	S "	"	X
4	HA12-0.75	S "	"	X
5	HA12-1.0	S "	"	X
6	HA13-0.0	S "	"	X
7	HA13-0.25	S "	"	X
8	HA13-0.5	S "	"	X
9	HA13-0.75	S "	"	X
10	HA13-1.0	S "	"	X
11	HA14-0.0	S "	"	X
12	HA14-0.25	S "	"	X
13	HA14-0.5	S "	"	X
14	HA14-0.75	S "	"	X
15	HA14-1.0	S "	"	X
16	HA15-0.0	S "	"	X
17	HA15-0.25	S "	"	X
18	HA15-0.5	S "	"	X
19	HA15-0.75	S "	"	X
20	HA15-1.0	S "	"	X
21	HA16-0.0	S "	"	X
22	HA16-0.25	S "	"	X
23	HA16-0.5	S "	"	X
24	HA16-0.75	S "	"	X
25	HA16-1.0	S "	"	X
26	HA18-0.0	S "	"	X

EB1021528

SCANNED 24/11/10 TEH

Lab ID.	Sample ID	Matrix	Date Sampled.	Analyses $pH_F + pH_{Fox}$ (non-NATA)
27	HA18-0.25	S bag	24/11/10	✓
28	HA18-0.5	S "	"	X
29	HA18-0.75	S "	"	X
30	HA18-1.0	S "	"	X
31	HA19-0.0	S "	"	X
32	HA19-0.25	S "	"	X
33	HA19-0.5	S "	"	X
34	HA19-0.75	S "	"	X
35	HA19-1.0	S "	"	X
36	HA20-0.0	S "	"	X
37	HA20-0.25	S "	"	X
38	HA20-0.5	S "	"	X
39	HA20-0.75	S "	"	X
40	HA20-1.0	S "	"	X

Relinquished by: Karen Hagger. via TNT courier
Date: 25/11/2010. KHagger.
Time:

Recieved by:
Date:
Time:

Notes: * all samples frozen prior to dispatch and dispatched with ice.

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EB1021528**		
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS KAREN HAGER	Contact	: Milan Pavasovic
Address	: 439 MONTAGUE ROAD WEST END QLD, AUSTRALIA 4101	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: karen.hager@douglaspartners.com.au	E-mail	: milan.pavasovic@alsglobal.com
Telephone	: +61 07 32378900	Telephone	: +61 7 3243 7129
Facsimile	: +61 07 32378999	Facsimile	: +61 7 3243 7218
Project	: 74586 00 GK1 EIS	Page	: 1 of 3
Order number	: ----		
C-O-C number	: ----	Quote number	: ES2010DOUPAR0245 (EN/020/10)
Site	: ----		
Sampler	: ----	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 26-NOV-2010	Issue Date	: 29-NOV-2010 12:12
Client Requested Due Date	: 01-DEC-2010	Scheduled Reporting Date	: **01-DEC-2010**

Delivery Details

Mode of Delivery	: Carrier	Temperature	: 6°C - Ice present
No. of coolers/boxes	: 1 MEDIUM	No. of samples received	: 40
Security Seal	: Intact.	No. of samples analysed	: 40

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Sample(s) have been received within recommended holding times.**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Matt Goodwin.
- Analytical work for this work order will be conducted at ALS Brisbane.
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - EA037 ASS Field Screening Analysis
EB1021528-001	24-NOV-2010 15:00	HA12 - 0.0	✓
EB1021528-002	24-NOV-2010 15:00	HA12 - 0.25	✓
EB1021528-003	24-NOV-2010 15:00	HA12 - 0.5	✓
EB1021528-004	24-NOV-2010 15:00	HA12 - 0.75	✓
EB1021528-005	24-NOV-2010 15:00	HA12 - 1.0	✓
EB1021528-006	24-NOV-2010 15:00	HA13 - 0.0	✓
EB1021528-007	24-NOV-2010 15:00	HA13 - 0.25	✓
EB1021528-008	24-NOV-2010 15:00	HA13 - 0.5	✓
EB1021528-009	24-NOV-2010 15:00	HA13 - 0.75	✓
EB1021528-010	24-NOV-2010 15:00	HA13 - 1.0	✓
EB1021528-011	24-NOV-2010 15:00	HA14 - 0.0	✓
EB1021528-012	24-NOV-2010 15:00	HA14 - 0.25	✓
EB1021528-013	24-NOV-2010 15:00	HA14 - 0.5	✓
EB1021528-014	24-NOV-2010 15:00	HA14 - 0.75	✓
EB1021528-015	24-NOV-2010 15:00	HA14 - 1.0	✓
EB1021528-016	24-NOV-2010 15:00	HA15 - 0.0	✓
EB1021528-017	24-NOV-2010 15:00	HA15 - 0.25	✓
EB1021528-018	24-NOV-2010 15:00	HA15 - 0.5	✓
EB1021528-019	24-NOV-2010 15:00	HA15 - 0.75	✓
EB1021528-020	24-NOV-2010 15:00	HA15 - 1.0	✓
EB1021528-021	24-NOV-2010 15:00	HA16 - 0.0	✓
EB1021528-022	24-NOV-2010 15:00	HA16 - 0.25	✓
EB1021528-023	24-NOV-2010 15:00	HA16 - 0.5	✓
EB1021528-024	24-NOV-2010 15:00	HA16 - 0.75	✓
EB1021528-025	24-NOV-2010 15:00	HA16 - 1.0	✓
EB1021528-026	24-NOV-2010 15:00	HA18 - 0.0	✓
EB1021528-027	24-NOV-2010 15:00	HA18 - 0.25	✓
EB1021528-028	24-NOV-2010 15:00	HA18 - 0.5	✓
EB1021528-029	24-NOV-2010 15:00	HA18 - 0.75	✓
EB1021528-030	24-NOV-2010 15:00	HA18 - 1.0	✓
EB1021528-031	24-NOV-2010 15:00	HA19 - 0.0	✓
EB1021528-032	24-NOV-2010 15:00	HA19 - 0.25	✓
EB1021528-033	24-NOV-2010 15:00	HA19 - 0.5	✓
EB1021528-034	24-NOV-2010 15:00	HA19 - 0.75	✓
EB1021528-035	24-NOV-2010 15:00	HA19 - 1.0	✓

			SOIL - EA037 ASS Field Screening Analysis
EB1021528-036	24-NOV-2010 15:00	HA20 - 0.0	✓
EB1021528-037	24-NOV-2010 15:00	HA20 - 0.25	✓
EB1021528-038	24-NOV-2010 15:00	HA20 - 0.5	✓
EB1021528-039	24-NOV-2010 15:00	HA20 - 0.75	✓
EB1021528-040	24-NOV-2010 15:00	HA20 - 1.0	✓

Requested Deliverables

MS DONNA PYKE

- A4 - AU Tax Invoice (INV)	Email	donna.pyke@douglaspartners.com.au

MS KAREN HAGER

- A4 - AU Sample Receipt Notification - Environmental (SRN)	Email	karen.hager@douglaspartners.com.au
- Chain of Custody (CoC) (COC)	Email	karen.hager@douglaspartners.com.au
- EDI Format - ENMRG (ENMRG)	Email	karen.hager@douglaspartners.com.au
- EDI Format - XTab (XTAB)	Email	karen.hager@douglaspartners.com.au

THE ACCOUNTS PAYABLE

- A4 - AU Tax Invoice (INV)	Email	brisbane@douglaspartners.com.au

ALS Batch EB1021845

Craig Bryant

From: Bryn Stephens
Sent: Wednesday, 1 December 2010 11:00 AM
To: Craig Bryant
Cc: Samples Brisbane; Stephen Hislop; Milan Pavasovic
Subject: EB1021528 - DOUPAR - Cr Suite REBATCH
Importance: High
Follow Up Flag: Follow up
Flag Status: Red

Freezer "E"?

Hi Craig,

Can you please perform this REBATCH of samples from EB1021528 ASAP please?

I have attached an edited XTAB file with the required samples detailed within.

Thanks,

How was your customer experience? Please send us your feedback

Bryn Stephens
CLIENT SERVICES

ALS | Environmental

Address
32 Shand Street, Stafford, QLD, 4053

PHONE +61 7 3243 7222
DIRECT +61 7 3243 7125
FAX +61 7 3243 7218

www.alsglobal.com

From: Karen Hager [mailto:karen.hager@douglaspartners.com.au]
Sent: Wednesday, 1 December 2010 10:41 AM
To: Bryn Stephens
Subject: Additional Analyses - Batch EB1021528
Importance: High

Bryn,

Could you please arrange for **chromium suite analysis** of the following soil samples from EB1021528??

Sample ID
1 12-1.0
2 13-0.25
3 14-0.75
4 15-0.5
5 16-1.0
6 18-0.75

Environmental Division
Brisbane
ML
Work Order
EB1021845

Telephone : +61-7-3243 7222

1/12/2010

7 19-0.5
8 20-1.0

A 5 day turn around would be sufficient.

Kind regards,

Karen Hager | Environmental Engineer

Douglas Partners Pty Ltd | ABN 75 053 980 117 | www.douglaspartners.com.au

439 Montague Road West End QLD 4101

P: 07 3237 8913 | F: 07 3237 8999 | M: 0417 544 122 | E: karen.hager@douglaspartners.com.au

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EB1021845**		
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS KAREN HAGER	Contact	: Milan Pavasovic
Address	: 439 MONTAGUE ROAD WEST END QLD, AUSTRALIA 4101	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: karen.hager@douglaspartners.com.au	E-mail	: milan.pavasovic@alsglobal.com
Telephone	: +61 07 32378900	Telephone	: +61 7 3243 7129
Facsimile	: +61 07 32378999	Facsimile	: +61 7 3243 7218
Project	: 74586 00 GK1 EIS	Page	: 1 of 2
Order number	: ----		
C-O-C number	: ----	Quote number	: ES2010DOUPAR0245 (EN/020/10)
Site	: ----		
Sampler	: Karen Hager	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 01-DEC-2010	Issue Date	: 02-DEC-2010 17:50
Client Requested Due Date	: 10-DEC-2010	Scheduled Reporting Date	: **10-DEC-2010**

Delivery Details

Mode of Delivery	: Samples on hand	Temperature	: CHILLED
No. of coolers/boxes	: ----	No. of samples received	: 8
Security Seal	: Intact.	No. of samples analysed	: 8

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.**
- **Sample(s) have been received within recommended holding times.**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Matt Goodwin.
- Analytical work for this work order will be conducted at ALS Brisbane.
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.
When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - EA033 Chromium Suite for Acid Sulphate Soils
EB1021845-001	24-NOV-2010 15:00	12 - 1.0	✓
EB1021845-002	24-NOV-2010 15:00	13 - 0.25	✓
EB1021845-003	24-NOV-2010 15:00	14 - 0.75	✓
EB1021845-004	24-NOV-2010 15:00	15 - 0.5	✓
EB1021845-005	24-NOV-2010 15:00	16 - 1.0	✓
EB1021845-006	24-NOV-2010 15:00	18 - 0.75	✓
EB1021845-007	24-NOV-2010 15:00	19 - 0.5	✓
EB1021845-008	24-NOV-2010 15:00	20 - 1.0	✓

Requested Deliverables

MS DONNA PYKE

- A4 - AU Tax Invoice (INV)	Email	donna.pyke@douglaspartners.com.au

MS KAREN HAGER

- *AU Certificate of Analysis - NATA (COA)	Email	karen.hager@douglaspartners.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	karen.hager@douglaspartners.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	karen.hager@douglaspartners.com.au
- A4 - AU Sample Receipt Notification - Environmental (SRN)	Email	karen.hager@douglaspartners.com.au
- Chain of Custody (CoC) (COC)	Email	karen.hager@douglaspartners.com.au
- EDI Format - ENMRG (ENMRG)	Email	karen.hager@douglaspartners.com.au
- EDI Format - XTab (XTAB)	Email	karen.hager@douglaspartners.com.au

THE ACCOUNTS PAYABLE

- A4 - AU Tax Invoice (INV)	Email	brisbane@douglaspartners.com.au

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1021845**	Page	: 1 of 4
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS KAREN HAGER	Contact	: Milan Pavasovic
Address	: 439 MONTAGUE ROAD WEST END QLD, AUSTRALIA 4101	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: karen.hager@douglaspartners.com.au	E-mail	: milan.pavasovic@alsglobal.com
Telephone	: +61 07 32378900	Telephone	: +61 7 3243 7129
Facsimile	: +61 07 32378999	Facsimile	: +61 7 3243 7218
Project	: 74586 00 GK1 EIS	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 01-DEC-2010
Sampler	: Karen Hager	Issue Date	: 07-DEC-2010
Site	: ----		
		No. of samples received	: 8
Quote number	: EN/020/10	No. of samples analysed	: 8

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Myles.Clark	Acid Sulfate Soils Supervisor	Bne Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.**

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: 12 - 1.0	13 - 0.25	14 - 0.75	15 - 0.5	16 - 1.0
				Client sampling date / time: 24-NOV-2010 15:00	24-NOV-2010 15:00	24-NOV-2010 15:00	24-NOV-2010 15:00	24-NOV-2010 15:00
				EB1021845-001	EB1021845-002	EB1021845-003	EB1021845-004	EB1021845-005
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.6**	**4.3**	**8.7**	**8.4**	**6.4**
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	**44**	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	**0.07**	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.012**	<0.005	<0.005	<0.005	<0.005
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**4.05**	----	<0.01	<0.01	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**810**	----	<10	<10	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**1.30**	----	<0.01	<0.01	----
EA033-D: Retained Acidity								
KCl Extractable Sulfur (23Ce)	----	0.02	% S	----	<0.02	----	----	----
HCl Extractable Sulfur (20Be)	----	0.02	% S	----	**0.02**	----	----	----
Net Acid Soluble Sulfur (20Je)	----	0.02	% S	----	**0.02**	----	----	----
acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	----	**12**	----	----	----
sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	----	<0.02	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.09**	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	**56**	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	**4**	<1	<1	<1

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	Client sample ID: 18 - 0.75	19 - 0.5	20 - 1.0	----	----
				Client sampling date / time: 24-NOV-2010 15:00	24-NOV-2010 15:00	24-NOV-2010 15:00	----	----
				EB1021845-006	EB1021845-007	EB1021845-008	----	----
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**6.4**	**6.5**	**5.8**	----	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	----	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	<0.005	<0.005	----	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	<10	<10	----	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	<0.01	----	----	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	<10	----	----	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	<0.01	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	----	----
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	----	----

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EB1021845**	Page	: 1 of 5
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS KAREN HAGER	Contact	: Milan Pavasovic
Address	: 439 MONTAGUE ROAD WEST END QLD, AUSTRALIA 4101	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: karen.hager@douglaspartners.com.au	E-mail	: milan.pavasovic@alsglobal.com
Telephone	: +61 07 32378900	Telephone	: +61 7 3243 7129
Facsimile	: +61 07 32378999	Facsimile	: +61 7 3243 7218
Project	: 74586 00 GK1 EIS	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 01-DEC-2010
Sampler	: Karen Hager	Issue Date	: 07-DEC-2010
Order number	: ----		
		No. of samples received	: 8
Quote number	: EN/020/10	No. of samples analysed	: 8

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Myles.Clark	Acid Sulfate Soils Supervisor	Bne Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA033-A: Actual Acidity (QC Lot: 1588990)									
EB1021835-001	Anonymous	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.0	9.1	1.1	0% - 20%
EA033-B: Potential Acidity (QC Lot: 1588990)									
EB1021835-001	Anonymous	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.168	0.157	6.8	0% - 20%
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	105	98	6.8	No Limit
EA033-C: Acid Neutralising Capacity (QC Lot: 1588990)									
EB1021835-001	Anonymous	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	1.34	1.37	2.0	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	0.43	0.44	0.0	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	268	274	2.0	0% - 20%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA033-A: Actual Acidity (QCLot: 1588990)								
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 1588990)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	----	----	----	----
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 1588990)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	----	----	----	----
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA033-D: Retained Acidity (QCLot: 1588990)								
EA033: Net Acid Soluble Sulfur (20Je)	----	0.02	% S	<0.02	----	----	----	----
EA033: acidity - Net Acid Soluble Sulfur (a-20J)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Net Acid Soluble Sulfur (s-20J)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033: KCl Extractable Sulfur (23Ce)	----	0.02	% S	<0.02	----	----	----	----
EA033: HCl Extractable Sulfur (20Be)	----	0.02	% S	<0.02	----	----	----	----

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) Results are required to be reported.**

Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EB1021845**	Page	: 1 of 5
Client	: DOUGLAS PARTNERS PTY LTD	Laboratory	: Environmental Division Brisbane
Contact	: MS KAREN HAGER	Contact	: Milan Pavasovic
Address	: 439 MONTAGUE ROAD WEST END QLD, AUSTRALIA 4101	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: karen.hager@douglaspartners.com.au	E-mail	: milan.pavasovic@alsglobal.com
Telephone	: +61 07 32378900	Telephone	: +61 7 3243 7129
Facsimile	: +61 07 32378999	Facsimile	: +61 7 3243 7218
Project	: 74586 00 GK1 EIS	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 01-DEC-2010
Sampler	: Karen Hager	Issue Date	: 07-DEC-2010
Order number	: ----		
		No. of samples received	: 8
Quote number	: EN/020/10	No. of samples analysed	: 8

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-A: Actual Acidity							
80* dried soil 12 - 1.0, 13 - 0.25, 14 - 0.75, 15 - 0.5, 16 - 1.0, 18 - 0.75, 19 - 0.5, 20 - 1.0	**24-NOV-2010**	**06-DEC-2010**	24-NOV-2011	✓	**07-DEC-2010**	06-MAR-2011	✓
EA033-B: Potential Acidity							
80* dried soil 12 - 1.0, 13 - 0.25, 14 - 0.75, 15 - 0.5, 16 - 1.0, 18 - 0.75, 19 - 0.5, 20 - 1.0	**24-NOV-2010**	**06-DEC-2010**	24-NOV-2011	✓	**07-DEC-2010**	06-MAR-2011	✓
EA033-C: Acid Neutralising Capacity							
80* dried soil 12 - 1.0, 13 - 0.25, 14 - 0.75, 15 - 0.5, 16 - 1.0, 18 - 0.75, 19 - 0.5, 20 - 1.0	**24-NOV-2010**	**06-DEC-2010**	24-NOV-2011	✓	**07-DEC-2010**	06-MAR-2011	✓
EA033-D: Retained Acidity							
80* dried soil 12 - 1.0, 13 - 0.25, 14 - 0.75, 15 - 0.5, 16 - 1.0, 18 - 0.75, 19 - 0.5, 20 - 1.0	**24-NOV-2010**	**06-DEC-2010**	24-NOV-2011	✓	**07-DEC-2010**	06-MAR-2011	✓
EA033-E: Acid Base Accounting							
80* dried soil 12 - 1.0, 13 - 0.25, 14 - 0.75, 15 - 0.5, 16 - 1.0, 18 - 0.75, 19 - 0.5, 20 - 1.0	**24-NOV-2010**	**06-DEC-2010**	24-NOV-2011	✓	**07-DEC-2010**	06-MAR-2011	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	1	10	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	1	10	**10.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW 846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- **No Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**