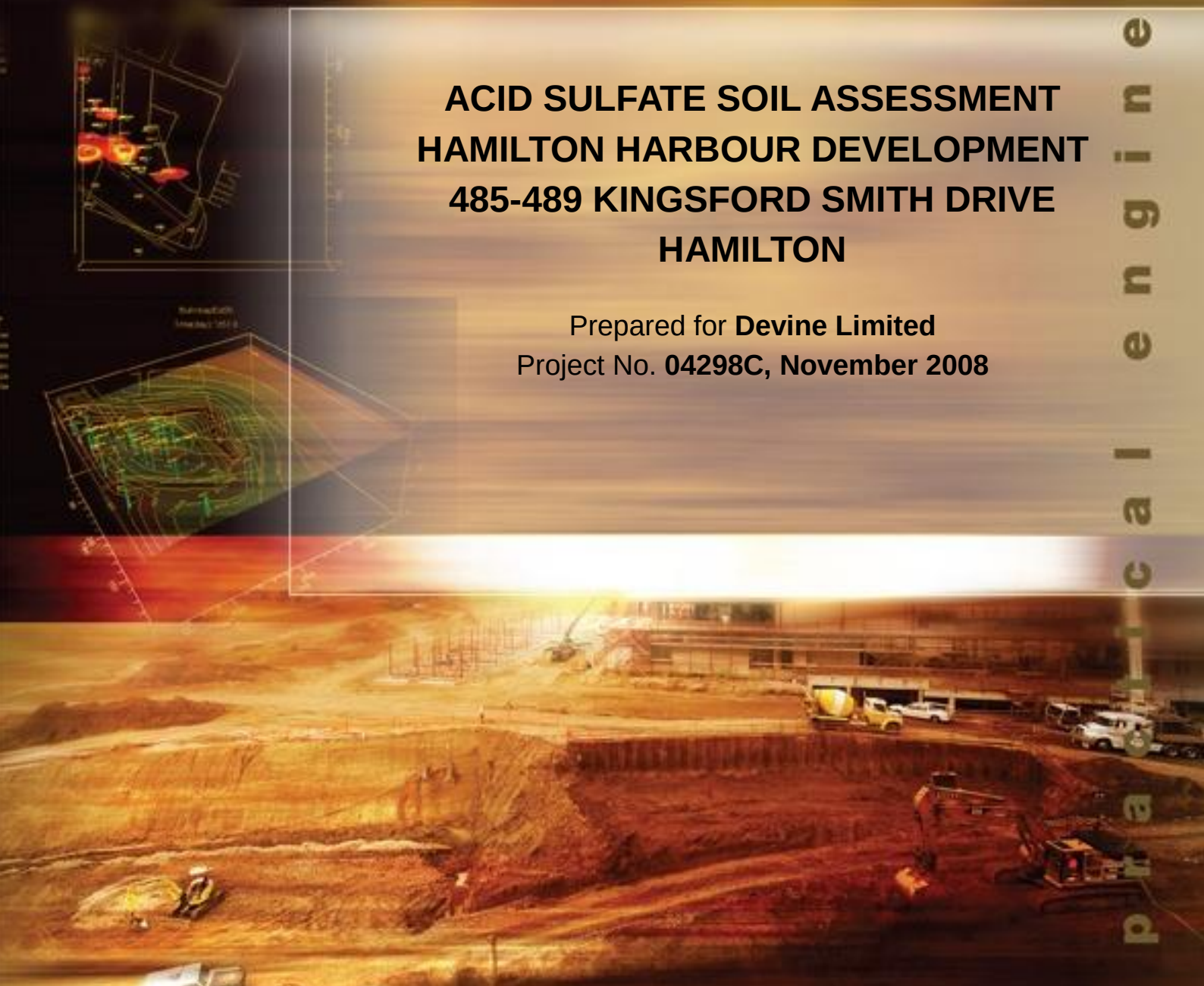
ACID SULFATE SOIL ASSESSMENT
HAMILTON HARBOUR DEVELOPMENT
485-489 KINGSFORD SMITH DRIVE
HAMILTON

Prepared for **Devine Limited**

Project No. **04298C, November 2008**



Hamilton Harbour Development
485-489 Kingsford Smith Drive, Hamilton
Project No. 04298C, November 2008

Butler Partners Pty Ltd
ABN 14 816 574 868
79 Doggett Street
Newstead, Queensland 4006
P.O. Box 2267
Fortitude Valley BC
Queensland 4006

www.butlerpartners.com.au

Ph: 61 7 **3852 3800**
Fx: 61 7 3852 3808
enquiries@butlerpartners.com.au

TABLE OF CONTENTS

SECTION 1 - INTRODUCTION

1.1 *Project*

It is understood that it is proposed to develop the Hamilton Harbour site by constructing a multi-level building over a one or two level basement car park, which will involve excavation to between 5.0m and 6.0m approximately below ground level.

1.2 *Proposed Scope of Work*

Based on a visit to site and prior knowledge gained from past investigation conducted both in the general vicinity of the site and for the adjacent Portside Site. It is anticipated that the site ground conditions will comprise fill material, sands and silts overlying estuarine clays.

Based on the scope of the proposed development, the anticipated ground conditions and the requirements of Sections 6 to 8 of the *State Planning Policy 2/02 Guidelines – Planning & Managing Development Involving Acid Sulfate Soils*, it was proposed to investigate the site by:

- collecting samples from six environmental test locations to a depth of 6.5m, or prior refusal;
- conducting ASS screening tests at 0.25m depth intervals from each location;
- undertaking Chromium Suite laboratory testing on selected soil samples; and
- collecting a groundwater sample for laboratory analysis.

It was further proposed that details of the investigation as carried out would be incorporated into a report that would also discuss the nature, treatment and management of ASS.

1.3 *Commission*

Based on the nominated scope of work, a fee to undertake the acid sulfate soil assessment was presented in a proposal of 14 February 2007. Butler Partners Pty Ltd was subsequently commissioned by Devine Limited to conduct the assessment as proposed.

SECTION 2 - THE SITE

2.1 *Site Description*

At the time of assessment, the site had been cleared of previous development and was relatively level, except for an approximately 1.5m excavation located in the central western section of the site. The site appeared to be cut down below the level of Kingsford Smith Drive by approximately 1m in a local area between Bores 3 and 4. Other than the excavated area, ground surface levels varied between approximately RL 3.3m and RL 5.1m and appeared to generally increase in a north-westerly direction across the site. Isolated medium to tall trees were present over the site and the site ground surface comprised grass, paving and bare earth. Two general views of the site at the time of investigation are presented in Photographs 1 and 2.

Photograph 1: Panoramic view of the site looking south-west from the eastern end of the site

Photograph 2: Panoramic view of the site looking east from the western end of the site

2.2 *Geology*

Reference to the Geological Survey of Queensland's 1:31,680 City of Brisbane Sheet indicates that the site is mapped in an area of Quaternary alluvial sand, silt, mud, clay and gravel, close to a boundary with (and underlain by) Tingalpa Formation comprising carbonaceous shale and lithic sandstone with minor conglomerate and coal.

2.3 *Acid Sulfate Soils and Hydrogeology*

Reference to the Department of Natural Resource and Mines' 'Acid Sulfate Soils, Tweed Heads to Redcliffe, Map 1' indicates the site is located in an area mapped as 'disturbed' land likely to contain Acid Sulfate Soils.

A study of the hydrogeology of the site was not conducted as part of this investigation. However, it is considered reasonable to assume the area is dominated by the presence of the Brisbane River located to the south of the site. Groundwater flow beneath the site is therefore anticipated to be toward the river, in a generally southerly direction.

SECTION 3 - FIELDWORK

3.1 *Fieldwork Methods*

The bores were drilled with a truck mounted Mobile B40L drilling rig, using solid flight augers. Strata identification was based on inspection of the materials recovered on the augers during drilling, supplemented by inspection of disturbed samples undertaken at 0.25m depth intervals. All bores were backfilled upon completion.

3.2 *Bore Locations and Supervision*

Bore locations were determined by direct measurement from existing site features and are indicated approximately on the attached Drawing No. 1.

Ground surface levels at the bore locations have been determined using standard levelling techniques, referenced to a temporary bench mark (TBM) located in Harbour Road. An approximate TBM level of RL 2.83m has been adopted, based on past information from previous projects located in the area. The TBM level should be confirmed by a licensed surveyor.

An experienced geotechnician set out of the test locations, logged the subsurface soil profiles, determined the in-situ sampling and testing program and supervised the fieldwork.

SECTION 4 - INVESTIGATION RESULTS

4.1 *Reports*

Subsurface conditions encountered in the bores are presented on Bore Report sheets included in Appendix A, using classification and descriptive terms defined in accompanying notes. Laboratory test result sheets are included in Appendix B.

4.2 *Subsurface Conditions*

For a description of the subsurface conditions encountered at the bore locations, the Bore Report sheets should be referred to. The subsurface conditions encountered in the bores were highly variable, however, in broad summary, the bores encountered a surface fill and/or sand layer to between 0.7m to 4.8m depth approximately, overlying layers of generally grey, silty clays to between 5.0m and >6.5m depth approximately in Bores 1, 2, 5 and 6; no silty clays were encountered in Bores 3 and 4. Extremely weathered sandstone was encountered below 2.9m and 3.3m depth in Bores 3 and 4 and (residual) gravelly clay was encountered below 5.0m depth in Bore 6.

4.3 *Groundwater*

Free groundwater was encountered during drilling in Bores 1, 2 and 5, at the depths/approximate RLs indicated in Table 1.

Table 1: Groundwater Depth/RL Measurements

Bore	Depth (m)	Reduced Level
1	3.7	RL -0.2m
2	3.8	RL -0.3m
3	Not encountered	-
4	Not encountered	-
5	3.0	RL 0.3m
6	Not encountered	-

Groundwater levels could rise during rainfall and would be expected to vary in accordance with the prevailing weather/seasonal conditions. It is suggested that groundwater conditions be rechecked prior to construction, if a significant time elapses between this investigation and construction.

4.4 *Laboratory Testing*

4.4.1 ASS Screening Tests

ASS screening tests were carried out on samples collected from all bores. Analyses comprised two sub-samples of about 20g of soil, one mixed with approximately 10mL of distilled water, and the other mixed with approximately 10mL of hydrogen peroxide (H_2O_2), buffered to a pH of approximately 5.0 with sodium hydroxide. Slurry pH was measured with a calibrated pH meter. The pH of the distilled water/soil slurry (pH_F) was measured approximately 1 to 2 hours after mixing, whilst the pH of the hydrogen peroxide/soil slurry (pH_{FOX}) was measured after approximately 3 to 4 hours after visible signs of an oxidation reaction were observed to be complete. The results of the slurry screening analyses are presented in Table 2.

Table 2: Summary of Acid Sulfate Soil Field Screening Tests

Bore	Depth (m)	Reaction	Sample Description	pH_F	pH_{FOX}	pH Change	Screening Test Indicators			Chromium Suite Tested
							a	b	c	
1	0.0-0.25	Strong	Fill	7.8	6.9	0.9	✓			
	0.25-0.5	Strong	Fill	7.8	6.0	1.7	✓	✓		
	0.5-0.75	Strong	Fill	7.7	6.8	0.9	✓			
	0.75-1.0	Very Strong	Fill	7.8	6.9	0.9	✓			
	1.0-1.25	Very Strong	Fill	6.9	4.7	2.2	✓	✓		
	1.25-1.5	Very Strong	Silty Clay	6.7	4.9	1.8	✓	✓		
	1.5-1.75	Very Strong	Silty Clay	6.7	5.0	1.7	✓	✓		
	1.75-2.0	Very Strong	Silty Clay	7.1	5.3	1.8	✓	✓		
	2.0-2.25	Strong	Silty Clay	5.4	4.1	1.3	✓	✓		
	2.25-2.5	Weak	Silty Clay	5.5	3.7	1.8		✓		
	2.5-2.75	Weak	Silty Clay	5.6	3.6	2.0		✓		
	2.75-3.0	Weak	Silty Clay	5.1	3.5	1.6		✓		
	3.0-3.25	Moderate	Silty Clay	5.1	3.2	1.9		✓		
	3.25-3.5	Strong	Silty Clay	6.9	2.9	4.0	✓	✓	✓	✓
	3.5-3.75	Strong	Silty Clay	7.1	2.6	4.5	✓	✓	✓	
	3.75-4.0	Very Strong	Silty Clay	6.4	2.7	3.7	✓	✓	✓	
	4.0-4.25	Strong	Silty Clay	6.7	2.9	3.9	✓	✓	✓	
	4.25-4.5	Very Strong	Silty Clay	7.0	2.9	4.2	✓	✓	✓	
	4.5-4.75	Moderate	Silty Clay	7.8	3.2	4.6		✓		
	4.75-5.0	Strong	Silty Clay	8.1	2.9	5.2	✓	✓	✓	
	5.0-5.25	Strong	Silty Clay	7.9	2.9	5.1	✓	✓	✓	✓
	5.25-5.5	Strong	Silty Clay	7.2	2.9	4.4	✓	✓	✓	
	5.5-5.75	Very Strong	Silty Clay/Sandy Clay	7.3	4.0	3.3	✓	✓		
	5.75-6.0	Very Strong	Sandy Clay	7.5	3.2	4.3	✓	✓		
	6.0-6.25	Very Strong	Sandy Clay	8.0	6.4	1.7	✓	✓		
	6.25-6.5	Strong	Sandy Clay	7.5	3.4	4.2	✓	✓		

Hamilton Harbour Development
485-489 Kingsford Smith Drive, Hamilton
Project No. 04298C, November 2008

Table 2 continued

Bore	Depth (m)	Reaction	Sample Description	pH_F	pH_{FOX}	pH Change	Screening Test Indicators			Chromium Suite Tested
							a	b	c	
2	0.0-0.25	Weak	Fill	7.5	6.7	0.8				
	0.25-0.5	Weak	Fill	7.3	7.0	0.2				
	0.5-0.75	Weak	Sand (possibly fill)	7.0	6.8	0.2				
	0.75-1.0	Weak	Sand (possibly fill)	7.4	7.0	0.4				
	1.0-1.25	Weak	Sand (possibly fill)	7.4	7.2	0.2				
	1.25-1.5	Moderate	Sand (possibly fill)	7.5	7.4	0.0				
	1.5-1.75	Strong	Sand (possibly fill)	7.4	7.3	0.2	✓			
	1.75-2.0	Moderate	Sand (possibly fill)	7.4	7.2	0.2				
	2.0-2.25	Strong	Sand (possibly fill)	7.3	7.5	0.1	✓			
	2.25-2.5	Strong	Sand (possibly fill)	7.5	7.5	0.0	✓			
	2.5-2.75	Moderate	Sand (possibly fill)	7.5	7.8	0.3				
	2.75-3.0	Moderate	Sand (possibly fill)	7.6	7.6	0.0				
	3.0-3.25	Weak	Sand (possibly fill)	5.7	4.8	0.8				
	3.25-3.5	Weak	Sand (possibly fill)	6.0	4.1	1.9		✓		
	3.5-3.75	Weak	Sand (possibly fill)	5.2	4.0	1.2		✓		
	3.75-4.0	Moderate	Sand (possibly fill)	5.3	4.9	0.4				
	4.0-4.25	Weak	Sand (possibly fill)	5.6	4.3	1.3		✓		
	4.25-4.5	Weak	Sand (possibly fill)	5.6	4.1	1.5		✓		
	4.5-4.75	Weak	Sand (possibly fill)	5.7	3.3	2.4		✓		
	4.75-5.0	Weak	Sand/Silty Clay	5.6	3.5	2.1		✓		
	5.0-5.25	Weak	Silty Clay	6.0	2.9	3.2		✓	✓	✓
	5.25-5.5	Moderate	Silty Clay	6.6	2.7	3.9		✓	✓	
	5.5-5.75	Moderate	Silty Clay	7.0	3.1	3.9		✓		
	5.75-6.0	Very Strong	Silty Clay	7.6	3.1	4.5	✓	✓		
	6.0-6.25	Very Strong	Silty Clay	7.7	4.2	3.5	✓	✓		
	6.25-6.5	Very Strong	Silty Clay	8.0	3.3	4.7	✓	✓		
3	0.0-0.25	Very Strong	Fill	7.7	6.2	1.4	✓	✓		
	0.25-0.5	Very Strong	Fill	7.8	5.2	2.6	✓	✓		
	0.5-0.75	Very Strong	Fill	8.1	6.1	1.9	✓	✓		
	0.75-1.0	Very Strong	Fill	8.0	6.1	1.9	✓	✓		
	1.0-1.25	Very Strong	Fill	7.8	6.5	1.2	✓	✓		
	1.25-1.5	Strong	Fill	7.4	6.7	0.7	✓			
	1.5-1.75	Strong	Fill	6.5	4.1	2.4	✓	✓		✓
	1.75-2.0	Very Strong	Fill	6.7	6.3	0.4	✓			
	2.0-2.25	Strong	Fill	7.2	6.8	0.4	✓			
	2.25-2.5	Moderate	Fill	7.3	7.1	0.2				
	2.5-2.75	Strong	Fill	7.0	7.3	0.3	✓			
	2.75-3.0	Very Strong	Fill	7.2	7.7	0.5	✓			
	3.0-3.25	Very Strong	Fill	7.2	7.0	0.2	✓			
	3.25-3.5	Very Strong	Sandstone	7.6	7.1	0.5	✓			
	3.5-3.75	Very Strong	Sandstone	7.3	6.7	0.5	✓			
	3.75-4.0	Very Strong	Sandstone	7.6	6.9	0.7	✓			
	4.0-4.25	Strong	Sandstone	7.2	7.0	0.1	✓			
	4.25-4.5	Strong	Sandstone	7.5	7.0	0.5	✓			
	4.5-4.75	Strong	Sandstone	7.9	6.8	1.1	✓	✓		
	4.75-5.0	Very Strong	Sandstone	7.8	6.8	1.1	✓	✓		

Table 2 continued

Bore	Depth (m)	Reaction	Sample Description	pH_F	pH_{FOX}	pH Change	Screening Test Indicators			Chromium Suite Tested
							a	b	c	
4	0.0-0.25	Very Strong	Fill	5.3	3.3	2.0	✓	✓		
	0.25-0.5	Very Strong	Fill	5.5	3.1	2.4	✓	✓		
	0.5-0.75	Very Strong	Fill	5.7	3.4	2.3	✓	✓		
	0.75-1.0	Very Strong	Fill	5.8	3.3	2.5	✓	✓		
	1.0-1.25	Strong	Fill/Silty Sand	6.6	4.7	1.9	✓	✓		
	1.25-1.5	Moderate	Silty Sand	6.7	5.6	1.1		✓		
	1.5-1.75	Moderate	Silty Sand	7.0	6.3	0.7				
	1.75-2.0	Moderate	Silty Sand	6.5	4.5	1.9		✓		
	2.0-2.25	Moderate	Silty Sand	6.8	4.9	1.9		✓		
	2.25-2.5	Strong	Silty Sand	6.9	4.9	2.0	✓	✓		✓
	2.5-2.75	Moderate	Silty Sand	7.2	5.2	2.1		✓		
	2.75-3.0	Moderate	Silty Sand/ Sandstone	7.3	5.0	2.3		✓		
	3.0-3.25	Moderate	Sandstone	7.0	4.9	2.1		✓		
	3.25-3.5	Strong	Sandstone	7.1	4.6	2.5	✓	✓		
	3.5-3.75	Strong	Sandstone	6.8	4.8	2.0	✓	✓		
	3.75-4.0	Very Strong	Sandstone	6.7	5.9	0.8	✓			
	4.0-4.25	Strong	Sandstone	6.6	5.9	0.8	✓			
	4.25-4.5	Moderate	Sandstone	6.6	5.9	0.7				
	4.5-4.75	Moderate	Sandstone	6.8	5.4	1.5		✓		
	4.75-5.0	Moderate	Sandstone	6.5	5.3	1.2		✓		
	5.0-5.25	Weak	Sandstone	6.8	6.2	0.5				
	5.25-5.5	Weak	Sandstone	6.5	6.0	0.5				
	5.5-5.75	Moderate	Sandstone	7.1	6.7	0.4				
5	0.0-0.25	Very Strong	Fill	7.6	5.2	2.4	✓	✓		
	0.25-0.5	Very Strong	Fill	8.1	5.7	2.4	✓	✓		
	0.5-0.75	Very Strong	Fill	7.9	5.6	2.4	✓	✓		
	0.75-1.0	Very Strong	Silty Clay	7.4	5.7	1.7	✓	✓		
	1.0-1.25	Very Strong	Silty Clay	7.9	6.2	1.7	✓	✓		
	1.25-1.5	Very Strong	Silty Clay	8.1	6.3	1.8	✓	✓		
	1.5-1.75	Very Strong	Silty Clay	8.0	5.8	2.2	✓	✓		
	1.75-2.0	Very Strong	Silty Clay	7.8	5.8	2.0	✓	✓		✓
	2.0-2.25	Very Strong	Silty Clay	8.0	5.6	2.4	✓	✓		
	2.25-2.5	Strong	Silty Clay	7.5	5.7	1.8	✓	✓		
	2.5-2.75	Very Strong	Silty Clay	7.7	3.7	4.0	✓	✓		
	2.75-3.0	Very Strong	Silty Clay	7.7	5.0	2.7	✓	✓		
	3.0-3.25	Very Strong	Silty Clay	7.7	5.8	1.9	✓	✓		
	3.25-3.5	Strong	Silty Clay	7.8	5.3	2.5	✓	✓		
	3.5-3.75	Very Strong	Silty Clay	7.7	4.5	3.2	✓	✓		
	3.75-4.0	Very Strong	Silty Clay	7.7	2.8	4.9	✓	✓	✓	✓
	4.0-4.25	Very Strong	Silty Clay	7.7	3.3	4.4	✓	✓		
	4.25-4.5	Very Strong	Silty Clay	7.8	3.3	4.5	✓	✓		
	4.5-4.75	Very Strong	Silty Clay	7.8	4.1	3.7	✓	✓		
	4.75-5.0	Very Strong	Silty Clay	7.7	3.4	4.3	✓	✓		
	5.0-5.25	Very Strong	Silty Clay	7.4	3.3	4.1	✓	✓		
	5.25-5.5	Very Strong	Silty Clay	7.8	3.2	4.6	✓	✓		
	5.5-5.75	Very Strong	Silty Clay	7.0	3.2	3.8	✓	✓		
	5.75-6.0	Very Strong	Silty Clay	7.2	3.0	4.2	✓	✓		
	6.0-6.25	Very Strong	Silty Clay	7.8	2.8	5.1	✓	✓	✓	
	6.25-6.5	Very Strong	Silty Clay	7.8	2.9	4.9	✓	✓	✓	

Table 2 continued

Bore	Depth (m)	Reaction	Sample Description	pH_F	pH_{FOX}	pH Change	Screening Test Indicators			Chromium Suite Tested
							a	b	c	
6	0.0-0.25	Strong	Fill	7.1	8.6	1.5	✓			
	0.25-0.5	Moderate	Fill	7.6	8.4	0.8				
	0.5-0.75	Moderate	Fill	7.8	8.8	1.1		✓		
	0.75-1.0	Moderate	Fill	7.8	8.3	0.5				
	1.0-1.25	Moderate	Fill/Silty Clay	7.4	7.8	0.4				
	1.25-1.5	Very Strong	Silty Clay	7.3	5.7	1.6	✓	✓		
	1.5-1.75	Strong	Silty Clay	7.2	6.4	0.8	✓			
	1.75-2.0	Very Strong	Silty Clay	7.3	6.3	1.0	✓	✓		
	2.0-2.25	Very Strong	Silty Clay	5.6	3.8	1.7	✓	✓		
	2.25-2.5	Moderate	Silty Clay	5.7	3.5	2.2		✓		✓
	2.5-2.75	Strong	Silty Clay	5.9	3.5	2.4	✓	✓		
	2.75-3.0	Very Strong	Silty Clay	6.5	3.5	2.9	✓	✓		
	3.0-3.25	Moderate	Silty Clay	6.7	3.9	2.8		✓		
	3.25-3.5	Moderate	Silty Clay	6.5	3.7	2.8		✓		
	3.5-3.75	Strong	Silty Clay	6.4	3.4	3.0	✓	✓		
	3.75-4.0	Strong	Silty Clay	6.6	3.5	3.1	✓	✓		
	4.0-4.25	Strong	Silty Clay	6.5	3.1	3.5	✓	✓		
	4.25-4.5	Very Strong	Silty Clay	6.7	2.7	4.0	✓	✓	✓	
	4.5-4.75	Very Strong	Silty Clay	6.8	2.7	4.1	✓	✓	✓	
	4.75-5.0	Very Strong	Silty Clay	6.8	2.7	4.1	✓	✓	✓	
	5.0-5.25	Strong	Gravelly Clay	5.0	3.5	1.6	✓	✓		
	5.25-5.5	Moderate	Gravelly Clay	5.0	3.6	1.4		✓		✓
	5.5-5.75	Very Strong	Gravelly Clay	5.7	3.1	2.7	✓	✓		
	5.75-6.0	Very Strong	Gravelly Clay	6.6	3.0	3.6	✓	✓		
	6.0-6.25	Strong	Gravelly Clay	5.2	3.3	1.9	✓	✓		
	6.25-6.5	Very Strong	Gravelly Clay	6.2	3.2	3.1	✓	✓		

The pH screening tests can be used for the preliminary identification of a potential or actual ASS by considering a combination of three trigger factors[1] as follows:

a) The strength of the reaction with peroxide is a useful indicator but cannot be used alone. Organic matter and other soil constituents such as manganese oxides can also cause a reaction.

b) A pH_{FOX} value at least one unit below pH_F may indicate a potential acid sulfate soil (PASS). The greater the difference between the two measurements, the more indicative the value is of a PASS. The lower the final pH_{FOX} value is, the better the indication of a positive result.

c) If the pH_{FOX} <3, and the other two conditions apply, then it strongly indicates a PASS. The more the pH_{FOX} drops below 3, the more positive the presence of sulfides.

Table 2 notes which, if any, of the screening test results meet any of the above three trigger factors.

As some very strong reactions were observed with the addition of peroxide, pH_{FOX} values of more than one pH unit reduction occurred and pH_{FOX} values of less than 3.0 were obtained during some tests, it was considered that the site soils (particularly the silty clay soils) may be acid sulfate soils, and Chromium Suite laboratory testing was undertaken on selected samples as nominated in Table 2.

[1] Ahern C.R., Ahern M.R., Powell B. 'Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998'

4.4.2 *Chromium Suite Tests*

Based on the results of the acid sulfate soil screening tests, nine samples were selected for Chromium Suite analysis. Samples were transported to Australian Laboratory Services Pty Ltd (ALS) under standard chain of custody protocol. ALS is registered with the National Association of Testing Authorities (NATA) for the relevant testing and the results are summarised in Table 3.

Table 3: Summary of Chromium Suite Test Results

Bore	Depth (m)	Sample Description	pH_{KCL}	Sulfidic – Titratable Actual Acidity (% Pyrite S)	Chromium Reducible Sulfur (%S)	Net Acidity (%S)
1	3.25-3.0	Silty Clay	5.4	<0.02	<0.02	<0.02
	5.0-5.25	Silty Clay	5.7	<0.02	<0.02	<0.02
2	5.0-5.25	Silty Clay	5.7	<0.02	**0.05**	**0.06**
3	1.5-1.75	Clayey Silty Sand	5.4	<0.02	<0.02	0.02
4	2.25-2.50	Silty Sand	5.5	<0.02	<0.02	<0.02
5	1.75-2.0	Silty Clay	5.8	<0.02	**0.07**	**0.08**
	3.75-4.0	Silty Clay	5.6	<0.02	**0.10**	**0.10**
6	2.25-2.5	Silty Clay	4.5	**0.04**	<0.02	**0.05**
	5.25-5.50	Gravelly Clay	4.7	<0.02	<0.02	0.02

Note: **Bold** values exceed State Planning Policy 2/02 Guideline values

SECTION 5 - COMMENTS AND DICUSSION

5.1 *Assessment Criteria of Acid Sulfate Soils*

ASS in Queensland are assessed in accordance with the Queensland Acid Sulfate Soils Investigation Team (QASSIT) *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998 (QASSIT Guidelines)* and the State Planning Policy 2/02 Guideline *Planning and Managing Development Involving Acid Sulfate Soils*. The State Planning Policy 2/02 Guideline provide Action Criteria for assessing the results of laboratory testing quantifying the acid producing effects based on the sum of existing plus potential acidity. These action criteria are presented in Table 4.

Table 4: Action Criteria based on ASS Analysis for Three Broad Texture Categories

Type of Material		Action Criteria (1-1000 tonnes disturbed)		Action Criteria (>1000 tonnes disturbed)	
		Existing + Potential Acidity		Existing + Potential Acidity	
Texture Range	Approx. Clay Content (%)	Equivalent Sulfur %S	Equivalent Acidity Mol H^+/tonne	Equivalent Sulfur %S	Equivalent Acidity Mol H^+/tonne
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, silty clays	>40	0.1	62	0.03	**18**

It has been assumed that the volume of natural soil to be disturbed during site development works will exceed 1000 tonnes and the '> than 1000 tonnes disturbed Action Criteria' from Table 4 has therefore been used as the basis for assessment of the disturbed soils.

5.2 *Discussion of Results*

The results of the Chromium Suite analyses indicate that all soils analysed are acidic (pH_{KCL} ranged between 4.5 and 5.8 units) and that the levels of titratable actual acidity (TAA) range from <0.02%S to 0.04%S, with one of the nine samples submitted for laboratory analysis exceeding the Action Criteria of 0.03%S.

The reported levels of chromium reducible sulfur (S_{CR}) for three samples of silty clays submitted for laboratory analysis exceeded the relevant Action Criteria, indicating a potential for generation of additional acidity from the oxidation of pyrite.

The reported net acidity levels for four samples of silty clay submitted for analysis exceeded the relevant Action Criteria of 0.03%S, indicating that if the natural silty clay soils are disturbed to 6.0m depth they will require neutralising with ag-lime.

The results of Acid Sulfate Soil assessments previously carried out by Butler Partners Pty Ltd for adjacent development sites (including the Portside Wharf site) indicated that the sand and sand fill are not ASS, which is confirmed by the results of the current testing. The extremely weathered rock and the gravelly clays (which are residual soils derived from the in place weathering of rock) are not ASS.

Based on the laboratory analyses undertaken, it is considered that disturbance of natural silty clay soils to 6.0m depth will require management and a draft Acid Sulfate Soil Management Plan (ASSMP) is provided in Appendix C for consideration. ***If excavation to greater than 6.0m depth is to be undertaken, additional (deeper) ASS assessment will be required and the results of the additional assessment may lead to changes being required in the ASSMP.***

Based on the laboratory test results the suggested liming rate for neutralisation (adopting a factor of safety of 1.5 and the use of good quality fine ag-lime with a neutralising value of 100%), is 5 kg per dry tonne of natural silty clay soil.

If the site excavation process does not allow the complete segregation of the silty clays from the other soils, fill and weathered rock, it will be necessary to treat all excavated material as ASS.

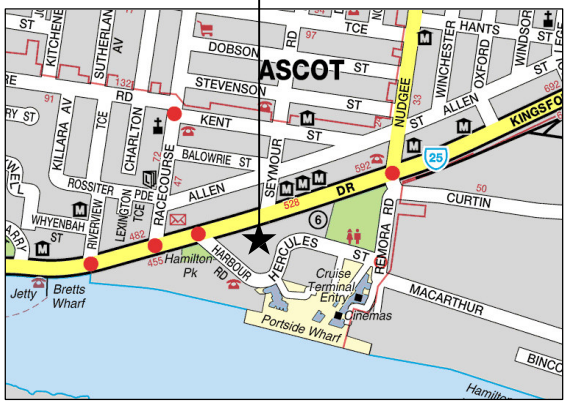
BUTLER PARTNERS PTY LTD

Reviewed By

BRUCE BUTLER
PRINCIPAL

MIKE NEIGHBOUR
PRINCIPAL

SITE



Reproduced with Permission, Copyright Universal Press Pty Ltd
UBD Reference: Map 140 Ref P,Q18 (51st Edition) N.T.S.

LEGEND

- 1 Bore
- Site Boundary
- Area inaccessible at time of drilling

Reference: PMM's 'Detail Survey', Drawing No.22151-2.

CLIENT:

DEVINE LIMITED

BUTLER PARTNERS

79 Doggett Street, Newstead
Queensland 4006 Australia
Telephone 61 7 3852 3800
Facsimilie 61 7 3852 3808

HAMILTON HARBOUR DEVELOPMENT

485-489 KINGSFORD SMITH DRIVE, HAMILTON

LOCALITY PLAN AND TEST LOCATIONS

NORTH

0 25 50 75m

SCALE: 1:2000 (A4)

DATE: APRIL 2007

DRAWN BY: FD

APPROVED:

PROJECT No: 04298C

DRAWING No: 1 REV: A

ACEA

Hamilton Harbour Development
485-489 Kingsford Smith Drive, Hamilton
Project No. 04298C, November 2008

APPENDIX A

BORE REPORTS WITH EXPLANATORY NOTES

BORE REPORT

Client: Devine Limted
Project: Hamilton Harbour Development
Location: 485-489 Kingsford Smith Drive, Hamilton
Project No: 04298C

BORE 1

Page No: 1 of 1
Date: 28 February 2007
Ground Surface Level: RL 3.5m* (approxiamte)

Depth (m)	Description	RL (m)	Sample Type	Sample Depth (m)
0		3.5		
	FILL - brown, sand with gravelly clay, wire encountered		D	0.0
			D	0.25
		3.0	D	0.5
			D	0.75
1			D	1.0
			D	1.25
	SILTY CLAY (CL) - grey-brown, hydrocarbor odour	2.0	D	1.5
			D	1.75
2			D	2.0
	- dark grey-brown		D	2.25
		1.0	D	2.5
			D	2.75
3			D	3.0
	- grey with strong hydrocarbon odour		D	3.25
		0.0	D	3.5
			D	3.75
4			D	4.0
			D	4.25
		-1.0	D	4.5
			D	4.75
5			D	5.0
			D	5.25
		-2.0	D	5.5
	SANDY CLAY (SC) - brown and grey, fine to medium coarse		D	5.75
6			D	6.0
			D	6.25
		-3.0	D	6.5
	End of Bore at 6.5 m			
7				
		-4.0		
8				

D	Disturbed Sample	E	Environmental Sample	C	NMLC Coring
B	Bulk Sample	S	Standard Penetrometer Test (SPT)	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	HB	SPT Hammer Bouncing	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	( )	No Sample Recovery	(a)	Axial Point Load Strength Test

Rig: Mobile B40L

Drilling Method: Auger

Groundwater: Free groundwater encountered at 3.7m depth

Remarks: * Approximate ground surface level referenced to a TBM located in Harbour Road (RL 2.83m), refer Drawing No. 1.

BORE REPORT

Client: Devine Limted
Project: Hamilton Harbour Development
Location: 485-489 Kingsford Smith Drive, Hamilton
Project No: 04298C

BORE 2

Page No: 1 of 1
Date: 28 February 2007
Ground Surface Level: RL 3.5m* (approxiamte)

Depth (m)	Description	RL (m)	Sample Type	Sample Depth (m)
0		3.5		0.0
	FILL - brown-pale brown, sandy clay, with cobbles		D	0.25
		3.0	D	0.5
	SAND (SP) - dense, grey-brown, fine to coarse sand (possibly fill)		D	0.75
1			D	1.0
			D	1.25
		2.0	D	1.5
	- hydrocarbon odour		D	1.75
2			D	2.0
			D	2.25
		1.0	D	2.5
3			D	2.75
			D	3.0
			D	3.25
		0.0	D	3.5
4			D	3.75
			D	4.0
			D	4.25
		-1.0	D	4.5
			D	4.75
5	*SILTY CLAY (CL)* - grey		D	5.0
			D	5.25
		-2.0	D	5.5
			D	5.75
6			D	6.0
			D	6.25
		-3.0	D	6.5
	End of Bore at 6.5 m			
7				
		-4.0		
8				

D	Disturbed Sample	E	Environmental Sample	C	NMLC Coring
B	Bulk Sample	S	Standard Penetrometer Test (SPT)	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	HB	SPT Hammer Bouncing	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	( )	No Sample Recovery	(a)	Axial Point Load Strength Test

Rig: Mobile B40L

Drilling Method: Auger

Groundwater: Free groundwater encountered at 3.8m depth

Remarks: * Approximate ground surface level referenced to a TBM located in Harbour Road (RL 2.83m), refer Drawing No. 1.

BORE REPORT

BUTLER PARTNERS

Client: Devine Limted

Project: Hamilton HarbourDevelopment

Location: 485-489 Kingsford Smith Drive, Hamilton

Project No: 04298C

BORE 3

Page No: 1 of 1

Date: 28 February 2007

Ground Surface Level: RL 5.0m*

Depth (m)	Description	RL (m)	Sample Type	Sample Depth (m)
		5.0		
0	*FILL* - brown, clayey silty sand, trace gravel		D	0.0
			D	0.25
			D	0.5
			D	0.75
1		4.0	D	1.0
			D	1.25
			D	1.5
			D	1.75
2		3.0	D	2.0
			D	2.25
			D	2.5
			D	2.75
3		2.0	D	3.0
	SANDSTONE (EW) - extremely weathered, brown-light brown		D	3.25
			D	3.5
			D	3.75
4		1.0	D	4.0
			D	4.25
			D	4.5
			D	4.75
5	End of Bore at 5 m	0.0	D	5.0
6		-1.0		
7		-2.0		
8		-3.0		

Test Results

D	Disturbed Sample	E	Environmental Sample	C	NMLC Coring
B	Bulk Sample	S	Standard Penetrometer Test (SPT)	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	HB	SPT Hammer Bouncing	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	( )	No Sample Recovery	(a)	Axial Point Load Strength Test

Rig: Mobile B40L

Drilling Method: Auger

Groundwater: No free groundwater encountered during auger drilling

Remarks: * Approximate ground surface level referenced to a TBM located in Harbour Road (RL 2.83m), refer Drawing No. 1.

BORE REPORT

BUTLER PARTNERS

Client: Devine Limted
Project: Hamilton Harbour Development
Location: 485-489 Kingsford Smith Drive, Hamilton
Project No: 04298C

BORE 4

Page No: 1 of 1
Date: 28 February 2007
Ground Surface Level: RL 4.1m* (approxiamte)

Depth (m)	Description	RL (m)	Lithology	Sample Type	Sample Depth (m)	Test Results
0		4.1				
	FILL - brown, silty clay			D	0.0	
				D	0.25	
				D	0.5	
				D	0.75	
1				D	1.0	
		3.0		D	1.25	
	SILTY SAND (SM) - pale brown-whiteish, fine to medium grained sand			D	1.5	
				D	1.75	
				D	2.0	
2		2.0		D	2.25	
				D	2.5	
				D	2.75	
				D	3.0	
3	*SANDSTONE (EW)* - extremely weathered, grey-pale brown	1.0		D	3.25	
				D	3.5	
				D	3.75	
	- brown			D	4.0	
4		0.0		D	4.25	
				D	4.5	
				D	4.75	
				D	5.0	
5		-1.0		D	5.25	
				D	5.5	
				D	5.75	
6	End of Bore at 5.75 m	-2.0				
7		-3.0				
8						

D Disturbed Sample
B Bulk Sample
U Undisturbed Tube (50mm diameter)
pp Pocket Penetrometer Test (kPa)

E Environmental Sample
S Standard Penetrometer Test (SPT)
HB SPT Hammer Bouncing
( ) No Sample Recovery

C NMLC Coring
Is(50) Point Load Test Result (MPa)
(d) Diametral Point Load Strength Test
(a) Axial Point Load Strength Test

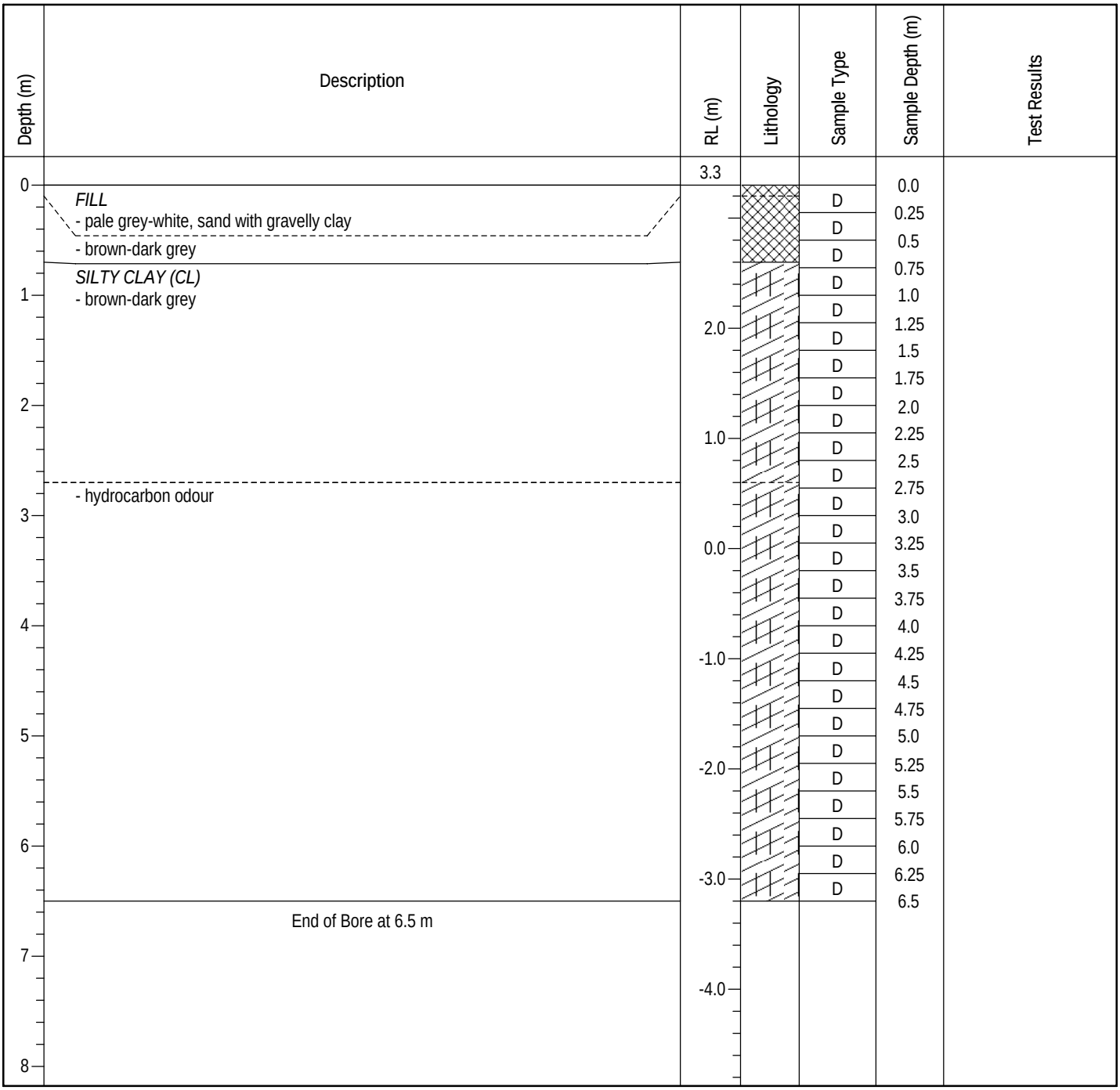
Rig: Mobile B40L
Drilling Method: Auger
Groundwater: No free groundwater encountered during auger drilling
Remarks: * Approximate ground surface level referenced to a TBM located in Harbour Road (RL 2.83m), refer Drawing No. 1.

BORE REPORT

Client: Devine Limted
Project: Hamilton Harbour Development
Location: 485-489 Kingsford Smith Drive, Hamilton
Project No: 04298C

BORE 5

Page No: 1 of 1
Date: 28 February 2007
Ground Surface Level: RL 3.3m* (approxiamte)



D	Disturbed Sample	E	Environmental Sample	C	NMLC Coring
B	Bulk Sample	S	Standard Penetrometer Test (SPT)	Is(50)	Point Load Test Result (MPa)
U	Undisturbed Tube (50mm diameter)	HB	SPT Hammer Bouncing	(d)	Diametral Point Load Strength Test
pp	Pocket Penetrometer Test (kPa)	( )	No Sample Recovery	(a)	Axial Point Load Strength Test

Rig: Mobile B40L

Drilling Method: Auger

Groundwater: Free groundwater encountered at 3.0m depth

Remarks: * Approximate ground surface level referenced to a TBM located in Harbour Road (RL 2.83m), refer Drawing No. 1.

BORE REPORT

Client: Devine Limted
Project: Hamilton Harbour Development
Location: 485-489 Kingsford Smith Drive, Hamilton
Project No: 04298C

BORE 6

Page No: 1 of 1
Date: 28 February 2007
Ground Surface Level: RL 3.4m* (approxiamte)

Depth (m)	Description	RL (m)	Sample Type	Sample Depth (m)	Test Results
0		3.4			
	FILL - pale brown, sand, with shells		D	0.0	
			D	0.25	
			D	0.5	
			D	0.75	
1			D	1.0	
	SILTY CLAY (CL) - brown and grey, faint hydrocarbon odour	2.0	D	1.25	
			D	1.5	
			D	1.75	
2			D	2.0	
			D	2.25	
		1.0	D	2.5	
			D	2.75	
3	- grey-dark grey		D	3.0	
			D	3.25	
		0.0	D	3.5	
			D	3.75	
4			D	4.0	
			D	4.25	
		-1.0	D	4.5	
			D	4.75	
5			D	5.0	
	GRAVELLY CLAY (GC) - grey and blue-brown-greenish, fine to medium gravel		D	5.25	
		-2.0	D	5.5	
			D	5.75	
6			D	6.0	
			D	6.25	
		-3.0	D	6.5	
	End of Bore at 6.5 m				
7					
		-4.0			
8					

D Disturbed Sample
B Bulk Sample
U Undisturbed Tube (50mm diameter)
pp Pocket Penetrometer Test (kPa)
E Environmental Sample
S Standard Penetrometer Test (SPT)
HB SPT Hammer Bouncing
( ) No Sample Recovery
C NMLC Coring
Is(50) Point Load Test Result (MPa)
(d) Diametral Point Load Strength Test
(a) Axial Point Load Strength Test

Rig: Mobile B40L
Drilling Method: Auger
Groundwater: No free groundwater encountered during auger drilling
Remarks: * Approximate ground surface level referenced to a TBM located in Harbour Road (RL 2.83m), refer Drawing No. 1.

Notes on Description and Classification of Soil

The methods of description and classification of soils used in this report are generally based on Australian Standard AS1726-1993 *Geotechnical Site Investigations*.

Soil description is based on an assessment of disturbed samples, as recovered from bores and excavations, or from undisturbed materials as seen in excavations and exposures or in undisturbed samples. Descriptions given on report sheets are an interpretation of the conditions encountered at the time of investigation.

In the case of cone or piezocone penetrometer tests, actual soil samples are not recovered and soil description is inferred based on published correlations, past experience and comparison with bore and/or test pit data (if available).

Soil classification is based on the particle size distribution of the soil and the plasticity of the portion of the material finer than 0.425mm. The description of particle size distribution and plasticity is based on the results of visual field estimation, laboratory testing or both. When assessed in the field, the properties of the soil are estimated; precise description will always require laboratory testing to define soil properties.

Where soil can be clearly identified as FILL this will be noted as the main soil type followed by a description of the composition of the fill (e.g. FILL – yellow-brown, fine to coarse grained gravelly clay fill with concrete rubble). If the soil is assessed as possibly being fill this will be noted as an additional observation.

Soils are generally described using the following sequence of terms. In certain instances, not all of the terms will be included in the soil description.

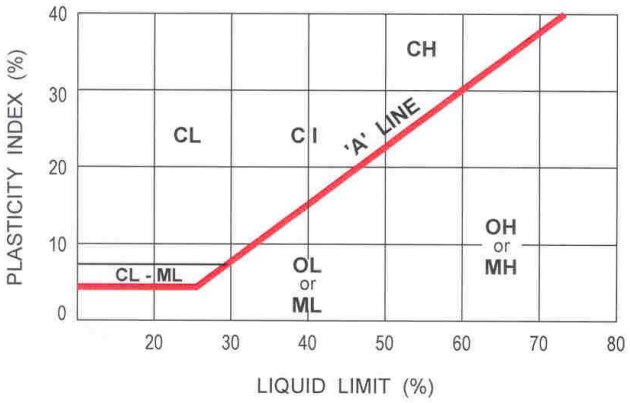
MAIN SOIL TYPE (CLASSIFICATION GROUP SYMBOL)
- strength/density, colour, structure/grain size, secondary and minor components, additional observations

Information on the definition of descriptive and classification terms follows.

SOIL TYPE and CLASSIFICATION GROUP SYMBOLS

	Major Divisions	Particle Size	Classification Group Symbol	Typical Names
COARSE GRAINED SOILS (more than half of material is larger than 0.075 mm)	BOULDERS	> 200mm		
	COBBLES	63 – 200mm		
	GRAVELS (more than half of coarse fraction is larger than 2.36mm)	Coarse: 20 – 63mm Medium: 6 – 20mm Fine: 2.36 – 6mm	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels.
			GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than 2.36mm)	Coarse: 0.6 – 2.36mm Medium: 0.2 – 0.6mm Fine: 0.075 – 0.2mm	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
			SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (more than half of material is smaller than 0.075 mm)	SILTS & CLAYS (liquid limit <50%)		ML	Inorganic silts and very fine sands, silty/clayey fine sands or clayey silts with low plasticity.
			CL and CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS & CLAYS (liquid limit >50%)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils.
			CH	Inorganic clays of high plasticity.
			OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

PLASTICITY CHART FOR CLASSIFICATION OF FINE GRAINED SOILS



(Reference: Australian Standard AS1726-1993 *Geotechnical site investigations*)

DESCRIPTIVE TERMS FOR MATERIAL PROPORTIONS

Coarse Grained Soils		Fine Grained Soils	
% Fines	Modifier	% Coarse	Modifier
< 5	Omit, or use 'trace'	< 15	Omit, or use trace.
5 – 12	Describe as 'with clay/silt' as applicable.	15 – 30	Describe as 'with sand/gravel' as applicable.
> 12	Prefix soil as 'silty/clayey' as applicable	> 30	Prefix soil as 'sandy/gravelly' as applicable.

STRENGTH TERMS – COHESIVE SOILS

Strength Term	Undrained Shear Strength	Field Guide to Strength
Very soft	< 12kPa	Exudes between the fingers when squeezed in hand.
Soft	12 – 25kPa	Can be moulded by light finger pressure.
Firm	25 – 50kPa	Can be moulded by strong finger pressure.
Stiff	50 – 100kPa	Cannot be moulded by fingers, can be indented by thumb.
Very stiff	100 – 200kPa	Can be indented by thumb nail.
Hard	> 200kPa	Can be indented with difficulty by thumb nail.

DENSITY TERMS – NON COHESIVE SOILS

Density Term	Density Index	SPT "N"	CPT Cone Resistance
Very loose	< 15%	0 – 5	0 – 2MPa
Loose	15 – 35%	5 – 10	2 – 5MPa
Medium dense	35 – 65%	10 – 30	5 – 15MPa
Dense	65 – 85%	30 – 50	15 – 25MPa
Very dense	> 85%	> 50	> 25MPa

COLOUR

The colour of a soil will generally be described in a 'moist' condition using simple colour terms (eg. black, grey, red, brown etc.) modified as necessary by "pale", "dark", "light" or "mottled". Borderline colours will be described as a combination of colours (eg. grey-brown).

EXAMPLE

e.g. CLAYEY SAND (SC) – medium dense, grey-brown, fine to medium grained with silt.

Indicates a medium dense, grey-brown, fine to medium grained clayey sand with silt.

Notes on Description and Classification of Rock

The methods of description and classification of rock used in this report are generally based on Australian Standard AS1726-1993 *Geotechnical Site Investigations*.

Rock description is based on an assessment of disturbed samples, as recovered from bores and excavations, or from undisturbed materials as seen in excavations and exposures, or in core samples. Descriptions given on report sheets are an interpretation of the conditions encountered at the time of investigation.

Notes outlining the method and terminology adopted for the description of rock defects are given below, however, detailed information on defects can generally only be determined where rock core is taken, or excavations or exposures allow detailed observation and measurement.

Rocks are generally described using the following sequence of terms. In certain instances not all of the terms will be included in the rock description.

ROCK TYPE (WEATHERING SYMBOL), strength, colour, grain size, defect frequency

Information on the definition of descriptive and classification terms follows.

ROCK TYPE

In general, simple rock names are used rather than precise geological classifications.

ROCK MATERIALS WEATHERING CLASSIFICATION

Term	Weathering Symbol	Definition
Residual soil	RS	Soil developed from extremely weathered rock; the mass structure and substance fabrics are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered	XW	Rock is weathered to such an extent that it has 'soil' properties, ie. it either disintegrates or can be remoulded in water.
Distinctly weathered *	DW	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 due to deposition of weathering products in pores.
Highly weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock, usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock may be no longer recognisable.
Slightly weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition or staining.

** Subdivision of this weathering grade into highly and moderately may be used where applicable.*

STRENGTH OF ROCK MATERIAL

Term	Symbol	Point Load Index I_s (50)	Field guide to strength
Extremely low	EL	< 0.03MPa	Easily remoulded by hand to a material with soil properties.
Very low	VL	0.03 – 0.1MPa	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low	L	0.1 – 0.3MPa	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	0.3 – 1.0MPa	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	H	1.0 – 3.0MPa	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very high	VH	3.0 – 10.0MPa	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely high	EH	> 10MPa	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Notes:
1. *These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considerably weaker due to the effect of rock defects.*
2. *The field guide visual assessment for rock strength may be used for preliminary assessment or when point load testing is not available.*
3. *Anisotropy of rock may affect the field assessment of strength.*

Notes on Description and Classification of Rock
(Revision 1, March 2001)

COLOUR

The colour of a rock will generally be described in a 'moist' condition using simple colour terms (eg. black, grey, red, brown, etc) modified as necessary by 'pale', 'dark', 'light' or 'mottled'. Borderline colours will be described as a combination of colours (eg. grey-brown).

GRAIN SIZE

Descriptive Term	Particle Size Range
Coarse grained	0.6 – 2.0mm
Medium grained	0.2 – 0.6mm
Fine grained	0.06 – 0.2mm

DEFECT FREQUENCY

Where appropriate, a defect frequency may be recorded as part of the rock description and will be expressed as the number of natural (or interpreted natural) defects present in an equivalent one metre length of core.

EXAMPLE

e.g. SANDSTONE (XW) – low strength, pale brown, fine to coarse grained, 3 defects per metre.

ROCK DEFECTS

Defects are discontinuities in the rock mass and include joints, sheared zones, cleavages and bedding partings. The ability to observe and log defects will depend on the investigation methodology. Defects logged in core are described using the abbreviations noted in the following tables.

The *depth* noted in the description is measured in metres from the ground surface, the *defect angle* is measured in degrees from horizontal, and the defect *thickness* is measured normal to the plane of the defect and is in millimetres (unless otherwise noted).

Defects are generally described using the following sequence of terms:

Depth, Defect Type, Defect Angle (dip), Surface Roughness, Infill, Thickness

DEFECT TYPE

B	– Bedding
J	– Joint
S	– Shear Zone
C	– Crushed Zone

SURFACE ROUGHNESS

i	- rough or irregular, stepped
ii	- smooth, stepped
iii	- slickensided, stepped
iv	- rough or irregular, undulating
v	- smooth, undulating
vi	- slickensided, undulating
vii	- rough or irregular, planar
viii	- smooth planar
ix	- slickensided, planar

INFILL

Infill refers to secondary minerals or other materials formed on the surface of the defect and some common descriptions are given in the following table together with their abbreviations.

Ls	- limonite staining
Fe	- iron staining
Cl	- clay
Mn	- manganese staining
Qtz	- quartz
Ca	- calcite
Clean	- no visible infill

EXAMPLE

3.59m, J, 90, vii, Ls, 0.1mm

indicates a joint at 3.59m depth that is at 90° to horizontal (i.e. vertical), is rough or irregular and planar, limonite stained and 0.1mm thick.

Hamilton Harbour Development
485-489 Kingsford Smith Drive, Hamilton
Project No. 04298C, November 2008

APPENDIX B

LABORATORY TEST REPORTS

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: **BUTLER PARTNERS PTY LTD**	*Laboratory*	: **Environmental Division Brisbane**	*Page*	: **1 of 5**
Contact	: **MR BRUCE BUTLER**	*Contact*	: **Michael Heery**	*Work Order*	: **EB0702709**
Address	: **P O BOX 2267 FORTITUDE VALLEY BC QLD AUSTRALIA 4006**	*Address*	: **32 Shand Street Stafford QLD Australia 4053**		
E-mail	: **bbutler@butlerpartners.com.au**	*E-mail*	: **Services.Brisbane@alsenviro.com**		
Telephone	: **38523800**	*Telephone*	: **61-7-3243 7222**		
Facsimile	: **38523808**	*Facsimile*	: **61-7-3243 7259**		
Project	: **- Not provided -**	*Quote number*	: **BN/217/06**	*Date received*	: **9 Mar 2007**
Order number	: **04298C**			*Date issued*	: **26 Mar 2007**
C-O-C number	: **- Not provided -**			*No. of samples*	- *Received* : **9**
Site	: **- Not provided -**				*Analysed* : **9**

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	*Position*	*Department*
Stacey Hawkins	**Instrument Chemist**	**Perth Inorganics - NATA 825 (15847 - Perth)**

ALS Environmental

Comments

This report for the ALSE reference EB0702709 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical Results for Samples Submitted**
- **Surrogate Recovery Data**

The analytical procedures used by ALS Environmental 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 herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Specific comments for Work Order **EB0702709**

Analysis conducted by ALS Perth, NATA accreditation no. 825, site no. 15842.

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID : Bore # 1 3.25-3.5	Bore # 1 5.0-5.25	Bore # 2 5.0-5.25	Bore # 3 1.5-1.75	Bore # 4 2.25-2.5
Sample Matrix Type / Description :				SOIL	SOIL	SOIL	SOIL	SOIL
Sample Date / Time :				7 Mar 2007 15:00	7 Mar 2007 15:00	7 Mar 2007 15:00	7 Mar 2007 15:00	7 Mar 2007 15:00
Laboratory Sample ID :				EB0702709-001	EB0702709-002	EB0702709-003	EB0702709-004	EB0702709-005
EA033-A: Actual Acidity								
pH KCl (23A)		0.1	pH Unit	5.4	5.7	5.7	5.4	5.5
Titratable Actual Acidity (23F)		2	mole H+ / t	8	5	<2	8	3
sulfidic - Titratable Actual Acidity (s-23F)		0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)		0.02	% S	<0.02	<0.02	0.05	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)		10	mole H+ / t	<10	<10	34	<10	<10
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	<0.02	0.06	0.02	<0.02
Net Acidity (acidity units)		10	mole H+ / t	10	<10	35	13	<10
Liming Rate		1	kg CaCO3/t	<1	<1	3	1	<1

ALS Environmental

Analytical Results

				Client Sample ID :	Bore # 5 1.75-2.0	Bore # 5 3.75-4.0	Bore # 6 2.25-2.5	Bore # 6 5.25-5.5	
				Sample Matrix Type / Description :	SOIL	SOIL	SOIL	SOIL	
				Sample Date / Time :	7 Mar 2007 15:00	7 Mar 2007 15:00	7 Mar 2007 15:00	7 Mar 2007 15:00	
				Laboratory Sample ID :	EB0702709-006	EB0702709-007	EB0702709-008	EB0702709-009	
Analyte	*CAS number*	*LOR*	*Units*						
EA033-A: Actual Acidity									
pH KCl (23A)		0.1	pH Unit		5.8	5.6	4.5	4.7	
Titratable Actual Acidity (23F)		2	mole H+ / t		8	5	25	9	
sulfidic - Titratable Actual Acidity (s-23F)		0.02	% pyrite S		<0.02	<0.02	0.04	<0.02	
EA033-B: Potential Acidity									
Chromium Reducible Sulfur (22B)		0.02	% S		0.07	0.10	<0.02	<0.02	
acidity - Chromium Reducible Sulfur (a-22B)		10	mole H+ / t		42	60	<10	<10	
EA033-E: Acid Base Accounting									
ANC Fineness Factor		0.5			1.5	1.5	1.5	1.5	
Net Acidity (sulfur units)		0.02	% S		0.08	0.10	0.05	0.02	
Net Acidity (acidity units)		10	mole H+ / t		50	65	33	<10	
Liming Rate		1	kg CaCO3/t		4	5	2	1	

ALS Environmental

Surrogate Control Limits

- **No surrogates present on this report.**

Hamilton Harbour Development
485-489 Kingsford Smith Drive, Hamilton
Project No. 04298C, November 2008

APPENDIX C

DRAFT ACID SULFATE SOIL MANAGEMENT PLAN

Hamilton Harbour Development
485-489 Kingsford Smith Drive, Hamilton
Draft Acid Sulfate Soil Management Plan (ASSMP)

Element	Acid Sulfate Soil Management Plan
Objective/Target	The objective of the ASS Management Plan is to control any acid generation from the soils and to restrict to an acceptable level any potential on-site and off-site environmental impacts from site excavation to a depth of approximately 6m below ground surface in the proposed development area.
ASS Management Strategy	To mitigate and manage any potential environmental impacts associated with ASS during site construction operations. This will be achieved as follows: • the excavation of soils within the site requires a materials handling and management strategy and procedure for on-site lime treatment of ASS ***or*** the appropriate off-site treatment of the ASS (if insufficient space is available for on-site treatment) to be in place; • appropriate erosion control measures will be adopted to limit sediment loss due to run-off from within the site; and • monitoring of waters collected within the work site will be carried out with treatment (if necessary) to a level suitable for discharge into external waterways.
Tasks/Actions	An ASS investigation has been carried out to assess soils to a maximum depth of approximately 6.5m below the existing ground level. The natural silty clay soils to 6.5m depth contain levels of actual and potential acidity that exceed the State Planning Policy 2/02 Guideline Action Criteria. The natural soils underlying the site to the maximum depth of excavation of 6m depth will require ASS management to restrict potential adverse environmental impacts. The following actions will be carried out during the earthworks/construction stage: • Based on the available space on-site it is considered unlikely that treatment of ASS will be undertaken on-site using temporary stockpiles and a treatment area. However, if on-site treatment of ASS is undertaken, then conditioning (drying) and lime treating of ASS can be undertaken as described below. • If lime treatment of the excavated soil is not to be undertaken within a treatment area, then the material will be lime treated during excavation ***or*** the soil will be excavated and treated off-site (in a properly designed treatment area). <u>ASS Treatment On-Site</u> Where excavated ASS is to be treated on site a suitably sized dedicated treatment area will be created. ASS to be treated shall be placed on the treatment area in layers not thicker than 0.3m. • Bunding will be constructed (if required) around the perimeter of the designated ASS treatment area to intercept and contain run-off from the area during the soil treatment operations. The base of the ASS treatment area is to be lime treated prior to placement of each layer of ASS. Re-treatment is required with ag-lime prior to placement of each new layer of soil to be treated, and at the conclusion of all treatment. The base of the treatment pad shall have the minimum ag-lime application rate of 5kg/square metre. • A suitably sized drain or temporary retention basin will be constructed to collect drainage water from the treatment area in the event of heavy rainfall during the construction period. • If insufficient space is available for a temporary retention basin, then suitably sized retention tanks can be used to collect drainage water from treatment areas and excavations. • Drainage water or run-off collected in the retention basin/retention tanks will be tested to determine the quality of the water, if the water quality falls outside the performance indicators (described below) the water will be treated prior to discharge from the site.

Tasks/Actions (Cont'd)	• Natural silty clay soils to 6.5m depth underlying the site have been shown by laboratory testing to comprise net acidity levels above the State Planning Policy 2/02 Guideline Action Criteria. In the event that the natural soils to 6m depth (maximum proposed excavation depth) are to be excavated or disturbed, they can either be spread out in the designated ASS treatment area in layers not exceeding 0.3m thickness ***or*** prior to excavation be tyned and mixed with ag-lime in layers of up to 0.25m thickness. Ag-lime will be applied evenly over the surface and thoroughly blended into the natural silty clay soils at a rate of 5kg of ag-lime/tonne of dry soil. • If site excavation works extends below 6m then additional investigative works will be required. • The above liming rates are based on a factor of safety of 1.5 and the use of good quality fine ag-lime with a neutralising value of 100%. • When incorporation of the lime is complete, Chromium Suite validation testing of the treated spoil will be carried out to establish that sufficient ag-lime has been added to neutralise the quantities of actual and potential acidity within the spoil. Chromium Suite validation testing will be carried out at a rate of one test/500m^3 of treated spoil. Each Chromium Suite validation test will be deemed to have passed if the net acidity is <10 moles H+/tonne or <0.02%S equivalent. A higher net acidity result will require the application of additional ag-lime until a satisfactory net acidity result has been achieved. • Once lime treatment is complete, the treated spoil may then be stockpiled for later use for landscaping, for general site fill requirements or disposed off-site (as appropriate). • The exposed natural soil surface in the base of excavations should be lime treated with a liming rate of 5 kg/square metre. • Should the proposed depth of excavation or disturbance extend below 6m in depth, then additional ASS testing will be required to determine the required liming rate based on SPOCAS or Chromium Suite test methods. Selection of the most appropriate test methods and determination of liming requirements for neutralisation will be determined by the ASS consultant. • Lime-treated stockpiled soil shall have sediment fences and/or hay bales placed downslope to intercept any eroded material. Earthen bunds shall be constructed downslope of any filled or stockpile areas to divert run-off/drainage to a temporary retention pond. All retained waters would then be tested before entering the site stormwater system and/or adjacent waterways. <u>ASS Treatment Off-Site</u> Where ASS is required to be treated off-site, treatment of the ASS will be undertaken either: • in accordance with the provisions of this ASSMP for on-site treatment, modified as necessary for use at an accessible alternative off-site treatment area; or • in accordance with the ASSMP for the designated off-site treatment area. **Groundwater Monitoring** Bulk excavation works during construction is anticipated to extend to the groundwater table. The water quality of any seepage will be required to be determined prior to discharge. If the water quality falls outside the performance indicators (described below) the water will be treated prior to discharge from site.

Tasks/Actions (Cont'd)	**Groundwater Treatment** Groundwater treatment will be undertaken where the performance indicators are not met, this may involve the addition of lime to adjust the pH (Ag-lime should be used in order to control the speed and extent of reaction); where the turbidity requires adjustment, a flocculant (e.g. Alum) should be applied and the water re-tested prior to off-site release.
Performance Indicators	Treated ASS Chromium Suite testing carried out for validation of applied liming rates will be deemed to be acceptable if the net acidity level recorded is <10 moles H^+/tonne or <0.02 %S equivalent. Retained Water / Treated Groundwater Laboratory testing of retention basin/tank drainage water will be carried out for pH, dissolved oxygen and turbidity. Levels of these parameters considered acceptable are as follows: pH 6.5 to 8.5 pH units Turbidity <20NTU Dissolved Oxygen >80% saturated
Frequency/Timing	Treated ASS The sampling and testing of any lime treated ASS will be subject to validation testing which will be repeated until satisfactory results are obtained. Retained Water When run-off accumulates, water quality in drains or retention basins/tanks will be monitored regularly during the construction period, particularly following substantial rainfall events. Retained water will be sampled, tested and treated to a level acceptable for discharge to external waterways. Treated Groundwater Prior to off-site release, treated groundwater will be re-tested to assess compliance with the performance indicators, if the results of this testing do not indicate compliance, further treatment should be undertaken and the water re-tested until compliance with the performance indicators is attained.
Contingency Plan	If lime treatment of ASS is unsuccessful whereby performance targets are not being met as indicated by the validation testing and water quality testing procedures then: • the earthworks schedule will be reassessed and action taken to determine the problems causing the breach of standards; • if the problems are related to ineffective implementation of the ASSMP, then the plan will be audited by a person nominated by the Project Manager to ensure improved implementation. Monitoring and testing will be increased to ensure compliance with the established standards; and • any significant changes to the ASSMP will be subject to discussions with the relevant regulatory authorities.
Responsibility	The satisfactory implementation of the ASSMP is the responsibility of the Principal Contractor.

Reporting	The Principal Contractor shall report to the Project Manager on: • the effectiveness of the operating strategies; • problems in implementing the ASSMP management strategies; • compliance with testing requirements, run-off control and materials handling; and • effectiveness of any corrective action adopted.