Douglas Partners
Geotechnics / Environment / Groundwater

Acid Sulphate Soil Management Plan

Proposed Northbank Enterprise Hub
Business and Industrial Park
Lot 1001 DP 1127780, 365 Tomago Road, Tomago

Prepared for
ADW Johnson Pty Ltd
On behalf of
Northbank Enterprise Hub

Project 49608.02
August 2012

Integrated Practical Solutions

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	49608.02	Document No.	1
Document title	Acid Sulphate Soil Management Plan Proposed Northbank Enterprise Hub Business and Industrial Park		
Site address	Lot 1001 DP 1127780, 365 Tomago Road, Tomago		
Report prepared for	ADW Johnson Pty Ltd		
File name	P:\49608.02\Docs\49608.02 - ASSMP.doc		

Document status and review

Revision	Prepared by	Reviewed by	Date issued
0 (Draft)	Michael Wroblewski Matthew Blackert	Stephen Jones	7 August 2012
1 (Final)	Michael Wroblewski	Stephen Jones	15 August 2012

Distribution of copies

Revision	Electronic	Paper	Issued to
0 (Draft)	1	0	Scott Day, ADW Johnson Pty Ltd
1 (Final)	1	3	Scott Day, ADW Johnson Pty Ltd

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		15 August 2012
Reviewer		15 August 2012

NCS INTERNATIONAL
CERTIFIED
QUALITY
MANAGEMENT SYSTEM

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Region MC NSW 2310
Phone (02) 4960 9600
Fax (02) 4960 9601

Table of Contents

Acid Sulphate Soil Management Plan
Proposed Northbank Enterprise Hub Business and Industrial Park
Lot 1001 DP 1127780, 365 Tomago Road, Tomago

1. Introduction

This Acid Sulphate Soil Management Plan (ASSMP) has been prepared for the proposed Northbank Enterprise Hub development at Lot 1001 DP 1127780, 365 Tomago Road, Tomago, New South Wales. The ASSMP was prepared at the request of ADW Johnson Pty Ltd (ADW) on behalf of Northbank Enterprise Hub. It is understood that the ASSMP will form part of the overall Contractor Environmental Management Plan (CEMP) for construction of the project.

It is understood that the Northbank Enterprise Hub is a proposed business and industrial park. The main features of the proposed development are:

- Filling of the majority of the site to surface levels above the 1:100 flood levels. The design finished surface level of the fill platform is expected to be about RL 2.5 to 4.8 AHD, therefore requiring about 2 m to 5 m depth of fill;
- Construction of a low permeability perimeter berm, with a crest level of 1.2 AHD;
- Construction of an open drain with invert level 0.5 m below natural surface level, running the full length of the common boundary between the subject site (Lot 1001) and adjacent 'environment conservation' zone to the south-east (Lot 1002);
- An overflow wetland rehabilitation area, with an adjoining pond and drains excavated below natural surface level;
- Construction of internal open channel drains between allotments, generally constructed within the fill profile;
- Construction of internal roads to service the allotments.

The site will require a substantial amount of fill material to raise the ground to the design levels. It is understood from ADW that the fill material will most likely be sand from the Salt Ash area, however will be dependent on availablilty and cost at the time of construction.

The ASSMP was prepared to provide the following information:

- Acid sulphate soil management strategies;
- Monitoring program for soil and water quality;
- Contingency procedure.

The results of the Stage 2 Contamination Assessment undertaken at the site (Ref 1) and the results of additional detailed laboratory analysis have been used in formulating this ASSMP. Reference has also been made to the NSW Acid Sulphate Soil Management Advisory Committee (ASSMAC), August 1998 (Ref 2) and the Queensland Acid Sulphate Soil Technical Manual, Soil Management Guidelines (QASSIT), November 2002 (Ref 3), and recent experience with similar works in acid sulphate soils.

Reference to the Beresfield and Williamtown Acid Sulphate Soil Risk Map prepared by the Department of Infrastructure, Planning and Natural Resources (DIPNR) indicates that the site lies within two acid sulphate soil risk zones. The majority of the site lies within an area of high risk of acid sulphate conditions between 1 m to 3 m below the ground surface (Ap4 – alluvial plain, elevation 2 m - 4 m), while the north-western portion of the site (raised sandy area within 100 m to 200 m of Tomago Road) lies within an area of low probability of acid sulphate soil conditions greater than 3 m below the ground surface (Wa4(p) – Aeolian sandplain, elevation >4 m).

2. Summary of Acid Sulphate Soil Conditions

The acid sulphate screening results conducted for the Stage 2 Contamination Assessment (Ref 1) have been reproduced in Table 1, below. A total of 129 samples collected from 27 bores or pits were tested for pH in water (pH_F), and pH in water following oxidation (pH_{FOX}) with hydrogen peroxide (H_2O_2), using a calibrated pH meter in the Douglas Partners Pty Ltd (DP) laboratory. These screening tests were undertaken with reference to the *NSW Acid Sulphate Soil Management Advisory Committee (ASSMAC),Acid Sulphate Soil Manual* (Ref 2).

Table 1: Results of Acid Sulphate Soil Screening Tests

Sample ID	Sample Depth [a] (m)	Sample Description	Screening Test Results			
			pH			Strength of Reaction [b]
			pH_F	pH_{FOX}	pH_F-pH_{FOX}	
Bore 2	0.1	Sand	7.4	4.5	2.9	2, F
	0.25	Sand	7.4	4.3	3.1	2, F
	0.5	Sand	7.5	5.1	2.4	1-2
	1.0	Sand	6.6	5.8	0.8	1
	1.5-1.95	Sand	6.8	4.6	2.2	1
Bore 3	0.5	Sand	7.5	3.3	4.2	1, CC
	1.0	Sand	6.3	3.2	3.1	1
	1.5-1.95	Sand	6.4	2.8	3.6	1, CC
	3-3.45	Sand	6	2.8	3.2	1, CC
Bore 5	0.25	Filling	5.5	3.9	1.6	1
	0.5	Sand	5.9	4.3	1.6	1
	1.0	Sand	5.5	4.5	1	1
	1.5-1.95	Sand	5.6	4.1	1.5	1
	3-3.45	Sand	6.4	3.9	2.5	1
Bore 6	0.5	Sand	5.7	4.7	1	1-2, F
	1.0	Sand	5.9	4.8	1.1	1
	1.5-1.95	Sand	6.2	5.5	0.7	1
	3.2-3.65	Sand	6.7	2.8	3.9	1-2, F, CC
Bore 8	0.25	Filling	5.6	2.9	2.7	1, F
	0.5	Sand	5.7	3	2.7	1, F
	1.0	Sand	5.6	4	1.6	1, CC
	1.5-1.95	Sand	6.1	3.6	2.5	1, CC
	3-3.45	Sand	5.9	2.8	3.1	1
Bore 9	0.1	Filling	5.8	4	1.8	1-2, F
	0.5	Filling	6.2	4.1	2.1	1-2, F
	1.0	Filling	6.9	5.1	1.8	1-2, F
	1.5-1.8	Filling	6.6	5.4	1.2	1-2, F
	1.9-2.0	Clay	6.6	5.3	1.3	1-2, F
	3-3.45	Clay	6.1	3.9	2.2	3, F, H, O
Bore 10	0.1	Filling	6.2	3.9	2.3	1-2, F
	0.5	Filling	6.2	6.1	0.1	1-2, F
	1.0	Clayey sand	7.4	6.6	0.8	1-2, F
	1.5-1.95	Clayey sand	7.4	6.5	0.9	1
	3.0	Clay	6.8	6.4	0.4	1-2, F
	4.5-4.95	Sandy clay	7.1	6.5	0.6	1, F
	6.0	Sand	7.7	4.1	3.6	1, CC
	8.0	Sand	6.1	3.1	3	1, CC
Bore 11	0.5	Clay	6.9	6.8	0.1	1
	1.0	Clayey sand	7.3	4.8	2.5	1-2, F
	1.5-1.95	Clay	7.2	2.7	4.5	4, F, H
	3-3.45	Sand	6.1	2.8	3.3	1
Bore 12	1	Clay	7	4.1	2.9	2, F
	1.5-1.95	Sandy clay	6.5	4.4	2.1	1-2, F
	3-3.45	Clay	8.2	2.8	5.4	4, F, H

Table 1: Results of Acid Sulphate Soil Screening Tests (continued)

Sample ID	Sample Depth ^{a} (m)	Sample Description	Screening Test Results			
			pH			Strength of Reaction ^{b}
			pH_F	pH_{FOX}	pH_F-pH_{FOX}	
Bore 13	0.05	Silty clay	7.2	4.1	3.1	1-2, F
	0.5	Sandy clay	7.4	6.6	0.8	1
	1.0	Sandy clay	7	6.6	0.4	1-2, F
	1.5-1.95	Silty clay	7.6	2.8	4.8	4, F, H
	3-3.45	Silty clay, shells	8.7	7.4	1.3	1-2, F
Bore 14	0.5	Silty clay	7	5.1	1.9	1
	1.0	Clayey sand	7	5.3	1.7	1, F
	1.5-1.95	Sand	6.8	6.1	0.7	1
	3-3.45	Clay	7.4	6.6	0.8	1-2, F
	4.5-4.95	Clay	8.1	7.3	0.8	1-2, F
	6-6.45	Clay	8.2	7.6	0.6	1-2, F
	7.5-7.95	Clayey sand	8.7	7.4	1.3	1, F
	9-9.45	Clayey sand	8.4	2.3	6.1	1, F, CC
Bore 15	0.05	Silty clay	7	3.6	3.4	2, F
	0.5	Silty clay	7.3	6.8	0.5	1-2, F
	1.0	Clayey sand	7.2	6.6	0.6	1
	1.5-1.95	Clayey sand	7.1	2.4	4.7	1
	3-3.45	Clayey sand	9.5	7.2	2.3	1
Bore 16	0.05	Silty clay	6.8	4.8	2	1-2, F
	0.25	Clay	6.4	4.8	1.6	1-2, F
	0.5	Clay	6.2	5.1	1.1	1
	1.0	Sandy clay	6	4.2	1.8	1
	1.5-1.95	Sandy clay	5.9	2.5	3.4	3-4, F, H
	3-3.45	Silty clay	7.9	5.1	2.8	2-3, F
Bore 17	0.05	Silty clay	8.3	4.3	4	1, F
	0.5	Sand	7.5	4.8	2.7	1, F
	1.0	Sand	6.8	4.4	2.4	1
	1.5-1.95	Sand	6.5	2.6	3.9	1, F
	3-3.45	Silty clay	6.9	5.9	1	1, F
Bore 18	0.05	Silty clay	6.4	4.1	2.3	1, F
	0.5	Silty clay	7.2	5.1	2.1	1, F
	1.0	Clayey sand	6.5	3.8	2.7	1, F
	1.5-1.95	Sandy clay	6.8	2.6	4.2	1, F
	3-3.45	Sandy clay	7.2	3.2	4	1, F
Bore 20	0.05	Silty clay	6.2	3.9	2.3	1-2, F
	0.5	Silty clay	7.2	4.8	2.4	1
	1.0	Sandy clay	5.5	4.2	1.3	1
	1.5-1.95	Sandy clay	6.2	2.4	3.8	3-4, F, H, O, CC
	3-3.45	Silty clay	7.5	6	1.5	1-2, F
	6-6.45	Sandy clay	8.3	7.1	1.2	1, F
	7.5-7.95	Clayey sand	8.5	7.4	1.1	1
	9-9.45	Sand	8.4	2.7	5.7	1, CC

Table 1: Results of Acid Sulphate Soil Screening Tests (continued)

Sample ID	Sample Depth [a] (m)	Sample Description	Screening Test Results			
			pH			Strength of Reaction [b]
			pH_F	pH_{FOX}	pH_F-pH_{FOX}	
Bore 21	0.05	Silty clay	4.4	2.1	2.3	2, F
	0.5	Silty clay	4.5	2.9	1.6	4, F, H
	1.0	Silty clay	5.8	3.3	2.5	2, F, CC
	1.5-1.95	Silty clay	5.7	2.4	3.3	4, F, H
	3-3.45	Silty clay	8.3	6.7	1.6	3-4, F, H
Bore 22	0.05	Silty clay	6.3	2.9	3.4	2, F
	0.5	Silty clay	4.4	2.6	1.8	2, F
	1.0	Silty clay	5.7	2.9	2.8	2, F
	1.5-1.95	Silty clay	6.4	2.6	3.8	4, F, H
Pit 30	0.25	Clay	7.6	5.7	1.9	4, F, H
	0.5	Clay	7.1	5.5	1.6	1-2, F
	1.0	Clay	7.3	6.3	1	1-2, F
	1.5	Clay	7.3	6.8	0.5	1
Pit 63	0.25	Topsoil, clay	7.4	4	3.4	2, F
	0.5	Clay	6.9	6.2	0.7	1-2, F
	1.0	Clay	6.9	6.8	0.1	1
	1.5	Clay	7.1	6.8	0.3	1
Pit 70	0.25	Sand	5.8	3	2.8	1
	0.5	Sand	5.8	4	1.8	1
	1.0	Clayey sand	6.1	5.4	0.7	1
	1.5	Clayey sand	6.5	5	1.5	1
Pit 71	0.05	Filling	6.7	3.3	3.4	2, F
	0.25	Clay	6.2	3.5	2.7	2, F
	0.5	Clay	6.7	3.9	2.8	2, F
	1.0	Clay	8.3	7.3	1	3-4, F, H
	1.3	Clay	8.2	6	2.2	1
	1.5	Sand	7.3	6.5	0.8	1
Pit 74	0.05	Topsoil, clay	6.4	4	2.4	2-3, F, H
	0.25	Clay	6.4	4.9	1.5	3-4, F, H
	0.5	Clay	6.7	4.8	1.9	2-3, F, H
	1.0	Clay	6.8	6.5	0.3	4, F, H
Pit 78	0.5	Filling	7.8	7.8	0	4, F, H
	1.0	Clay	7.8	7.3	0.5	2, F
	1.5	Clay	7.8	4.8	3	2-3, F, H
Pit 90	0.05	Silt and organics	5	3.2	1.8	4, F, H, CC
	0.25	Silty clay	6.4	3	3.4	4, F, H, CC
	0.45	Clay	4.7	2.9	1.8	1-2, F
Pit 98	0.05	Silty clay	6.9	4.5	2.4	2-3, F
	0.25	Clay	6.6	5.5	1.1	2-3, F
	0.45	Clay	6.8	5.3	1.5	2-3, F
Pit 117	0.05	Silty sand	5.8	2.9	2.9	1-2, F
	0.25	Silty sand	5.6	2.8	2.8	1-2, F
	0.45	Silty sand	5.7	3.3	2.4	1-2, F
Guideline		Sands to loamy sands	$<4^d$	$<3.5^e$	$\geq 1^e$	-
		Sandy loams to light clays				
		Medium to heavy clays and silty clays				

Notes to Table 1:

a Depth below ground surface

b Strength of Reaction

- 1 denotes no or slight reaction
- 2 denotes moderate reaction
- 3 denotes high reaction
- 4 denotes very vigorous reaction
- F denotes bubbling/frothy reaction indicative of organics
- H denotes heat generated
- O denotes odour detected
- CC denotes colour change observed

d For actual acid sulphate soils (ASS)

e Indicative value only for Potential Acid Sulphate Soils (PASS)

Shaded results indicate an exceedence of ASSMAC/QASSMAC criteria (Ref 2)

pH_f - Soil pH Test (1:5 soil:distilled water)

pH_{FOX} - Soil Peroxide pH Test (1:4 soil:distilled water following oxidation of soil with 30% hydrogen peroxide (H202))

The results of acid sulphate soil screening tests generally suggested the presence of potential acid sulphate soil conditions within natural sands and clays.

Based on the results of the screening tests, 30 soil samples were selected for detailed laboratory testing, comprising the Full Chromium Suite in accordance with QASSIT guidelines (Ref 4).

Detailed analysis results are contained in the laboratory report sheets provided in Appendix B, and are summarised in Table 2 below.

Table 2: Results of Detailed Acid Sulphate Analysis

Sample ID	Sample Depth [a] (m)	Sample Description	Screening Test Results				Laboratory Results						
			pH			Strength of Reaction [b]	pH_{KCL}	Scr %S	s-TAA %S	S_{NAS} %S	s-ANC$_{BT}$ %S	s-C$_{IN}$ %S	Net Acidity [c] %S
			pH_F	pH_{FOX}	pH_F-pH_{FOX}								
Bore 2	0.25	Sand	7.4	4.3	3.1	2, F	5.3	0.01	0.01	<0.005	<0.05	NA	0.03
	1.5-1.95	Sand	6.8	4.6	2.2	1	5.7	0.02	0.10	<0.005	<0.05	NA	0.12
Bore 3	1.5-1.95	Sand	6.4	2.8	3.6	1, CC	4.7	0.06	0.02	<0.005	<0.05	NA	0.08
Bore 5	3-3.45	Sand	6.4	3.9	2.5	1	5.3	0.01	0.01	<0.005	<0.05	NA	0.03
Bore 6	3.2-3.65	Sand	6.7	2.8	3.9	1-2, F, CC	5.1	0.06	<0.01	<0.005	<0.05	NA	0.07
Bore 8	0.5	Sand	5.7	3	2.7	1, F	4.7	0.02	0.02	<0.005	<0.05	NA	0.04
	3-3.45	Sand	5.9	2.8	3.1	1	5.0	0.04	0.01	<0.005	<0.05	NA	0.05
Bore 10	0.1	Filling	6.2	3.9	2.3	1-2, F	5.1	0.02	0.01	0.009	<0.05	NA	0.04
	8.0	Sand	6.1	3.1	3	1, CC	5.7	0.02	<0.01	<0.005	<0.05	NA	0.03
Bore 11	1.5-1.95	Clay	7.2	2.7	4.5	4, F, H	7.9	0.25	<0.01	<0.005	0.95	NA	<0.01
Bore 12	3-3.45	Clay	8.2	2.8	5.4	4, F, H	6.4	0.86	<0.01	<0.005	<0.05	NA	0.86
Bore 13	1.5-1.95	Silty clay	7.6	2.8	4.8	4, F, H	8.0	0.46	<0.01	<0.005	1.60	NA	<0.01
Bore 14	0.5	Silty clay	7	5.1	1.9	1	4.8	0.02	0.02	0.011	<0.05	NA	0.05
Bore 15	1.5-1.95	Clayey sand	7.1	2.4	4.7	1	7.8	0.25	<0.01	<0.005	0.47	NA	<0.01
Bore 16	1.5-1.95	Sandy clay	5.9	2.5	3.4	3-4, F, H	6.5	0.34	<0.01	<0.005	<0.05	NA	0.33
Bore 17	1.5-1.95	Sand	6.5	2.6	3.9	1, F	5.4	0.09	<0.01	<0.005	<0.05	NA	0.10
Bore 18	1.5-1.95	Sandy clay	6.8	2.6	4.2	1, F	4.9	0.31	0.10	<0.005	<0.05	NA	0.41
Bore 20	1.5-1.95	Sandy clay	6.2	2.4	3.8	3-4, F, H, O, CC	4.4	0.96	0.04	0.007	<0.05	NA	1.00
	9-9.45	Sand	8.4	2.7	5.7	1, CC	7.4	0.06	<0.01	<0.005	0.07	0.21	0.01
Bore 21	0.05	Silty clay	4.4	2.1	2.3	2, F	3.3	0.01	0.32	0.42	<0.05	NA	0.75
Bore 22	1.5-1.95	Silty clay	6.4	2.6	3.8	4, F, H	5.8	0.48	<0.01	<0.005	<0.05	NA	0.49
Pit 63	0.25	Topsoil, clay	7.4	4	3.4	2, F	5.1	0.007	0.01	0.006	<0.05	NA	0.03
Pit 70	0.25	Sand	5.8	3	2.8	1	4.4	<0.005	0.02	<0.005	<0.05	NA	0.03
	1.5	Clayey sand	6.5	5	1.5	1	5.1	<0.005	0.01	<0.005	<0.05	NA	0.01
Pit 71	0.05	Filling	6.7	3.3	3.4	2, F	5.0	0.01	0.01	0.007	<0.05	NA	0.03
	0.25	Clay	6.2	3.5	2.7	2, F	4.9	0.006	0.01	0.006	<0.05	NA	0.02

Table 2: Results of Detailed Acid Sulphate Analysis (continued)

Sample ID	Sample Depth[a] (m)	Sample Description	Screening Test Results				Laboratory Results						
			pH			Strength of Reaction[b]	pH_{KCL}	Scr %S	s-TAA %S	S_{NAS} %S	s-ANC_{BT} %S	s-C_{IN} %S	Net Acidity[c] %S
			pH_F	pH_{FOX}	pH_F-pH_{FOX}								
Pit 78	1.5	Clay	7.8	4.8	3	2-3, F, H	6.0	0.006	<0.01	<0.005	<0.05	NA	0.01
Pit 90	0.25	Silty clay	6.4	3	3.4	4, F, H, CC	4.1	0.01	0.06	0.023	<0.05	NA	0.10
Pit 98	0.05	Silty clay	6.9	4.5	2.4	2-3, F	5.4	0.007	0.01	0.014	<0.05	NA	0.04
Pit 117	0.45	Silty sand	5.7	3.3	2.4	1-2, F	4.7	<0.005	0.01	<0.005	<0.05	NA	0.02
Guideline		Sands to loamy sands	<4[d]	<3.5[e]	≥1[e]	-	-	-	-	-	-	-	0.03
		Sandy loams to light clays											0.06[f]/0.03[g]
		Medium to heavy clays and silty clays											0.1[f]/0.03[g]

Notes to Table 2:

a Depth below ground surface

b Strength of Reaction

- 1 denotes no or slight reaction
- 2 denotes moderate reaction
- 3 denotes high reaction
- 4 denotes very vigorous reaction
- F denotes bubbling/frothy reaction indicative of organics
- H denotes heat generated
- O denotes odour detected
- CC denotes colour change observed

c Calculated by the laboratory from ABA equation in ASS Laboratory Methods Guidelines (Ref 4)

d For actual acid sulphate soils (ASS)

e Indicative value only for Potential Acid Sulphate Soils (PASS)

f ASSMAC Action Criteria for disturbance of 1-1000 tonnes of material

g ASSMAC Action Criteria for disturbance of more than 1000 tonnes of material

Shaded results indicate an exceedence of QASSIT criteria (Ref 4)

The results of detailed laboratory analysis indicate that acid sulphate soils are present within the site, with Net Acidity values above the QASSIT action criteria (Ref 4) for disturbance of more than 1000 tonnes of material, for 22 of the 30 samples tested.

Given the sensitive nature of the site (i.e. adjacent SEPP 14 conservation zone) and the widespread distribution of identified acid sulphate soils within the site, as a precautionary measure and for practical purposes it is recommended to treat all soils likely to be disturbed by the proposed works as acid sulphate soils.

For construction purposes, disturbance of all soils (either by excavation or dewatering) below the ground surface should be treated as acid sulphate soils and managed under the guidance of this ASSMP.

The Stage 2 Contamination Assessment (Ref 1) indicated subsurface conditions varied across the site. The north-western portion of the site along Tomago Road typically comprised filling and sands with trace to abundant rootlets to depths of 0.15 m. Subsurface conditions across the remainder of the site typically comprised clay, sandy clay, silty clay and clayey sand to depths of between 4.9 m and 8.5 m, underlain by sand up to termination at 13.5 m depth.

Full details subsurface conditions at the site, including borehole logs are found in Ref 1. A copy of the test location plan from Ref 1 is provided in Appendix C.

Groundwater was encountered at all bore and test pit locations (except Pit 63) from a depth of 0.1 m above ground level to 1.4 m below ground level during drilling and test pitting between 26 July 2011 and 10 August 2011. Groundwater levels were subsequently measured prior to purging within PVC standpipes between 16 and 23 August 2011. The water levels and the results of groundwater testing undertaken in the field using calibrated portable meters is presented in Table 3, below. It should be noted that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

Table 3: Groundwater Level and pH/EC Measurements - 16 to 23 August 2011

Bore	RL Ground Surface (m AHD)	RL Top of Casing (m AHD)	Depth of Groundwater Below Top of Casing	RL Groundwater (m AHD)	pH	EC (mS/cm)
2	3.015	3.99	1.621	2.37	5.3	0.3
3	1.513	2.43	1.024	1.40	5.8	0.3
5	3.129	4.16	1.665	2.50	5.0	0.3
6	2.208	3.03	1.123	1.90	5.7	0.4
8	2.158	3.25	1.433	1.82	5.3	0.4
10-U	1.470	2.46	2.014	0.45	6.9	8.8
10-L	1.470	2.64	2.318	0.32	5.9	1.2
11	0.907	1.81	0.912	0.89	6.5	0.5
12	1.298	2.11	1.237	0.87	7.0	2.4
13	0.638	1.44	0.903	0.54	6.7	18.9
14-U	0.570	1.65	1.260	0.39	6.5	14.3
14-L	0.570	1.66	1.450	0.21	7.3	45.6
15-U	0.715	1.59	0.887	0.71	6.8	1.2
15-L	0.715	1.73	0.994	0.74	5.6	0.8
16	0.533	1.42	0.914	0.51	6.4	16.0
17	0.550	1.57	1.116	0.45	6.5	15.0
18	0.799	2.24	1.427	0.81	6.8	0.4
20-U	0.715	1.58	1.148	0.44	6.4	22.6
20-L	0.715	2.04	1.645	0.39	6.9	39.4
21	0.530	1.32	1.031	0.29	6.3	27.2
22	0.681	1.65	1.425	0.23	6.3	19.0

Notes to Table 3:

Top of Casing – top of PVC Standpipe Casing

EC – Electrical Conductivity

U – well screened in upper clays

L – well screened in lower sands

3. Potential for Oxidising Acid Sulphate Soils

The following activities may expose acid sulphate soils to oxidising conditions during construction:

- Excavations for construction including excavation of ponds, drains, pits and other waterways where these extend into the natural soils;
- Dewatering of excavations, if required during the construction works;
- Stripping and/or stockpiling of existing soil or fill material, such as for landscaping, construction of roads and similar works;
- Disturbance of vegetation cover.

The NSW Office of Water requested comment on the likelihood of a lower water table beneath the filled area, potentially resulting in exposure of PASS. Filling the site is expected to result a general increase in water level such that the water table is likely to sit within the fill horizon. This will occur due to boundary condition groundwater levels, even though the majority of the developed area will have low-permeability surfaces (buildings and pavements). Consequently, filling and capping the site is expected to reduce the risk of PASS becoming exposed after construction of the development.

4. Management Strategy

4.1 Soil Treatment

Neutralisation of acid sulphate soils (ASS) should be undertaken in accordance with the ASSMAC and QASSIT guidelines. It will be necessary to set up a suitable treatment area on site, as described below.

The excavated material should be contained within a suitable bunded area with an impermeable base and appropriately neutralised prior to re-use on-site. Alternatively the treatment area could be prepared as follows, provided soils can be treated/neutralised within 12 hours of excavation:

- Strip surface vegetation within area to be used for treatment/stockpiling of ASS;
- Conduct baseline inspection and testing within the treatment area:
    - Confirm that low permeability soils (i.e. clayey soils) are present at the surface; areas of sandy or highly permeable surface soils should be avoided for treatment of ASS where possible within the treatment area;
    - Baseline ASS screening tests (i.e. measurement of soil pH in distilled water and following oxidation with peroxide) on surface soils on a 10 x 10m grid;
    - Testing of groundwater pH within the general area and at the lowest point/proposed sump location within the area (via temporary standpipes).
- Conduct baseline pH testing of surface waters in the vicinity of the treatment area (adjacent to, up-gradient and down-gradient of possible overland flows (surface water migration pathways) from the treatment area;

- Broadcast a layer of agricultural lime over the ground surface to be used for treatment/stockpiling (1 to 2 kg/m^2). Re-application of lime may be required if this layer is disturbed or removed during treatment of soils;
- Construct perimeter bunding (i.e. using stripped surface soils) around the treatment area to a minimum height of 300 mm to prevent run-off, run-on. The soils utilised for the bunding should be limed at the rates as discussed below, as a contingency measure to minimise the potential for acid generation and to assist in neutralisation of any leachate/runoff coming into contact with the bunding:
  - North-western zone (along Tomago Road), (typically comprising sands) – 1 to 13 kg/m^3 (recommended rate 3 kg/m^3) of soil;
  - Remainder of site (typically comprising clays) – 1 to 82 kg/m^3 (recommended rate 18 kg/m^3) of soil.
- Construct a catch drain/sump at the lowest point on the inside of the bund to collect run-off/leachate from the treatment area. The base of the sump should be inspected and must comprise low permeability (i.e. clayey) soils. The surface of the sump/catch drain should also be limed with 1 to 2 kg/m^2 of agricultural lime;
- Install appropriate erosion and sediment control measures for the perimeter of the treatment area.

The Estuarine sands beneath the clay were typically encountered from depths ranging between 5.9 m and 10 m and are considered unlikely to be excavated during site development.

It is noted that the recommendations above for the preparation of the treatment area rely on ASS treatment being conducted within 12 hrs of excavation, together with baseline testing, and monitoring during treatment, in order to avoid requirements for impervious liners and imported materials. This strategy has been effective in previous projects with ASS.

If stockpiling of acid sulphate soils is required for longer periods prior to treatment (i.e. greater than 12 hours), the material should be contained within a suitable bunded area with an impermeable base, and appropriately neutralised prior to re-use. The location of the bunded area should be selected in order to minimise the potential for impact on nearby sensitive receptors. Any leachate produced in the bunded area should be contained for monitoring and treatment as discussed below.

Suitable neutralising agents for acid sulphate or potential acid sulphate soils include agricultural lime ($CaCO_3$), calcined magnesia (MgO or $Mg(OH)_2$), and dolomite ($MgCO_3.CaCO_3$).

An assessment of the dosing rate for lime treatment can be calculated from the results of detailed laboratory testing, using the following equation, which includes a factor of safety.

Alkali Material Required (kg)

per unit volume of soil $(m^3) = \left(\frac{\%\,S \text{ x } 623.7}{19.98}\right) \text{ x } \frac{100}{\text{ENV}(\%)} \text{ x } D \text{ x } FOS$

Where: *%S = net acidity (% S units);*

623.7 = % S to mol H^+/t;

19.98 = mol H^+/t *to kg* $CaCO_3/t$;

D = Bulk density of soil (t/m^3);

FOS = safety factor (usually 1.5);

ENV = Effective Neutralising Value (eg. 80% for Grade 1 Agricultural lime).

Note: *The ENV is calculated based on the molecular weight, particle size and purity of the neutralising agent and should be assessed for proposed materials in accordance with ASSMAC (Ref 2).*

It is recommended that Grade 1 agricultural lime is used for the neutralisation of potential acid sulphate soils excavated during the construction.

The following liming/monitoring procedures for the treatment of ASS are recommended:

- All excavated soil should be contained within a suitably bunded area and kept moist to minimise oxidation, prior to treatment with lime. Progressive neutralisation will minimise the area required for bunding;
- The base and sides of permanent drains or ponds should be treated to a depth of 0.3 m as per excavated clay material (see below), by mixing and re-compaction.
- Stockpiled soil should be limed initially at a rate of about 3 kg/m^3 of soil (sand material in the north-western zone), or 18 kg/m^3 of soil (clay material across the remainder of the site) (2 kg and 13 kg lime/tonne of soil respectively) for neutralisation as soon as practicable following excavation. Lime treatment rates based on the detailed laboratory testing, attached ranged from 1 to 13 kg/m^3 (average 5 kg/m^3) of soil (sand material), and from 1.8 to 82 kg/m^3 (average 24 kg/m^3) of soil. Average lime rates of 3 kg/m^3 (sand material) and 18 kg/m^3 (clay material) are recommended initially, and should be refined based on monitoring results as construction proceeds;
- The neutralising agent and acid sulphate soils should be thoroughly mixed and aerated using, for example, an agricultural lime spreader and excavator. The soil should be treated in layers up to 300 mm thick to encourage aeration (i.e. incorporate treatment with progressive reuse of soil or disposal at a suitably licensed landfill);
- It should be noted that the actual lime rate required will also depend on the results of monitoring during neutralisation. Additional lime will be required if monitoring results indicate that appropriate neutralisation has not been achieved. Conversely the liming rate may decrease if monitoring suggests over liming is occurring;

- Sampling and testing should be undertaken in accordance with Section 5.1 to verify the neutralisation treatment. The acceptance criteria are discussed in Section 5.2. Depending on the results of testing, reapplication of lime may be necessary to gain adequate neutralisation;
- Upon verification of treatment, the neutralised acid sulphate soils should be either progressively reused on site at approved locations, or disposed of at a licensed landfill following confirmation of the waste classification by an appropriate qualified consultant.

Ongoing management of acid sulphate soils should generally not be required; however permanent drains should be subject to periodic checks of the pH of seepage water (i.e. water entering the drains from the sides) to confirm neutralisation is being maintained.

4.2 Neutralising Leachate

Leachate water collected from the bunded area should be neutralised as necessary before disposal. Calcined magnesia (magnesium hydroxide, burnt magnesite, or magnesia) is the recommended neutralising agent as it produces a two-step reaction, which proceeds rapidly at acidic pH and slows down as higher pH is approached, and hence reduces the potential for over neutralisation to occur.

The amount of neutraliser required to be added to the leachate can be calculated from the equation below:

$$\textit{Alkali Material Required (kg)} = \frac{M_{\text{Alkali}} \text{ x } 10^{-\text{pH initial}}}{2 \text{ x } 10^{3}} \text{ x } V$$

Where: *pH initial = initial pH of leachate*

V = volume of leachate (litres)

M_{Alkali} *= molecular weight of alkali material (g/mole)*

Note: *molecular weight of calcined magnesia (*M_{MgO}*) = 40 g/mole.*

The alkali should be added to the leachate as a slurry. Mixing of the slurry is best achieved using an agitator.

Notwithstanding regulatory authority requirements, the leachate should meet the water quality criteria presented in Section 5.2 prior to discharge.

4.3 Dewatering

Based on recent experience, the following procedure is recommended in order to minimise potential adverse impacts resulting from excavation and dewatering of acid sulphate soils during construction:

- Minimise the dewatering depth required for installation (i.e. as close as practicable to the invert level of the excavation);
- Minimise the time and volume of exposed acid sulphate soils (i.e. stage excavation and dewatering);
- Collection of extracted groundwater in a multi stage sedimentation tank and neutralise as necessary prior to release;
- The extracted groundwater could then be discharged to a bunded area or constructed permanent pond away from the dewatering site (i.e. evaporation/infiltration) or discharged to stormwater/sewer, subject to regulatory requirements;
- The pH of the extracted water should be monitored prior to discharge. Neutralisation should be undertaken, as discussed in Section 5.1.2, if discharge water pH falls below natural groundwater levels (evaporation/infiltration) or regulatory requirements (stormwater disposal);
- Dose the base of the excavation at a rate of approximately 1 kg/m^2 of Agricultural lime in order to counteract the generation of acidic leachate following groundwater recovery;
- Treat acid sulphate soils excavated during construction as discussed in Section 4.1;
- Undertake monitoring as recommended in Section 5 below.

5. Monitoring Strategies

5.1 Procedures

Monitoring programs for the various construction and treatment methods discussed are outlined below.

5.1.1 Soil Neutralisation / Management

It is recommended that the following inspections and monitoring be undertaken when excavating acid sulphate soil materials, based on guidelines presented in the ASSMAC and QASSIT manuals:

- Daily inspection of liming operations during excavation;
- Sampling and testing after lime treatment (i.e. measurements of soil pH in distilled water and pH following oxidation with peroxide) should be undertaken at a frequency of at least one sample per 10 m^3 excavated soil to verify the neutralisation treatment and confirm oxidation of acid sulphate soils is not occurring.

5.1.2 Leachate Management

Leachate collected within the bunded area should be temporarily stored and neutralised as necessary. The pH of the leachate should be monitored daily, and prior to discharge. The leachate could be discharged overland (i.e. evaporation/infiltration), or discharged to stormwater/sewer, subject to regulatory requirements and licences.

Neutralisation should be undertaken if discharge water pH falls below natural background groundwater levels (evaporation/infiltration) or regulatory requirements (stormwater or sewer discharge).

A contingency procedure should be in place to allow lime dosing and monitoring to confirm neutralisation prior to discharge.

5.1.3 Dewatering

Extracted groundwater should be temporarily stored, and neutralised as necessary. The pH of extracted water associated with areas of acid sulphate soils should be monitored twice daily (am, pm) prior to discharge. The groundwater could be discharged overland (i.e. evaporation/infiltration) as discussed in Section 4.3, or discharged to stormwater/sewer subject to regulatory requirements and licences.

Neutralisation should be undertaken if discharge water pH falls below natural background groundwater levels (evaporation/infiltration) or regulatory requirements (stormwater or sewer discharge). Natural groundwater pH should be confirmed at the commencement of dewatering.

A contingency procedure should be in place to allow lime dosing and monitoring to confirm that neutralisation has been achieved prior to discharge. Similarly, nearby creeks/drains should be periodically monitored for pH prior to and during construction.

5.1.4 Reporting

A record of treatment of acid sulphate soil and leachate should be maintained by the contractor and should include the following details:

- Date;
- Location;
- Time of excavation and reuse or disposal (ie. time stockpile has been exposed);
- Neutralisation process undertaken;
- Lime rate utilised;
- Results of monitoring of soil, leachate, and groundwater.

A record of dewatering activities should also include the following:

- Groundwater pH at commencement of dewatering;
- Daily pH monitoring of discharge water and surface waters in the vicinity of discharge (i.e. upstream and downstream).

A record should also be maintained confirming contingency measures and additional treatment if undertaken.

A final report should be issued upon completion of the works presenting the monitoring regime and results, and confirming that no adverse environmental impact has occurred during the works.

5.2 Acceptance Criteria

5.2.1 Water

Notwithstanding regulatory requirements, it is recommended that the pH of discharge waters from dewatering or leachate are within measured back ground groundwater pH levels (i.e. pH 5.0 – 7.4), and that the ANZECC Guidelines for Fresh and Marine Water Quality, 2000 (Ref 5) be considered before discharging any waters to the environment.

Background pH levels should be confirmed prior to commencement of works, and the acceptable range amended (if required).

5.2.2 Soil

Further treatment of soils may be required if monitoring of the material reveals any of the following properties:

- pH of soil in water is less than background values (ie typically pH 5.5 to 8.5 – Ref 1);
- pH in water minus pH in hydrogen peroxide is greater than 1 and pH in water is less than background values;
- pH of soil in hydrogen peroxide is greater than background (ie over-liming).

Depending on the results of testing, reapplication of lime may be necessary to gain adequate neutralisation. Care should be taken to ensure over liming does not occur.

6. Contingency Plan

Remedial action will be required if the standards or acceptance criteria outlined above are not being achieved. Remedial action shall comprise mixing of additional lime through the excavated material and neutralisation of leachate (if under-liming has occurred). If monitoring indicates that over-liming has occurred, additional ASS or leachate should be mixed to reduce pH to acceptable levels. The required mixing rate to treat the soil or leachate should be confirmed by monitoring tests.

If overland discharge of groundwater is proposed, a contingency plan should be in place to allow neutralisation and confirmation monitoring prior to discharge if pH levels are low or fall below natural background levels.

During periods of heavy or prolonged rainfall, stockpiling of acid sulphate soils should be appropriately contained/bunded to collect leachate for testing and neutralisation (if required) prior to disposal (see Section 4.1). Alternatively, backfilling of acid sulphate soils could be undertaken to prevent the migration of leachate.

Sufficient lime should be stored on site during construction for the neutralisation of acid sulphate soils and contingency measures.

7. Conclusions

The principal findings of the acid sulphate soil assessment are:

- potential acid sulphate soils are widely present within the natural soils at this site;
- all natural soils disturbed either by excavation or dewatering should be treated as acid sulphate soils and managed under the guidance of this ASSMP;
- appropriate treatment methodologies and liming rates are provided within to manage and neutralise acid sulphate soils; it will be necessary to set up a suitable treatment area on site;
- filling and capping the site is expected to reduce the risk of PASS becoming exposed after construction, due to water levels rising to sit within the fill horizon.

8. References

1. Douglas Partners Pty Ltd “Report on Stage 2 Contamination Assessment, Proposed Northbank Enterprise Hub, Lot 1001, DP 1127780, 365 Tomago Road, Tomago”, Project 49608.01, October 2011.

2. ASSMAC “ASSMAC Acid Sulphate Soil Manual”, New South Wales Acid Sulphate Soil Management Advisory Committee, August 1998.

3. Dear SE, Moore NG, Dobos SK, Watling KM and Ahern CR, “Soil Management Guidelines” in “Queensland Acid Sulphate Soil Technical Manual”, Department of Natural Resources and Mines, November 2002.

4. Ahern CR, Sullivan LA and McElnea AE, “Acid Sulphate Soils Laboratory Methods Guidelines” in “Queensland Acid Sulphate Soil Technical Manual”, Department of Natural Resources and Mines, June 2004.

5. ANZECC 2000): Australian Water Quality Guidelines for Fresh and Marine Waters, November 2000.

9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Lot 1001 DP 1127780, 365 Tomago Road, Tomago in accordance with DP’s proposal NCL120312 Rev 1 dated 19 July 2012 and acceptance received from Kurt Robinson dated 23 July 2012. The work was carried out under DP’s

Conditions of Engagement. This report is provided for the exclusive use of Northbank Enterprise Hub for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and / or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and /or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About this Report

About this Report

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

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

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.

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

Laboratory Test Results

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

CERTIFICATE OF ANALYSIS 60582

Client:

Douglas Partners Newcastle
Box 324 Hunter Region Mail Centre
Newcastle
NSW 2310

Attention: Matthew Blackert / Angela Peade

Sample log in details:

Your Reference:	**49608.01, Tomago**
No. of samples:	30 Soils
Date samples received / completed instructions received	25/08/11 / 25/08/11

Analysis Details:

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

Report Details:

Date results requested by: / Issue Date:	2/09/11 / 2/09/11
Date of Preliminary Report:	Not Issued

NATA accreditation number 2901. This document shall not be reproduced except in full.
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

M. Mansfield
Matt Mansfield
Approved Signatory

Chromium Suite						
Our Reference:	UNITS	60582-1	60582-2	60582-3	60582-4	60582-5
Your Reference	-------------	Bore 2/0.25	Bore 2/1.5-1.95	Bore 3/1.5-1.95	Bore 5/3-3.45	Bore 6/3.2-3.65
Date Sampled	------------	1/08/2011	1/08/2011	29/07/2011	27/07/2011	26/07/2011
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_{kcl}	pH units	5.3	5.7	4.7	5.3	5.1
s-TAA pH 6.5	%w/w S	0.01	0.10	0.02	0.01	<0.01
TAA pH 6.5	moles H^+/t	7	64	11	8	<5
Chromium Reducible Sulfur	%w/w	0.01	0.02	0.06	0.01	0.06
a-Chromium Reducible Sulfur	moles H^+/t	8	11	36	9	40
S_{HCl}	%w/w S	<0.005	<0.005	0.008	<0.005	0.010
S_{KCl}	%w/w S	<0.005	<0.005	0.005	<0.005	0.006
S_{NAS}	%w/w S	<0.005	<0.005	<0.005	<0.005	<0.005
ANC_{BT}	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
s-ANC_{BT}	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
s-Net Acidity	%w/w S	0.03	0.12	0.08	0.03	0.07
a-Net Acidity	moles H^+/t	15	11	47	16	44
Liming rate	kg $CaCO_3$/t	1.1	0.86	3.5	1.2	3.3
a-Net Acidity without ANCE	moles H^+/t	15	11	47	16	44
Liming rate without ANCE	kg $CaCO_3$/t	1.1	0.86	3.5	1.2	3.3

Chromium Suite						
Our Reference:	UNITS	60582-6	60582-7	60582-8	60582-9	60582-10
Your Reference	-------------	Bore 8/0.5	Bore 8/3-3.45	Bore 10/0.1	Bore 10/8	Bore 11/1.5-1.95
Date Sampled	------------	26/07/2011	26/07/2011	28/07/2011	28/07/2011	27/07/2011
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_{kcl}	pH units	4.7	5.0	5.1	5.7	7.9
s-TAA pH 6.5	%w/w S	0.02	0.01	0.01	<0.01	<0.01
TAA pH 6.5	moles H^+/t	13	10	9	<5	<5
Chromium Reducible Sulfur	%w/w	0.02	0.04	0.02	0.02	0.25
a-Chromium Reducible Sulfur	moles H^+/t	10	23	10	16	160
S_{HCl}	%w/w S	<0.005	<0.005	0.014	0.005	0.078
S_{KCl}	%w/w S	<0.005	<0.005	0.005	<0.005	0.085
S_{NAS}	%w/w S	<0.005	<0.005	0.009	<0.005	<0.005
ANC_{BT}	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	3.0
s-ANC_{BT}	%w/w S	<0.05	<0.05	<0.05	<0.05	0.95
s-Net Acidity	%w/w S	0.04	0.05	0.04	0.03	<0.01
a-Net Acidity	moles H^+/t	23	32	20	17	<10
Liming rate	kg $CaCO_3$/t	1.7	2.4	1.5	1.3	<0.75
a-Net Acidity without ANCE	moles H^+/t	23	32	20	17	160
Liming rate without ANCE	kg $CaCO_3$/t	1.7	2.4	1.5	1.3	12

Chromium Suite						
Our Reference:	UNITS	60582-11	60582-12	60582-13	60582-14	60582-15
Your Reference	-------------	Bore 12/3-3.45	Bore 13/1.5-1.95	Bore 14/0.5	Bore 15/1.5-1.95	Bore 16/1.5-1.95
Date Sampled	------------	27/07/2011	27/07/2011	2/08/2011	8/08/2011	8/08/2011
Type of sample		Soil	Soil	Soil	Soil	Soil
pH$_{kcl}$	pH units	6.4	8.0	4.8	7.8	6.5
s-TAA pH 6.5	%w/w S	<0.01	<0.01	0.02	<0.01	<0.01
TAA pH 6.5	moles H^+/t	<5	<5	16	<5	<5
Chromium Reducible Sulfur	%w/w	0.86	0.46	0.02	0.25	0.34
a-Chromium Reducible Sulfur	moles H^+/t	540	280	11	150	220
S_{HCl}	%w/w S	0.11	0.30	0.050	0.042	0.15
S_{KCl}	%w/w S	0.11	0.33	0.039	0.038	0.16
S_{NAS}	%w/w S	<0.005	<0.005	0.011	<0.005	<0.005
ANC_{BT}	% $CaCO_3$	<0.05	5.0	<0.05	1.5	<0.05
s-ANC_{BT}	%w/w S	<0.05	1.6	<0.05	0.47	<0.05
s-Net Acidity	%w/w S	0.86	<0.01	0.05	<0.01	0.33
a-Net Acidity	moles H^+/t	540	<10	27	<10	220
Liming rate	kg $CaCO_3$/t	40	<0.75	2.0	<0.75	16
a-Net Acidity without ANCE	moles H^+/t	540	280	27	150	220
Liming rate without ANCE	kg $CaCO_3$/t	40	21	2.0	12	16

Chromium Suite						
Our Reference:	UNITS	60582-16	60582-17	60582-18	60582-19	60582-20
Your Reference	-------------	Bore 17/1.5-1.95	Bore 18/1.5-1.95	Bore 20/1.5-1.95	Bore 20/9-9.45	Bore 21/0.05
Date Sampled	------------	4/08/2011	11/08/2011	10/08/2011	10/08/2011	10/08/2011
Type of sample		Soil	Soil	Soil	Soil	Soil
pH$_{kcl}$	pH units	5.4	4.9	4.4	7.4	3.3
s-TAA pH 6.5	%w/w S	<0.01	0.10	0.04	<0.01	0.32
TAA pH 6.5	moles H^+/t	<5	63	27	<5	200
Chromium Reducible Sulfur	%w/w	0.09	0.31	0.96	0.06	0.01
a-Chromium Reducible Sulfur	moles H^+/t	57	190	600	38	7
S_{HCl}	%w/w S	0.048	0.086	0.31	0.009	0.47
S_{KCl}	%w/w S	0.049	0.081	0.30	0.010	0.045
S_{NAS}	%w/w S	<0.005	<0.005	0.007	<0.005	0.42
ANC_{BT}	% $CaCO_3$	<0.05	<0.05	<0.05	0.21	<0.05
s-ANC_{BT}	%w/w S	<0.05	<0.05	<0.05	0.07	<0.05
s-Net Acidity	%w/w S	0.1	0.41	1.0	0.01	0.75
a-Net Acidity	moles H^+/t	61	250	630	<10	470
Liming rate	kg $CaCO_3$/t	4.6	19	48	<0.75	35
a-Net Acidity without ANCE	moles H^+/t	61	250	630	38	470
Liming rate without ANCE	kg $CaCO_3$/t	4.6	19	48	2.8	35

Chromium Suite						
Our Reference:	UNITS	60582-21	60582-22	60582-23	60582-24	60582-25
Your Reference	-------------	Bore 22/1.5-1.95	TP63/0.25	TP70/0.25	TP70/1.5	TP71/0.05
Date Sampled	------------	9/08/2011	9/08/2011	10/08/2011	10/08/2011	10/08/2011
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_{kcl}	pH units	5.8	5.1	4.4	5.1	5.0
s-TAA pH 6.5	%w/w S	<0.01	0.01	0.02	0.01	0.01
TAA pH 6.5	moles H^+/t	<5	9	15	6	7
Chromium Reducible Sulfur	%w/w	0.48	0.007	<0.005	<0.005	0.01
a-Chromium Reducible Sulfur	moles H^+/t	300	4	<3	<3	6
S_{HCl}	%w/w S	0.11	0.009	<0.005	<0.005	0.010
S_{KCl}	%w/w S	0.11	<0.005	<0.005	<0.005	<0.005
S_{NAS}	%w/w S	<0.005	0.006	<0.005	<0.005	0.007
ANC_{BT}	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
s-ANC_{BT}	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
s-Net Acidity	%w/w S	0.49	0.03	0.03	0.01	0.03
a-Net Acidity	moles H^+/t	300	14	17	<10	13
Liming rate	kg $CaCO_3$/t	23	1.0	1.3	<0.75	0.97
a-Net Acidity without ANCE	moles H^+/t	300	14	17	<10	13
Liming rate without ANCE	kg $CaCO_3$/t	23	1.0	1.3	<0.75	0.97

Chromium Suite						
Our Reference:	UNITS	60582-26	60582-27	60582-28	60582-29	60582-30
Your Reference	-------------	TP71/0.25	TP78/1.5	TP90/0.25	TP98/0.05	TP117/0.45
Date Sampled	------------	10/08/2011	9/08/2011	5/08/2011	5/08/2011	3/08/2011
Type of sample		Soil	Soil	Soil	Soil	Soil
pH_{kcl}	pH units	4.9	6.0	4.1	5.4	4.7
s-TAA pH 6.5	%w/w S	0.01	<0.01	0.06	0.01	0.01
TAA pH 6.5	moles H^+/t	7	<5	40	9	9
Chromium Reducible Sulfur	%w/w	0.006	0.006	0.01	0.007	<0.005
a-Chromium Reducible Sulfur	moles H^+/t	4	4	6	4	<3
S_{HCl}	%w/w S	0.008	<0.005	0.033	0.019	<0.005
S_{KCl}	%w/w S	<0.005	<0.005	0.010	0.005	<0.005
S_{NAS}	%w/w S	0.006	<0.005	0.023	0.014	<0.005
ANC_{BT}	% $CaCO_3$	<0.05	<0.05	<0.05	<0.05	<0.05
s-ANC_{BT}	%w/w S	<0.05	<0.05	<0.05	<0.05	<0.05
s-Net Acidity	%w/w S	0.02	0.01	0.1	0.04	0.02
a-Net Acidity	moles H^+/t	11	<10	61	14	12
Liming rate	kg $CaCO_3$/t	0.83	<0.75	4.6	1.0	0.87
a-Net Acidity without ANCE	moles H^+/t	11	<10	61	14	12
Liming rate without ANCE	kg $CaCO_3$/t	0.83	<0.75	4.6	1.0	0.87

Method ID	Methodology Summary
Inorg-068	Chromium Reducible Sulfur - Hydrogen Sulfide is quantified by iodometric titration after distillation to determine potential acidity. Based on Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.

QUALITY CONTROL Chromium Suite	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
pH $_{kcl}$	pH units		Inorg-068	[NT]	60582-1	5.3 || 5.3 || RPD: 0	LCS	100%
s-TAA pH 6.5	%w/w S	0.01	Inorg-068	<0.01	60582-1	0.01 || 0.01 || RPD: 0	[NR]	[NR]
TAA pH 6.5	moles H^+/t	5	Inorg-068	<5	60582-1	7 || 8 || RPD: 13	LCS	111%
Chromium Reducible Sulfur	%w/w	0.005	Inorg-068	<0.005	60582-1	0.01 || 0.01 || RPD: 0	LCS	87%
a-Chromium Reducible Sulfur	moles H^+/t	3	Inorg-068	<3	60582-1	8 || 8 || RPD: 0	[NR]	[NR]
S_{HCl}	%w/w S	0.005	Inorg-068	<0.005	60582-1	<0.005 || <0.005	LCS	90%
S_{KCl}	%w/w S	0.005	Inorg-068	<0.005	60582-1	<0.005 || <0.005	LCS	110%
S_{NAS}	%w/w S	0.005	Inorg-068	<0.005	60582-1	<0.005 || <0.005	[NR]	[NR]
ANC_{BT}	% $CaCO_3$	0.05	Inorg-068	<0.05	60582-1	<0.05 || <0.05	[NR]	[NR]
s-ANC_{BT}	%w/w S	0.05	Inorg-068	<0.05	60582-1	<0.05 || <0.05	[NR]	[NR]
s-Net Acidity	%w/w S	0.01	Inorg-068	<0.01	60582-1	0.03 || 0.03 || RPD: 0	[NR]	[NR]
a-Net Acidity	moles H^+/t	10	Inorg-068	<10	60582-1	15 || 16 || RPD: 6	[NR]	[NR]
Liming rate	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	60582-1	1.1 || 1.2 || RPD: 9	[NR]	[NR]
a-Net Acidity without ANCE	moles H^+/t	10	Inorg-068	<10	60582-1	15 || 16 || RPD: 6	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$ /t	0.75	Inorg-068	<0.75	60582-1	1.1 || 1.2 || RPD: 9	[NR]	[NR]

QUALITY CONTROL Chromium Suite	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
pH $_{kcl}$	pH units	60582-11	6.4 || 6.3 || RPD: 2
s-TAA pH 6.5	%w/w S	60582-11	<0.01 || <0.01
TAA pH 6.5	moles H^+/t	60582-11	<5 || <5
Chromium Reducible Sulfur	%w/w	60582-11	0.86 || 0.88 || RPD: 2
a-Chromium Reducible Sulfur	moles H^+/t	60582-11	540 || 550 || RPD: 2
S_{HCl}	%w/w S	60582-11	0.11 || 0.11 || RPD: 0
S_{KCl}	%w/w S	60582-11	0.11 || 0.12 || RPD: 9
S_{NAS}	%w/w S	60582-11	<0.005 || <0.005
ANC_{BT}	% $CaCO_3$	60582-11	<0.05 || <0.05
s-ANC_{BT}	%w/w S	60582-11	<0.05 || <0.05
s-Net Acidity	%w/w S	60582-11	0.86 || 0.86 || RPD: 0

QUALITY CONTROL Chromium Suite	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
a-Net Acidity	moles H^+/t	60582-11	540 || 550 || RPD: 2
Liming rate	kg $CaCO_3$ /t	60582-11	40 || 41 || RPD: 2
a-Net Acidity without ANCE	moles H^+/t	60582-11	540 || 550 || RPD: 2
Liming rate without ANCE	kg $CaCO_3$ /t	60582-11	40 || 41 || RPD: 2

QUALITY CONTROL Chromium Suite	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
pH $_{kcl}$	pH units	60582-21	5.8 || 5.8 || RPD: 0
s-TAA pH 6.5	%w/w S	60582-21	<0.01 || <0.01
TAA pH 6.5	moles H^+/t	60582-21	<5 || <5
Chromium Reducible Sulfur	% w / w	60582-21	0.48 || 0.51 || RPD: 6
a-Chromium Reducible Sulfur	moles H^+/t	60582-21	300 || 320 || RPD: 6
S_{HCl}	%w/w S	60582-21	0.11 || 0.11 || RPD: 0
S_{KCl}	%w/w S	60582-21	0.11 || 0.11 || RPD: 0
S_{NAS}	%w/w S	60582-21	<0.005 || <0.005
ANC_{BT}	% $CaCO_3$	60582-21	<0.05 || <0.05
s-ANC_{BT}	%w/w S	60582-21	<0.05 || <0.05
s-Net Acidity	%w/w S	60582-21	0.49 || 0.52 || RPD: 6
a-Net Acidity	moles H^+/t	60582-21	300 || 320 || RPD: 6
Liming rate	kg $CaCO_3$ /t	60582-21	23 || 24 || RPD: 4
a-Net Acidity without ANCE	moles H^+/t	60582-21	300 || 320 || RPD: 6
Liming rate without ANCE	kg $CaCO_3$ /t	60582-21	23 || 24 || RPD: 4

Report Comments:

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

INS: Insufficient sample for this test
NA: Test not required
<: Less than

PQL: Practical Quantitation Limit
RPD: Relative Percent Difference
>: Greater than

NT: Not tested
NA: Test not required
LCS: Laboratory Control Sample

Quality Control Definitions

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

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

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

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

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

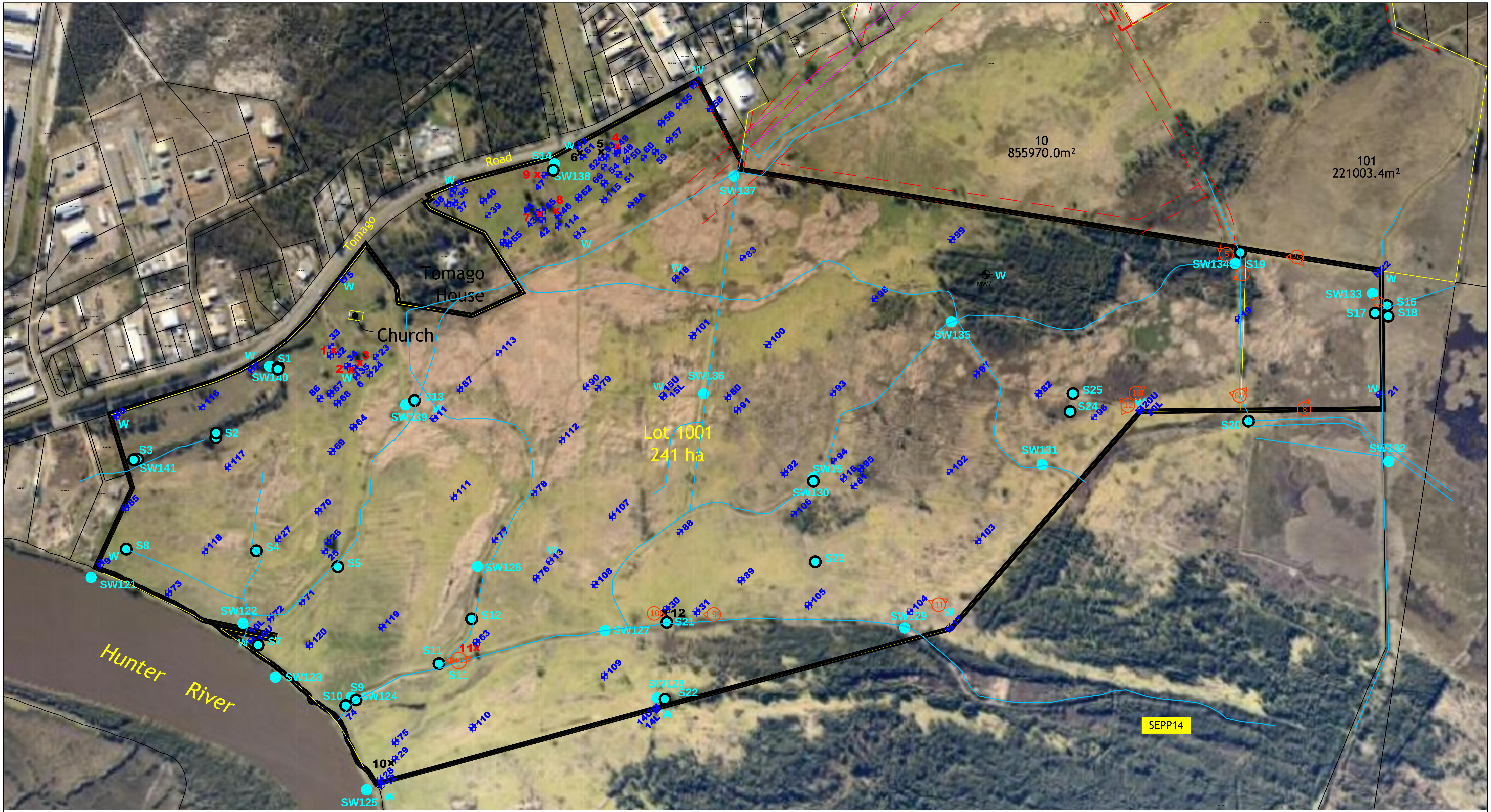
Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batched of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

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

Appendix C

Drawing 1 – Test Location Plan (from Report 49608.01)



0 50 100 150 200 300 400 600m

1:6000 @ A2

LEGEND

⌖ Test Pit Location	◁ Approximate Photo Location & Orientation
⌖ Test Bore Location	× Approximate Fibro Sheeting Sample Location
⌖ Test Bore Location (Previous Investigation)	× Approximate Fibro Sheeting/Underlying Soil Sample Location
W Wells	— Drains/Creeks
● Approximate Surface Water Sample Location	◉ Approximate Surface Water Field Monitoring Location (previous/current investigation)
▭ Boundary	

NOTE: Base drawing and survey plans supplied by Client, Ref 37672 Version A dated 22.03.2010, Ref 37672 Version B dated 25.8.2011 and NearMap Image

Ref:P:/49608.01/Drawings/49608.01 Drawing 1 Contamination Assessment

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: ADW Johnson Pty Ltd		TITLE: **Test Location Plan, Contamination Assessment**	PROJECT No: 49608.01
OFFICE: Newcastle	DRAWN BY: PLH	**Proposed Northbank Enterprise Hub,**	DRAWING No: 1
SCALE: 1:6000@A2	DATE: 10.10.2011	**Lot 1001, DP1127780 Tomago Road, Tomago**	REVISION: 0

N