mgt LabMark
ENVIRONMENTAL LABORATORIES

Certificate of Analysis

Coffey Environments Pty Ltd NSW
Level 1, 3 Rider Boulevard
Rhodes
New South Wales 2138

Attention: Edward Wu

NATA Accredited
Laboratory Number 13535

The tests covered by this document have been performed in accordance with NATA and ISO/IES 17025 and are traceable to national standards of measurement.

Report	291280-S
Client Reference	GEOTLCOV24207AB
Received Date	Feb 22, 2011

Client Sample ID			**DUP2**
Sample Matrix			**Soil**
mgt-LabMark Sample No.			**11-FE31947**
Date Sampled			**Feb 18, 2011**
Test/Reference	LOR	Unit	
Total Recoverable Hydrocarbons			
TRH C6-C9 Fraction by GC	10	mg/kg	< 10
TRH C10-C14 Fraction by GC	50	mg/kg	< 50
TRH C15-C28 Fraction by GC	100	mg/kg	< 100
TRH C29-C36 Fraction by GC	100	mg/kg	< 100
TRH C10-36 (Total)	100	mg/kg	< 100
BTEX			
Benzene	0.5	mg/kg	< 0.5
Toluene	0.5	mg/kg	< 0.5
Ethylbenzene	0.5	mg/kg	< 0.5
Total m+p-Xylenes	1	mg/kg	< 1
o-Xylene	0.5	mg/kg	< 0.5
Xylenes(ortho.meta and para)	0.15	mg/kg	< 0.15
Total BTEX	1	mg/kg	< 1
4-Bromofluorobenzene (surr.)	1	%	109
% Moisture	0.1	%	4.5
Heavy Metals			
Arsenic	2	mg/kg	4.7
Cadmium	0.5	mg/kg	< 0.5
Chromium	5	mg/kg	19
Copper	5	mg/kg	36
Lead	5	mg/kg	21
Nickel	5	mg/kg	25
Zinc	5	mg/kg	46
Mercury	0.1	mg/kg	< 0.1

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.

Description	Testing Site	Extracted	Holding Time
Total Recoverable Hydrocarbons - Method: E004 Petroleum Hydrocarbons (TPH)	Asquith	Feb 23, 2011	14 Day
BTEX - Method: E029/E016 BTEX	Asquith	Feb 23, 2011	14 Day
% Moisture - Method: E005 Moisture Content	Asquith	Feb 23, 2011	28 Day
Heavy Metals - Method: USEPA 6020 Heavy Metals & USEPA 7470/71 Mercury	Oakleigh	Feb 24, 2011	6 Month

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Phone : +61 7 3902 4600

Company Name: Coffey Environments Pty Ltd NSW
Address: Level 1, 3 Rider Boulevard
Rhodes
New South Wales 2138

Order No.:
Report #: 291280
Phone: 02 8083 1600
Fax: 02 8765 0762

Received: Feb 22, 2011 12:00
Due: Mar 1, 2011 05:00
Priority: 5 Day
Contact name: Edward Wu

Client Job No.: GEOTLCOV24207AB

mgt-LabMark Client Manager: Leanne Knowles

Sample Detail					% Moisture	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Total Recoverable Hydrocarbons	BTEX
Laboratory where analysis is conducted															
Oakleigh Laboratory - NATA Site #1261						X	X	X	X	X	X	X	X		
Thornleigh Laboratory - NATA Site #18217															
Asquith Laboratory - NATA Site #13535					X									X	X
Clayton Laboratory - NATA Site #1645															
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**											
DUP2	Feb 18, 2011		Soil	A11-FE31947	X	X	X	X	X	X	X	X	X	X	X

mgt-LabMark Internal Quality Control Review

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual PQLs are matrix dependant. Quoted PQLs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis.
7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001)
For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Acknowledgment.
If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as an RPD

UNITS

mg/kg: milligrams per Kilogram	**mg/L:** milligrams per litre
µg/l: micrograms per litre	**ppm:** Parts per million
ppb: Parts per billion	**%:** Percentage
org/100ml: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units

TERMS

Dry:	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR:	Limit Of Reporting.
SPIKE:	Addition of the analyte to the sample and reported as percentage recovery.
RPD:	Relative Percent Difference between two Duplicate pieces of analysis.
LCS:	Laboratory Control Sample - reported as percent recovery.
CRM:	Certified Reference Material - reported as percent recovery.
Method Blank:	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate:	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate:	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate:	A second piece of analysis from a sample outside of the client's batch of samples but run within the laboratory batch of analysis.
Batch SPIKE:	Spike recovery reported on a sample from outside of the client's batch of samples but run within the laboratory batch of analysis.
USEPA:	U.S Environmental Protection Agency
APHA:	American Public Health Association
ASLP:	Australian Standard Leaching Procedure (AS4439.3)
TCLP:	Toxicity Characteristic Leaching Procedure
COC:	Chain Of Custody
SRA:	Sample Receipt Advice

QC - ACCEPTANCE CRITERIA

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:
Results <10 times the LOR : No Limit
Results between 10-20 times the LOR : RPD must lie between 0-50%
Results >20 times the LOR : RPD must lie between 0-20%
Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC DATA GENERAL COMMENTS

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxophene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxophene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Arochlor 1260 in Matrix Spikes and LCS's.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPD's are calculated from raw analytical data thus it is possible to have two sets of data below the LOR with a positive RPD - eg: LOR 0.1, Result A = <0.1 (raw data is 0.02) & Result B = <0.1 (raw data is 0.03) resulting in a RPD of 40% calculated from the raw data.

Quality Control Results

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
Method Blank							
Total Recoverable Hydrocarbons E004 Petroleum Hydrocarbor							
TRH C6-C9 Fraction by GC	mg/kg	< 10			10	Pass	
TRH C10-C14 Fraction by GC	mg/kg	< 50			50	Pass	
TRH C15-C28 Fraction by GC	mg/kg	< 100			100	Pass	
TRH C29-C36 Fraction by GC	mg/kg	< 100			100	Pass	
Method Blank							
BTEX E029/E016 BTEX							
Benzene	mg/kg	< 0.5			0.5	Pass	
Toluene	mg/kg	< 0.5			0.5	Pass	
Ethylbenzene	mg/kg	< 0.5			0.5	Pass	
Total m+p-Xylenes	mg/kg	< 1			1	Pass	
o-Xylene	mg/kg	< 0.5			0.5	Pass	
Xylenes(ortho.meta and para)	mg/kg	< 0.15			0.15	Pass	
Total BTEX	mg/kg	< 1			1	Pass	
Method Blank							
Heavy Metals USEPA 6020 Heavy Metals & USEPA 7470/71 Mer							
Arsenic	mg/kg	< 2			2	Pass	
Cadmium	mg/kg	< 0.5			0.5	Pass	
Chromium	mg/kg	< 5			5	Pass	
Copper	mg/kg	< 5			5	Pass	
Lead	mg/kg	< 5			5	Pass	
Nickel	mg/kg	< 5			5	Pass	
Zinc	mg/kg	< 5			5	Pass	
Mercury	mg/kg	< 0.1			0.1	Pass	
LCS - % Recovery							
Total Recoverable Hydrocarbons E004 Petroleum Hydrocarbor		Result 1					
TRH C6-C9 Fraction by GC	%	109			70-130	Pass	
TRH C15-C28 Fraction by GC	%	84			70-130	Pass	
LCS - % Recovery							
BTEX E029/E016 BTEX		Result 1					
Benzene	%	102			70-130	Pass	
Toluene	%	107			70-130	Pass	
Ethylbenzene	%	109			70-130	Pass	
Total m+p-Xylenes	%	106			70-130	Pass	
o-Xylene	%	107			70-130	Pass	
Xylenes(ortho.meta and para)	%	106			70-130	Pass	
LCS - % Recovery							
Heavy Metals USEPA 6020 Heavy Metals & USEPA 7470/71 Mer		Result 1					
Arsenic	%	99			80-120	Pass	
Cadmium	%	99			80-120	Pass	
Chromium	%	95			80-120	Pass	
Copper	%	109			80-120	Pass	
Lead	%	103			80-120	Pass	
Nickel	%	104			80-120	Pass	
Zinc	%	103			80-120	Pass	
Mercury	%	106			75-125	Pass	
[Duplicate of 11-FE30901 - BATCH]							
Total Recoverable Hydrocarbons		Result 1	Result 2	RPD			
TRH C6-C9 Fraction by GC	mg/kg	< 10	< 10	<1	30%	Pass	
TRH C10-C14 Fraction by GC	mg/kg	< 50	< 50	<1	30%	Pass	
TRH C15-C28 Fraction by GC	mg/kg	480	500	4	30%	Pass	
TRH C29-C36 Fraction by GC	mg/kg	220	230	<1	30%	Pass	
[Duplicate of 11-FE30901 - BATCH]							
BTEX		Result 1	Result 2	RPD			
Benzene	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Toluene	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Ethylbenzene	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Total m+p-Xylenes	mg/kg	< 1	< 1	<1	30%	Pass	
o-Xylene	mg/kg	< 0.5	< 0.5	<1	30%	Pass	
Xylenes(ortho.meta and para)	mg/kg	< 0.15	< 0.15	<1	30%	Pass	
[Duplicate of 11-FE31768 - BATCH]							
Heavy Metals		Result 1	Result 2	RPD			
Arsenic	mg/kg	11	13	20	30%	Pass	

Sample, Test, Result Reference	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Codes
Chromium	mg/kg	11	10	4	30%	Pass	
Copper	mg/kg	25	28	13	30%	Pass	
Lead	mg/kg	24	26	7	30%	Pass	
Zinc	mg/kg	53	51	3	30%	Pass	
Mercury	mg/kg	< 0.1	< 0.1	<1	30%	Pass	
[Spike of 11-FE30901 - BATCH] - % Recovery							
Total Recoverable Hydrocarbons		Result 1					
TRH C6-C9 Fraction by GC	%	87			70 - 130	Pass	
TRH C15-C28 Fraction by GC	%	146			70 - 130	Fail	Q08
[Spike of 11-FE30901 - BATCH] - % Recovery							
BTEX		Result 1					
Benzene	%	86			70 - 130	Pass	
Toluene	%	89			70 - 130	Pass	
Ethylbenzene	%	90			70 - 130	Pass	
Total m+p-Xylenes	%	88			70 - 130	Pass	
o-Xylene	%	88			70 - 130	Pass	
Xylenes(ortho.meta and para)	%	88			70 - 130	Pass	
[Spike of 11-FE31768 - BATCH] - % Recovery							
Heavy Metals		Result 1					
Arsenic	%	85			75 - 125	Pass	
Cadmium	%	80			75 - 125	Pass	
Chromium	%	102			75 - 125	Pass	
Copper	%	112			75 - 125	Pass	
Lead	%	97			75 - 125	Pass	
Nickel	%	90			75 - 125	Pass	
Zinc	%	93			75 - 125	Pass	
Mercury	%	99			70 - 130	Pass	

Comments

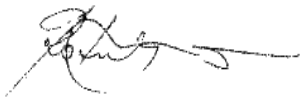
Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Organic samples had Teflon liners	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	Yes

Qualifier Codes/Comments

Code	Description
Q08	The matrix spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference

Authorised By



Dr. Bob Symons
NATA Signatory

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

coffey

Chain of Custody

No: 20564

Laboratory Quotation / Order No: GEOTLCOV24207AB

Job No:

Sheet 1 of 1

Dispatch to: (Address & Phone No.) MGT Labmark	Sampled by: Lucinda Gordon	Consigning Officer: Coffey Geotechnics Pty Ltd Date Dispatched:
Attention: Sample Receipt	Project Manager: (report results to) Edward Wu	Courier Service: Consignment Note No:

Relinquished by:	Date:	Time:	Received by:	Date:	Time:
E Wu	22/2	2.25	L W.	22/2	2.25

Comments	Sample Matrix	Container Type and Preservative	Sample No.	Date Sampled	Analyses Required: PAHs	TPHs	~~PAHs~~ = BTEX	Metals: 8	Sample Condition on Receipt
	Soil	glass jar, ice, zip lock bag	DUP2 11-FE31947	18/2/11		✓	✓	✓	

Special Laboratory Instructions: metals = As, Cd, Cr, Cu, Ni, Pb, Zn, Hg

291277

Detection Limits:

Turnaround Required: Standard 28/2/2011

JOB NUMBER **MUST** BE REFERENCED ON ALL SUBSEQUENT PAGES

64220/9-06

Copies: **WHITE:** Sign on release. **YELLOW:** If dispatched to interstate Lab, Lab to sign on receipt and fax back to Coffey. **BLUE:** To be returned with results.

mgt LabMark ENVIRONMENTAL LABORATORIES

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Brisbane
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Murarrie QLD 4172
Phone : +61 7 3902 4600

Sample Receipt Advice

Company name: **Coffey Environments Pty Ltd NSW**

Contact name: Edward Wu
Client job number: GEOTLCOV24207AB
COC number: 20564
Turn around time: 5 Day
Date received: Feb 22, 2011
MGT lab reference: **291280**

Sample information

☑ A detailed list of analytes logged into our LIMS, is included in the attached summary table.

☑ All samples have been received as described on the above COC.

☑ COC has been completed correctly.

☑ Attempt to chill was evident.

☑ Appropriately preserved sample containers have been used.

☑ All samples were received in good condition.

☑ Samples have been provided with adequate time to commence analysis in accordance with the relevant holding times.

☑ Organic samples had Teflon liners.

☑ Some samples have been subcontracted.

N/A Custody Seals intact (if used).

Notes

Metals by mgt Labmark Melbourne - results may be delayed.

Contact notes

If you have any questions with respect to these samples please contact:

Leanne Knowles on Phone : +61 2 9476 6533 or by e.mail: leanne.knowles@labmark.com.au

Results will be delivered electronically via e.mail to Edward Wu - edward_wu@coffey.com.

mgt Labmark Sample Receipt

Appendix D

QA/QC Validation Report

Coffey Environments Australia Pty Ltd

A.C.N. 140 765 902 A.B.N. 65 140 765 902

QA/QC DATA VALIDATION REPORT

Job No: GEOTLCOV24207AB – Blacktown Hospital

coffey environments
SPECIALISTS IN ENVIRONMENTAL, SOCIAL AND SAFETY PERFORMANCE

I. SAMPLE HANDLING

	Yes	No (Comment below)
1. Were the sample **holding times** met?	☒	☐
2. Were the samples in **proper custody** between the field and reaching the laboratory?	☒	☐
3. Were the samples **properly and adequately** preserved? *This includes keeping the samples chilled, where applicable.*	☒	☐
4. Were the samples received by the laboratory in good condition?	☒	☐

COMMENTS:

NA

Sample Handling was: ☒ Satisfactory ☐ Unsatisfactory ☐ Partially Satisfactory

II PRECISION/ACCURACY ASSESSMENT

	Yes	No (Comment below)
1. Was a NATA registered laboratory used?	☒	☐
2. Did the laboratory perform the requested tests?	☒	☐
3. Were the laboratory methods adopted NATA endorsed?	☒	☐
4. Were the appropriate test procedures followed?	☒	☐
5. Were the reporting limits satisfactory?	☒	☐
6. Was the NATA Seal on the reports?	☒	☐
7. Were the reports signed by an authorised person?	☒	☐

COMMENTS:

NA

Sample Handling was: ☒ Satisfactory ☐ Unsatisfactory ☐ Partially Satisfactory

III. FIELD QA/QC

1. Number of Samples Analysed — Soil: 22 (inc. 1 duplicate and 1 triplicate); Water: 0

2. Number of Days of Sampling: — Soil: 6; Water: 0

3. Number and Type of QA/QC Samples Collected:

	SOIL	WATER
Field Duplicates (at least 1 in 10 samples)	2	NA
Trip Blanks (at least 1/day or sampling event)	3	NA
Wash Blanks (at least 1/day/matrix/equipment)	1	NA
Other (Field Blanks, Spiked Trip Blanks, etc.)	1 x trip spike	NA

4. FIELD DUPLICATES

	Yes	No (Comment below)
A. Were an Adequate Number of field duplicates analysed for each chemical (min. 10%)?	☒	☐
B. Were RPDs within Control Limits?		
a. Organics (< 50 % for soil; < 30% for water)	☒	☐
b. Metals/Inorganics (< 50 % for soil; < 30% for water)	☐	☒

COMMENTS:

- An RPD of 76% was reported for nickel which exceeds the control limit of 50%. This result is considered to be attributed to the heterogeneous nature of the contaminant distribution throughout the soil/fill matrix and is not considered to affect the integrity and usability of the data presented as part of this report.

5. TRIP BLANKS

	Yes	No (Comment below)
A. Were an Adequate Number of trip blanks collected?	☒	☐
B. Were the Trip Blanks free of contaminants? (If no, comment whether the contaminants present are also detected in the samples and whether they are common laboratory chemicals.)	☒	☐

6. WASH BLANKS

	Yes	No (Comment below)
A. Were an adequate number of Wash Blanks collected?	☒	☐
B. Were the Wash Blanks free of contaminants? (If no, comment whether the contaminants present are also detected in the samples and whether they are common laboratory chemicals.)	☐	☒

COMMENTS:

- Although only three trip blanks and one wash blank were collected, limited environmental-based fieldwork was conducted on each day (i.e. geotechnical drilling comprised a large portion of the day) and therefore additional QC samples were not considered necessary.
- Detectable concentration of heavy metals were identified in the wash blank however given the results of the primary samples, this is not considered to affect the integrity and usability of the data presented as part of this report.

Sample Handling was: ☒ Satisfactory ☐ Unsatisfactory ☐ Partially Satisfactory

IV LABORATORY INTERNAL QUALITY CONTROL PROCEDURES

1. Type of QA/QC Samples (soil)

	TPH (C_6-C_9), BTEX	TPH (C_{10}-C_{36})	PAH	OCP	OPP	PCB	Metals	VHC	Asbestos
Laboratory Blanks/Reagent Blanks (at least 1 per batch)	2	2	2	2	N/A	2	2	N/A	N/A
Laboratory Duplicates (at least 1 per batch or 1 per 10 samples whichever is the smaller)	2	2	2	1	N/A	1	1	N/A	N/A
Matrix Spikes/Matrix Spike Duplicates (1 for each soil type)	1	1	1	1	N/A	1	1	N/A	N/A
Laboratory Control Spike	1	1	1	1	N/A	1	1	N/A	N/A
Surrogate (where appropriate)*	1	0	3	1	N/A	1	0	N/A	N/A

*Number of surrogates spikes carried out on each sample

	Yes	**No** (Comment below)
2 Were the laboratory blanks/reagents blanks free of contamination?	☒	☐
3. Were the spike recoveries within control limits?		
a. Organics (60% to 140%)	☒	☐
b. Metals/Inorganic (70% to 130%)	☒	☐
4. Were the RPDs of the laboratory duplicates within control limits?	☒	☐
5. Were the surrogate recoveries within control limits?	☒	☐

COMMENTS:

NA

Sample Handling was: ☒ Satisfactory ☐ Unsatisfactory ☐ Partially Satisfactory

V. DATA USABILITY

1. Data Directly Usable ☒
2. Data Usable with the following corrections/modifications (see comment below) ☐
3. Data Not Usable. ☐

COMMENTS:

NA

QA/QC Report Prepared by Sally King

QA/QC Report Reviewed by: _____
(Reviewer)

Appendix E

Construction Risk Register

PROPOSED ADDITIONS TO BLACKTOWN HOSPITAL - PRELIMINARY CONSTRUCTION RISK REGISTER FOR GEOTECHNICAL AND ENVIRONMENTAL ASPECTS

Identification						Analysis			Risk Rating 1			Treatment			Risk Rating 2			Contingency Plans		UPDATE
Risk ID	Date Raised	Risk Name	Category	Status	Risk Owner	Cause(s)	Effect / Consequence	Existing Controls	C	L	Risk Rating	List further Tasks required to Reduce Risk to acceptable criteria	Accountable Person	Due Date	C	L	Risk Rating	Actions / Comment	Financial Residual Risk Notes	Changes Assoc with Last Review
1	10/5/2011	Possibility of encountering abandoned underground storage tank	Construction (incl OHSE)	Open Risk	Contractor	An underground storage tank (location not known) is possibly present within the site	The excavation/foundation construction could be delayed. Environmental remediation may be required.	Giving due consideration in planning	S3	L3	M	Search for additional historic land use records to find location and dimensions. Possible use of geophysical survey	Shared	TBD	S4	L5	V	Sequence construction works such that the works at unaffected areas proceed while redesign/remediation requirements are reviewed for the affected area		
2	10/5/2011	Possibility of encountering old footings	Construction (incl OHSE)	Open Risk	Shared	Footings of the old buildings may be exposed during foundation excavations for the new structures	Delay due to associated removal, filling and compaction	Allow in planning	S4	L3	R	Search for additional historic land use records to find location and dimensions.	Shared	TBD	S4	L5	V	Allow for use of concrete breakers and additional filling and compaction		
3	10/5/2011	Potential for uncontrolled fill	Construction (incl OHSE)	Open Risk	Contractor	Fill thickness and distribution varies within the site	Shallow foundations are not recommended to be placed on uncontrolled fill. As such delay in removal/treatment may be encountered	Allow in construction planning	S5	L3	w	Search for records to verify whether the fill was placed to any engineering specification. Considering alternative foundation (e.g. Piles) or adopt a suitable treatment	Shared	TBD	S5	L5	Y	Allow for additional filling and compaction		
4	10/5/2011	Groundwater flow during excavation	Construction (incl OHSE)	Open Risk	Contractor	Excavation may result in ground water seepage	Inconvenience / delay in construction works	review excavation plan to assess the likelihood	S5	L4	X	Review excavation depths against expected water levels and provide collection pumps and sumps if required.	Shared	TBD	S5	L5	Y	Depending on severity of the problem, consider measures such as providing additional dewatering pumps, introduction of watertight retaining wall elements at affected area and recharging outside the excavation etc,		
5	10/5/2011	Rock wedge failure due to rock defects during excavation	Construction (incl OHSE)	Open Risk	Contractor	Unfavourably oriented defects may cause rock wedge failure during excavation	Possible injury to workers. Delay in construction	Review excavation design to assess the likelihood and design supports as necessary	S3	L4	N	Engage a geotech engineer to review the conditions and excavation progresses and provide support as	Shared	TBD	S4	L5	V	Barricade the affected area to prevent injury to workers and contact geotech engineers immediately for review of remediation measures		
6	10/5/2011	Encountering Services during foundation works	Construction (incl OHSE)	Open Risk	Shared	Foundation excavations may expose live services	Injury to workers. Disruption of services. Delay due to service diversion	Carrying out service mapping and carrying out advance diversion works if required prior to foundation works	S3	L5	O	Clear communication and liaising with relevant authorities to ensure precision in existing service documentation	Shared	TBD	S4	L5	V	Barricade the affected area and inform service provider immediately for further measures		
7	10/5/2011	Vibration during rock excavation	Construction (incl OHSE)	Open Risk	Contractor	Excavation in medium to high strength rock may cause vibrations	Impact to adjacent structures.	Review excavation scheme together with layout of adjacent structures and select appropriate excavation tools	S4	L4	U	Close and effective monitoring of vibration in excavation process by contractor and subcontractor	Shared	TBD	S4	L5	V	Consider use of alternative equipments (e.g. Rock saw)		
8	10/5/2011	Encountering contaminated soil during excavation	Construction (incl OHSE)	Open Risk	Shared	Ground variability and limitations in contamination assessments	Additional costs and time to manage the contamination	Allow in planning and have Unexpected Finds Protocol during excavation	S4	L3	R	Undertake additional contamination assessments to reduce uncertainty/limitations	Shared	TBD	S4	L4	U	Sequence construction works such that the works at unaffected areas proceed while additional assessment /remediation requirements are reviewed for the affected area		
END		END		END		END			END	END	END	END		END	END	END	END	END	END	END

Risk ID
Free Format

Category
Strategic
Design / Technical
Approvals / Licenses
Procurement
Stakeholder - Hospital
Stakeholder - Other
Construction (incl OHSE)
Commissioning & Handover
Operations and Maintenance
Other

Status
Open Risk
Open Opp
Duplicate
Transferred
Closed

Risk Owner
SWAHS
HI
PD
Contractor
Shared

Current Risk Controls

S1	L1	1- Extreme
S2	L2	2 - High
S3	L3	3 - Medium
S4	L4	4 - Low
S5	L5	-

Further Tasks required to Reduce Risk
Free Format

Responsibility
Free Format

HEALTH INFRASTRUCTURE
NSW HEALTH

NSW HEALTH RISK CATEGORIES	SUB-CATEGORIES	CONSEQUENCE EXAMPLES				
CLINICAL CARE AND PATIENT SAFETY		Unexpected multiple patient deaths unrelated to the natural course of the illness.	Unexpected patient death or permanent loss/reduction of bodily function unrelated to the natural course of the illness.	Unexpected temporary reduction of patient's bodily function unrelated to the natural course of the illness which differs from the expected outcome.	Patient's care level has increased unrelated to the natural course of the illness.	First Aid provided to patient unrelated to the natural course of the illness.
HEALTH OF POPULATION		NOT APPLICABLE TO HEALTH INFRASTRUCTURE				
WORKFORCE		NOT APPLICABLE TO HEALTH INFRASTRUCTURE				
COMMUNICATION AND INFORMATION		Loss or permanent damage of major utilities, records, IT data systems and communications resulting in prolonged suspension of service delivery.	Restriction or damage of or prolonged service disruption to some utilities, records, IT data systems & communication.	Temporary suspension of work due to damage to property, assets, records or access to IT or communication systems.	Localised damage to property, assets or records and restricted access to IT systems or communication.	Minimal effect on infrastructure, records, IT systems or communication and minimal or no disruption to service delivery or work.
FACILITIES AND ASSETS MANAGEMENT	HI - DESIGN / SCOPE / FUNCTIONALITY	Multiple critical design / functionality non-conformances. Service / Facility offered fails to meet most key expectations.	Critical design / functionality non-conformance. Service / facility offered fails to meet certain key expectations.	Major design / functionality non-conformance. Service / Facility offerred fails to meet expectations.	Moderate but fixable impacts to facility operation. Able to be fixed during commissioning.	Minor impacts to health facility operations. Operations may commence and fix later.
	HI - ENVIRONMENT EFFECTS / CULTURAL HERITAGE	Irreversible large scale environmental impact. Loss of valued ecosystem. Violation of environmental law or regulation such that very serious litigation, fines and prosecution.	Long-term environmental impairment felt in neighbouring or valued ecosystem functions. Long term remediation required. Major breach of environmental law or regulation with likely major litigation.	Impacts external ecosystem. Considerable remediation required. Serious breach of environmental law or regulation with investigation or report to authority with prosecution and/or Moderate fine possible.	Short lived or 'well contained' environmental effect. Minor remedial actions probably required. Breach of environmental law or regulation.	No appreciable change to environment or highly localised event.
EMERGENCY AND DISASTER RESPONSE		NOT APPLICABLE TO HEALTH INFRASTRUCTURE				
FINANCE AND LEGAL	NSW HEALTH - LEGAL	Legal judgement, claim, non compliance with legislation resulting in indeterminate or prolonged suspension of service delivery. Fraud impacts on service delivery.	Legal judgement, claim, non compliance with legislation resulting in medium term suspension of service delivery. A fraud impacts on service delivery.	Legal judgement, claim, non-compliance with legislation resulting in medium term but temporary suspension to services.	Legal judgement, claim, noncompliance with legislation resulting in short term disruption to services.	Legal judgement, claim or legislative change but no impact on service delivery.
	HI - FINANCIAL	Loss or increased cost of > $20M	Loss or increased cost of $5M - $20M.	Loss or increased cost of $2M to $5M.	Loss or increased cost of $100K - $2M.	Loss or increased cost of < $100K
	HI - SCHEDULE / PROGRAM	Milestone delay exceeds > 6months	Milestone delay 3 to 6 months	Milestone delay 1 to 3 months	Milestone delay 1 to 4 weeks	Milestone delay 1 to 7 days
SAFETY AND SECURITY		Multiple deaths or life threatening injuries to non-patients.	Death or life threatening injury/ illness causing hospitalisation of non-patients.	Serious harm / injury or illness causing hospitalisation or multiple medical treatment cases for non-patients.	Minor harm or injury to a non patient where treatment or First Aid is required.	Harm, injuries or ailments not requiring immediate medical treatment.
LEADERSHIP AND MANAGEMENT	NSW HEALTH	NOT APPLICABLE TO HEALTH INFRASTRUCTURE				
	HI - REPUTATION	Outrage – Reputation damaged beyond repair. Serious public or media outcry.	Displeasure – Reputation damaged but recoverable given significant effort, time & resources to put things right. Adverse media / public attention.	Disappointment to Concern – reputation damaged but recoverable. Ongoing local public and/or media attention and/or complaints.	Unease – reputation remains but loss of some goodwill. Some ongoing scrutiny / attention.	No reaction / apprehension. Goodwill and reputation retained.
COMMUNITY EXPECTATIONS	HI - COMMUNITY	Community reaction and concern is overwhelming, causing major changes or project cancellation. Requires fundamental changes to project resourcing / approach.	Community actively opposes activities. Issues are substantial and require diversion of resources to resolve.	Community reaction and concern is significant and may impact on the success of the operation/project. Issues require additional project resources to resolve.	Community reaction and concern is evident. All or most concerns are capable of management by actions.	Little or no community reaction or recognition.

Qualitative anaysis	Quantitative analysis	Probability analysis	LIKELIHOOD	CONSEQUENCE RATINGS				
				Catastrophic ($1)	Major ($2)	Moderate ($3)	Minor ($4)	Minimal ($5)
You expect it will almost definitely be a regular or repeated feature of the project life.	Several times per week	> 95%	Almost certain (L1)	A	D	J	P	S
You expect it is likely to occur during the project life.	Monthly or several times per year	70 to 95%	Likely (L2)	B	E	K	Q	T
You would expect it will occur more likely than not occur during the project life.	Once every 1 to 2 years	30 to 70%	Possible (L3)	C	H	M	R	W
You would expect it will more likely not occur than occur during the project life.	Once every 2 to 5 years	5 to 30%	Unlikely (L4)	F	I	N	U	X
You don't expect it to occur during the project life.	Greater than once every 5 years	< 5%	Rare (L5)	G	L	O	V	Y

Generally intolerable - action required to

Tolerable - treat risk until level is ALARP and monitor to ensure risk exposure does

Acceptable Monitor and

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ADDITIONAL GEOTECHNICAL INVESTIGATION FOR THE PROPOSED ADDITIONS TO BLACKTOWN HOSPITAL, NSW

Health Infrastructure, NSW

GEOTLCOV24508AA-AB
08 May 2012

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SPECIALISTS MANAGING THE EARTH

08 May 2012

Appian Group Pty Ltd (On Behalf of Health Infrastructure, NSW)
C/- Robert Bird Group
Level 1, 299 Elizabeth Street
Sydney, NSW 2000

Attention: Tony Kiernan

Dear Sir

RE: Additional Geotechnical Investigation for Proposed Additions to Blacktown Hospital, NSW Final Report

Coffey Geotechnics Pty Ltd (Coffey) is pleased to present this report for the additional geotechnical investigation undertaken as an extension to the previous geotechnical and environmental investigating for the proposed additions to Blacktown Hospital, NSW. Should you have any queries or comments regarding this report please do not hesitate to contact the undersigned on (02) 9911 1000.

For and on behalf of Coffey Geotechnics Pty Ltd

Viet Nguyen

Senior Geotechnical Engineer

Distribution: Original held by Coffey Geotechnics Pty Ltd
1 copy held by Coffey Geotechnics Pty Ltd
3 hard copies and electronic copy to Robert Bird Group Pty Ltd

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1 INTRODUCTION

This report presents the results of an additional geotechnical investigation carried out by Coffey Geotechnics Pty Ltd (Coffey) for Appian Group Pty Ltd on behalf of Health Infrastructure, NSW (the Principal) and Robert Bird Group (RBG, Principal's representative) for the proposed additions to Blacktown Hospital, NSW.

This additional geotechnical investigation was an extension to the previous geotechnical investigation completed by Coffey on March 2011 (Ref: GEOTLCOV24207AA-AB). This additional investigation was carried out to provide further subsurface ground information to support the recent changes of the new building layout. The investigation was undertaken in general accordance with the scope of works presented in our proposal, reference GEOTLCOV24508AA-AA, dated 17 February 2012. The results of this additional geotechnical investigation will be used to further refine the development and to assist with civil/structural design.

Reference should be made to the previous geotechnical investigation report "Geotechnical Investigation and Preliminary Contamination Assessment, Proposed Additions, Blacktown Hospital, NSW" (ref: GEOTLCOV24207AB-AA 10 May 2011) for further information on the proposed development and available geotechnical investigation information.

2 SITE INFORMATION

2.1 Published Geology

The Penrith 1:100,000 Geological Sheet indicates that the sites are underlain by Bringelly Shale of the Wianamatta Group. The Bringelly Shale is described as shale, carbonaceous claystone, claystone, laminate, fine to medium grained lithic sandstone, rare coal and tuff.

2.2 Site description

The site is located at the Blacktown Hospital Campus, south of Blacktown Road, occupying ground gently sloping down towards the north/northwest. The site is bounded to the north and east by Blacktown Road and to the south by Bungarribee Road. The areas of proposed development are located to the south of the existing Main Hospital Building on areas currently occupied by car parks on grade as shown in Figure 1. The areas subject to this additional geotechnical investigation include the paved road way immediately along the southern side of the Main Hospital Building and part of a carpark to the east of the Bungarribee House building.

2.3 Hydrogeology

A search for registered groundwater bores within a 500m radius of the site was undertaken using the NSW Natural Resources Atlas (NSW-NRA, http://nratlas.nsw.gov.au) on 11 November 2010 as part of a Stage 1 Site Contamination Assessment (Coffey, 2010). Records for four registered groundwater bores were found. A summary of groundwater bores is presented below:

- One bore located approximately 500m northwest of the site is reported to be used for waste disposal purposes; and
- Three bores located approximately 400m northeast of the site are reported to be used for monitoring purposes.

Based on data provided in the groundwater bore search results, it is estimated that groundwater beneath the site would lie at a depth of between about 3m and 11m below ground surface and is considered likely to flow in a broadly north and/or easterly direction.

2.4 Acid Sulfate Soils

Based on the published acid sulfate soils risk maps, the site is located in an area not known to contain acid sulfate soils.

2.5 Previous Geotechnical Investigations

Several geotechnical investigations have been undertaken by Jeffery and Katauskas Pty Ltd (J&K) at Blacktown Hospital pertaining to various previous developments. A summary of these previous works were presented in a Geotechnical Desktop Study Report authored by J&K (reference: 24416SBrpt dated 2 November 2010).

A geotechnical and environmental investigation was completed on March 2011 by Coffey to provide information on subsurface ground conditions for a preliminary civil/structural design for the proposed development. Key findings from the available geotechnical information were summarised and resented in this geotechnical and environmental report (ref: GEOTLCOV24207AA-AB).

3 METHOD OF INVESTIGATION

3.1 Geotechnical Fieldwork

The fieldwork for this investigation was conducted between the 14 and 16 March 2012, and comprised seven boreholes (BH13 to BH19). Figure 1 shows the approximate borehole locations. Boreholes from previous geotechnical investigation by Coffey are also shown in this figure.

The boreholes were drilled using a Mobile Drill truck mounted drilling rig. Each borehole was advanced using solid flight augers with a tungsten carbide (TC) drill bit until refusal on rock at approximately 7.5m to 8m or until the target depth of approximately 10m was achieved, with the exception of BH13. Boreholes (BH 14, BH15, BH17, and BH19) with TC bit refusal on rock at a depth shallower than the target depth were advanced using NLMC rock coring technique to the target depth.

Borehole BH13 was terminated at an auger refusal depth of 4.5m on concrete. The drilling termination at this borehole was due to a concern on the likely presence of live electrical services (advised by an electrician from the hospital). An additional underground service search was carried out at this location during drilling. However, due to the likely depth to the services exceeds the search equipment range (2m to 2.5m depth), the location of the live electrical services could not be confirmed and drilling at borehole BH13 was abandoned.

Standard Penetration Testing (SPT) was carried out at selected depth intervals to assess soil strength and obtain samples for logging purposes. Following TC bit refusal on rock the boreholes were cored using a triple tube core barrel to a depth of approximately 10m.

Groundwater inflows and soil moisture observed during drilling in soil were recorded. Groundwater observations were not possible in the cored sections of the boreholes during drilling as water was used as a drilling fluid. All remaining boreholes were backfilled with cuttings to 0.1m below ground level, and the pavement repaired at surface with bitumen.

Borehole locations were marked on the site survey plan supplied by the client and approximate interpreted reduced levels are noted on the logs.

A Coffey engineer was present throughout the fieldwork to conduct:

- Geotechnical sampling and testing, record test results and log materials encountered;
- Liaison with Principal's representatives and contractors; and
- Implementation of the Site Specific Health, Safety and Environmental Management Plans.

3.2 Geotechnical Laboratory Testing

Soil and rock samples obtained during the investigation were taken to our NATA registered laboratory. The following tests were carried out on selected samples:

- Atterberg Limits;
- Moisture Content;
- Soil Aggressivity for buried steel and concrete structures (ph, Sulphate and Chloride); and
- Point load testing on rock core samples.

4 RESULTS OF INVESTIGATION

4.1 Subsurface Conditions

Engineering borehole logs from this current geotechnical investigation are presented in Appendix A, together with Explanation Sheets defining the terms and symbols adopted in the borehole log preparation and photographs of the rock core.

The site is underlain by a variable thickness of fill overlying residual soils and shale or sandstone bedrock. To the south of the site relatively deep sandy/gravely clay fill was encountered (BH13, BH14, BH18, and BH19). Such deep fill deposits may be associated with levelling of the site during construction of the car parking area or backfilling associated with services trenches. At the location of BH13, fill comprised of bricks and concrete blocks were encountered that may be associated with an old building footing or other buried structures.

The encountered subsurface conditions in the additional boreholes are generally consistent with the subsurface conditions in the boreholes drilled during previous geotechnical investigation as reported in the report GEOTLCOV24207AA-AB.

Based on the information obtained from the boreholes, three cross sections have been drawn through the site and are presented in Figure 2. Two geotechnical models have been developed, pertaining to developments immediately south of the Main Hospital Building (Table 4.1) and another for the area to the east of Bungarribee House building (Table 4.2).

TABLE 4.1: Interpreted Subsurface Conditions – Area Along The Southern Side of The Main Hospital Building (BH15 to BH17)

Unit	Material / Origin	Depth to Top of Unit (m)	Thickness of Unit (m)	Approximate Top of Unit (mAHD)	Description
1	Fill and Topsoil	0	0.1 to 0.5	58.5	Pavement and topsoil
2	Residual Soil	0.1 to 0.5	1.6 to 4.1	58.0 to 58.4	Clay: medium and high plasticity, firm to hard, pale grey to reddish brown with ironstone gravels
3a	Class V Shale (1)	3.0 to 4.5	Not proven	54.0 to 55.5	Shale: dark grey, extremely to moderately weathered, very low to low strength

(1) Rock classified in accordance with Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl, Dec 1998.

TABLE 4.2: Interpreted Subsurface Conditions – Area to the East of Bungarribee House Building (BH13, BH14, BH18 and BH19)

Unit	Material / Origin	Depth to Top of Unit (m)	Thickness of Unit (m)	Approximately Top of Unit (mAHD)	Description
1	Fill	0	4.5 to 6.0	65.2 to 68.0	Topsoil / Clay and Sandy Clay
3a	Class V and IV Shale(1)	4.5 to 6.0	Not Proven	60.7 to 63.5	Shale: pale grey to reddish brown, extremely weathered, very low to medium strength

(1) Rock classified in accordance with Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl, Dec 1998.

The depths and layer thicknesses in Tables 4.1 and 4.2 are based on the subsurface conditions at the borehole locations and may not be representative of all areas of the site.

4.2 Laboratory Test Results

The soil laboratory test results are presented in Appendix B and a summary is presented in Table 4.3.

TABLE 4.3: Summary of Moisture Content, Atterberg Limits and Soil Aggressivity Tests

Borehole No.	Depth (m) BGL	pH	Soluble Sulfate ($SO4^{2-}$) (mg/kg)	Chloride (Cl^-) (mg/kg)	Moisture Content (%)	Atterberg Limits		
						LL (%)	PL (%)	PI (%)
BH13	1.5 - 1.95	7.4	8.0	<50.0	8.0	-	-	-
BH14	3.0 - 3.1	9.2	100.0	80	5.7	-	-	-
BH15	1.5 - 1.95	5.1	200.0	970	15.3	-	-	-
BH16	1.5 - 1.7	-	-	-	11.6	44	12	32
BH18	1.5 – 1.95	8.9	10.0	<50	11.9	31	14	17

Axial and diametral point load index strength testing was carried out on the rock cores, with the test results presented on the individual borehole engineering logs in Appendixes A.

5 DISCUSSION AND RECOMMENDATIONS

5.1 Foundation Options

5.1.1 General

There is a variable depth of fill across the site probably as a result of buried services, demolition of previous buildings and site levelling works during car park construction. We recommend piled foundations for multi storey building development where relatively high building loads and differential movement tolerances are tight, with the piles founded on bedrock.

For lightly loaded and minor structures, which can tolerate relative large differential settlements, it may be possible to adopt shallow footing such as a stiffened raft founded on the existing fill. This additional geotechnical investigation together with the previous geotechnical investigations indicate that the existing fill appears to be of moderately to well compacted.

However, unless records are available to confirm that fill has been placed and compacted to an engineering specification the existing fill should be treated as uncontrolled fill. As such, the existing fill should be excavated and re-compacted to form a competent founding layer for shallow footings. The excavation depth of fill below the base of shallow footings will be assessed on site by experienced geotechnical engineer during construction. A specification for excavation, unsuitable material removal, and re-compaction of the existing fill for use as founding material must be developed in accordance with

AS 3798-2007 prior to construction. Excavated fill should be re-compacted to at least 98% Standard Compaction at moisture content within 2% of Standard Optimum Moisture Content.

5.1.2 Shrink Swell Potential

In areas where existing fill occurs a site classification of 'P' as defined in AS2870-2011 should be adopted. If the fill is excavated and re-compacted it may be possible to found a raft slab on the fill. Reclassification of the site would depend on the nature and thickness of the compacted fill and foundation recommendations should be developed based on AS2870-2011.

Where residual soils are relatively shallow and form the bearing stratum for a shallow foundation, a classification of other than 'P' could be adopted. Based on the shrink swell test result, sites underlain by residual soils can be classified as 'H1' as defined in AS2870-2011.

5.1.3 Soil Aggressivity

Based on laboratory test results as summarized in Table 4.3, the soils could be classified as "mildly aggressive to non-aggressive" according to AS 2159-2009 for concrete and as "non-aggressive" for steel.

5.1.4 Shallow Footings

Where existing fill is excavated and re-compacted in accordance with an appropriate engineering specification, an allowable bearing pressure of 100kPa could be adopted for design of shallow footing bearing on re-compacted fill.

For shallow footings bearing on stiff residual soil (Unit 2) we recommend an allowable bearing pressure of 150kPa. Strip or pad footings should only be adopted for structures that are not susceptible to damage from shrink swell movements or relative large differential settlements. Alternatively, raft foundations or piles should be adopted.

Where distance from the centre of the footing to the edge of an excavation or a batter slope crest is less than the footing width, the design bearing capacity should be downgraded by multiplying the allowable bearing pressure with a factor of 0.6.

A geotechnical engineer should observe shallow footing excavations, re-compaction, and undertake dynamic cone penetration tests in each footing to confirm that a competent bearing stratum exists to an appropriate depth below the base of the footing.

5.1.5 Piled Foundations

Where a piled foundation is required the piles should penetrate the fill and residual soil layers and found within Unit 3a and 3b bedrock.

Open bored piles may be feasible but would require temporary liners when penetrating granular materials such as the sand fill encountered at some locations. In clay fill or clay residual soils open bored piles may still require temporary liners if groundwater seepage occurs as seepage will tend to soften the pile shaft if left open.

Continuous flight auger (CFA) piles should be practicable and do not require temporary casing. However, a high capacity CFA piling rig will be required to socket the piles into the bedrock if significant loads are to be carried in shaft adhesion or to take advantage of the parameters for the better quality

Unit 3b rock. Advice should be sought from specialist CFA piling contractors regarding the length of socket in the Unit 3b that can be achieved with their piling rigs.

For the limit state design of piles the geotechnical parameters provided in Table 5.1, below, can be adopted.

TABLE 5.1: Recommended Limit State Design Parameters for Piles on Rock

Geotechnical Unit (1)	Ultimate End Bearing (MPa) (2)	Ultimate Shaft Adhesion (kPa) (3)	Elastic Modulus (MPa) (4)
Unit 2 – Residual Soil	-	30	30
Unit 3a – Class IV and V Shale and Class V and IV Sandstone	3	100	100
Unit 3b – Class III Shale and Class III Sandstone	15[5]	500	500

(1) Rock classified in accordance with Pells et al (1998) "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl, Dec 1998.
(2) Assumes a minimum embedment of at least 0.3m into the relevant bearing stratum.
(3) Shaft adhesion should be ignored unless the pile has a minimum socket length of 3 pile diameters.
(4) Serviceability should be assessed using the tabulated modulus value to check that settlements are within tolerable limits.
(5) To adopt this value further assessment of rock quality will be required as discussed below.

We recommend a geotechnical strength reduction factor, Φ_g, of 0.7 for footings bearing on rock where a suitable program of verification is undertaken. If piles are required to resist uplift the shaft adhesion Φ_g of 0.6 should be adopted and the values in Table 5.1 should be multiplied by 0.6 and a cone pull out check should be carried out assuming a cone angle of $70^{0.}$

Where ultimate end bearing pressures of greater than 3MPa are adopted we recommend that additional cored boreholes be drilled at column locations to assess the uniformity and quality of the bearing stratum. The number of additional boreholes will be dependent on the piling layout. Cores may be required at 25% to 50% of pile locations to provide adequate information for the assessment of rock quality to justify the upper end of the recommended ultimate end bearing values.

A geotechnical engineer should be engaged to review piling records to confirm that piles have penetrated to the appropriate rock class. Pile dynamic integrity testing should be carried out particularly, if CFA piles are adopted. At least 5% of all piles should be subjected to integrity testing.

The base of open bored piles and pad footings should be clean of loose debris and water. Continuous flight auger piles should be carefully controlled to avoid spoil falling off the auger and fouling the base of the pile.

5.2 Groundwater

No groundwater inflow was observed during auger drilling up to depths ranging approximately 7m to 10m. Water level monitoring was not possible during rock coring as water was used as drilling fluid in the drilling process.

Previous investigations report water observations in some boreholes at depths ranging between 1.8m to 3.7m and suggest that water lies mainly along the soil/rock interface and within joints in rock. It is anticipated that high groundwater levels would be limited to prolonged periods of high rainfall or localised events such as failures of service lines.

We do not anticipate major groundwater inflows during excavations however; ground water seepages are likely due to high rainfall events, local drainage conditions etc and provision should be made for pumping form sumps. The risk of the development causing adverse impacts on adjacent sites due to changes in groundwater is assessed as low.

5.3 Other Recommendations

This additional geotechnical investigation indicates consistent sub-surface ground conditions with which were described in the previous geotechnical investigation reports (ref: GEOTLCOV24207AA-AB). Therefore, recommendations on the relevant geotechnical aspects such as excavation conditions, retention systems, pavement design, etc provided in the previous geotechnical report (GEOTLCOV24207AA-AB) are considered relevant to the revised developments.

6 LIMITATIONS

The geotechnical model and recommendations in this report are based on a limited number of boreholes. The engineering logs describe subsurface conditions only at the specific borehole locations. Ground conditions can vary over relatively close distances and a geotechnical engineer should be engaged at the construction stage to assess whether site conditions are consistent with design assumptions.

The attached document entitled “Important Information about your Coffey Report” presents additional information about the uses and limitations of this report.

For and on behalf of Coffey Geotechnics Pty Ltd

Viet Nguyen

Senior Geotechnical Engineer

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Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

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SPECIALISTS MANAGING THE EARTH

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

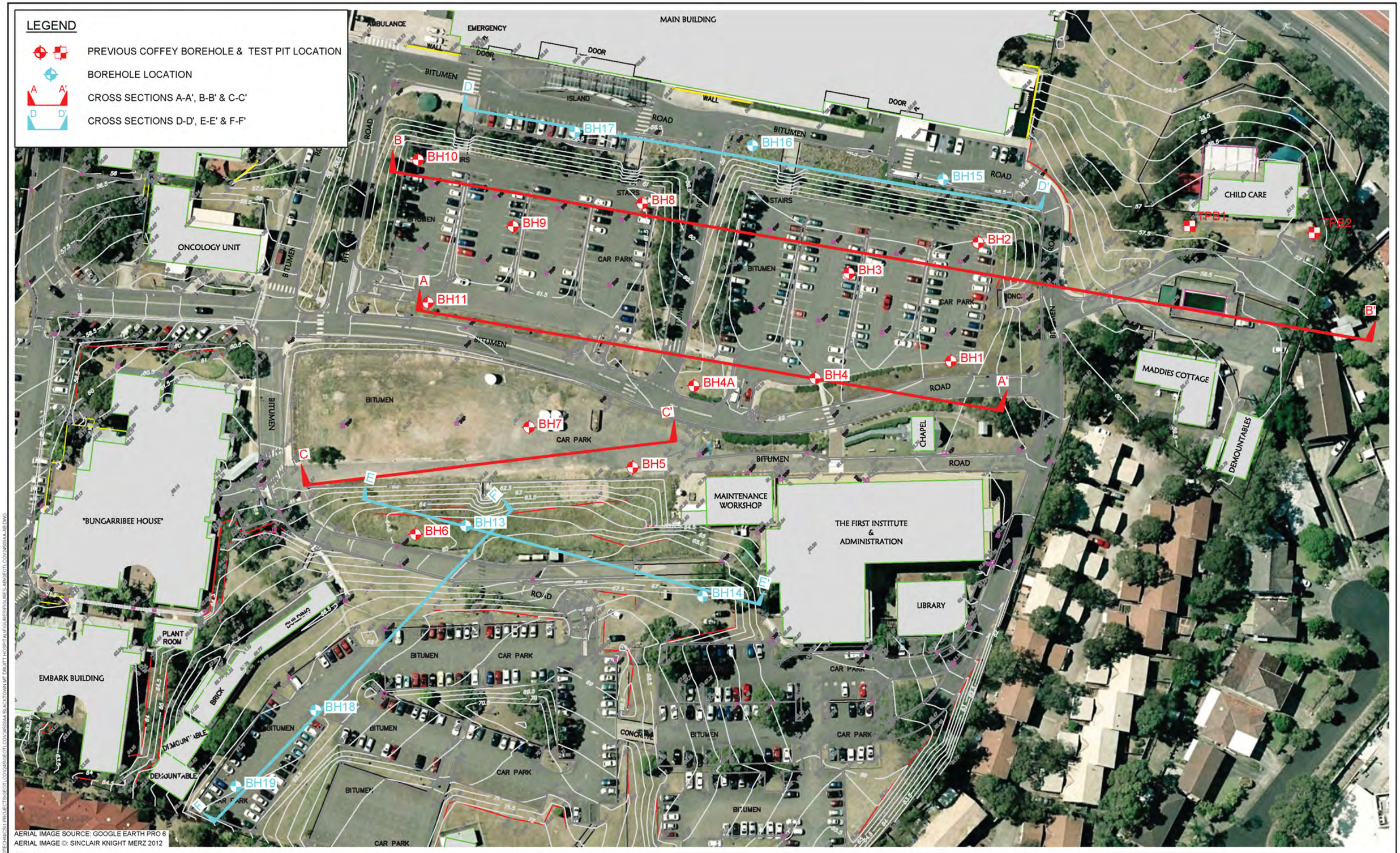
Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical information in Construction Contracts" published by the Institution of Engineers Australia, National headquarters, Canberra, 1987.

Figures

LEGEND

- PREVIOUS COFFEY BOREHOLE & TEST PIT LOCATION
- BOREHOLE LOCATION
- CROSS SECTIONS A-A', B-B' & C-C'
- CROSS SECTIONS D-D', E-E' & F-F'



AERIAL IMAGE SOURCE: GOOGLE EARTH PRO 6
AERIAL IMAGE ©: SINCLAIR KNIGHT MERZ 2012

revision	description	drawn	approved	date

10 0 10 30 50
Scale (metres) 1:1000

drawn	VN / MH
approved	RT
date	08 / 05 / 12
scale	1:1000
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

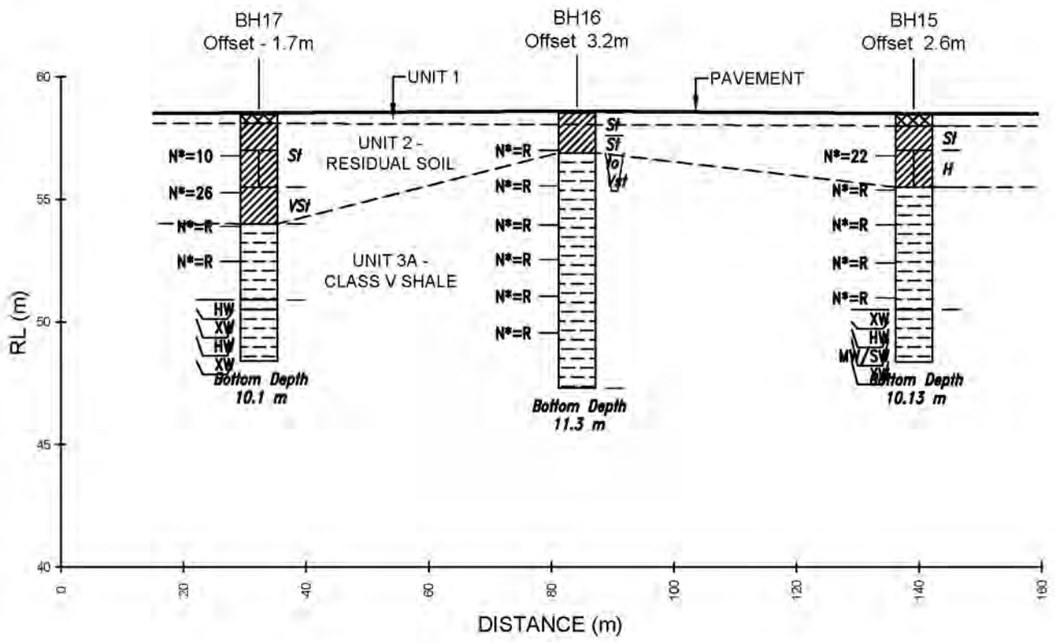
client: HEALTH INFRASTRUCTURE, NSW

project: BLACKTOWN HOSPITAL DEVELOPMENT
BLACKTOWN HOSPITAL, BLACKTOWN, NSW

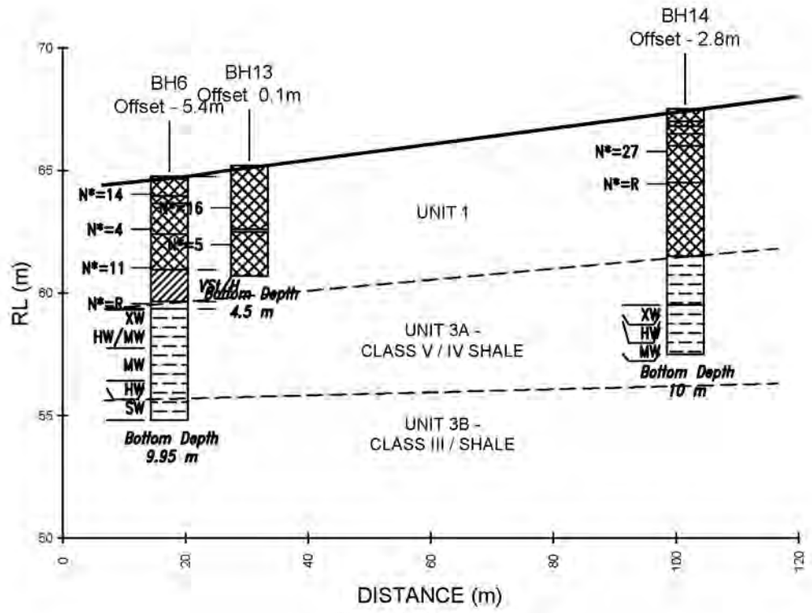
title: BOREHOLES LOCATION PLAN

project no: GEOTLCOV24508AA-AB | figure no: FIGURE 1

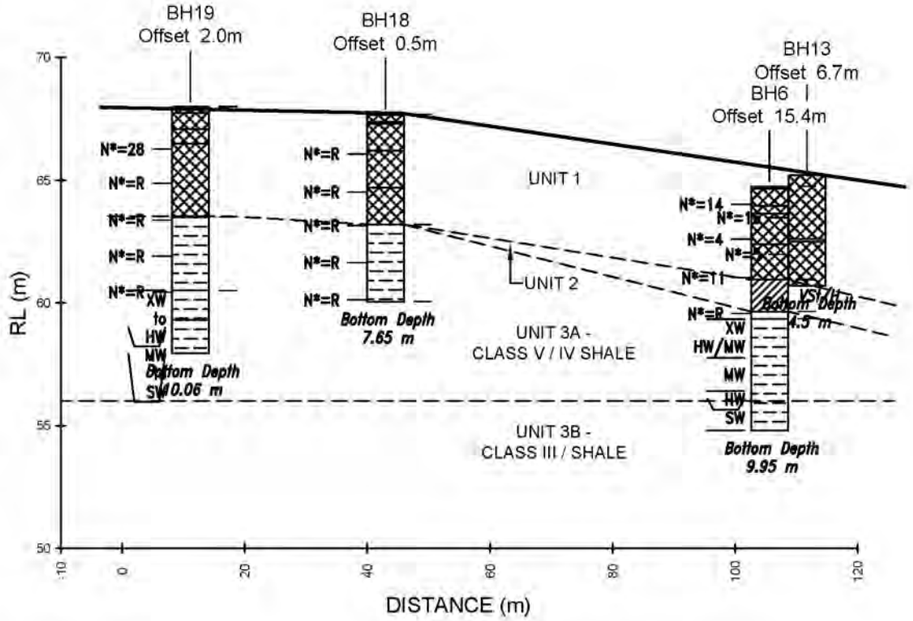
PLOT DATE: 8/05/2012 3:12:15 PM DWG FILE: F:\GEOTECHNICS\PROJECTS\GEOTLCOV24508AA BLACKTOWN MT DRUITT HOSPITAL\DRG\RESFIGURES-ABAGEOTLCOV24508AA-AB.DWG



SECTION D-D'



SECTION E-E'



SECTION F-F'

LEGEND

- ASPHALT
- FILL
- CLAY
- SILTY CLAY
- SHALE
- TOPSOIL
- CONCRETE

revision	description	drawn	approved	date

Horizontal Scale (metres) 1:1000

Vertical Scale (metres) 1:250

drawn	VN / MH
approved	RT
date	09/05/12
scale	AS SHOWN
original size	A3

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client:	HEALTH INFRASTRUCTURE, NSW
project:	BLACKTOWN HOSPITAL DEVELOPMENT BLACKTOWN HOSPITAL, BLACKTOWN, NSW
title:	CROSS SECTION D-D', E-E' AND F-F'
project no:	GEOTLCOV24508AA-AB
figure no:	FIGURE 2

Appendix A

Engineering Borehole Logs, Core Photographs and Explanation Sheets

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Engineering Log - Borehole

Borehole No. **BH13**

Sheet 1 of 1

Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***14.3.2012***

Principal:

Date completed: ***14.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***AWJ***

Borehole Location: ***Blacktown District Hospital***

Checked by: ***AJH***

drill model and mounting: Mobile Drill B8 Truck | Easting: 307086 | slope: -90° | R.L. Surface: 65.2

hole diameter: 100 mm | Northing 6260630 | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
HA					65	1			**FILL : Silty CLAY :** low to medium plasticity, dark brown, with some fine to medium gravel	D			FILL
ADV					64				At 1.00m: becoming with refuse of brick fragments and broken concrete				
			None encountered	SPT 2,5,11 N*=16	63	2							
ADT				SPT 2,2,3 N*=5	62	3			**CONCRETE**				V bit refusal at 2.6m on possible concrete slab
					61	4			**FILL : Silty CLAY :** low to medium plasticity, dark brown, with some fine to medium gravel				
					60	5			Borehole BH13 terminated at 4.5m				
					59	6							
					58	7							
						8							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

M mud N nil

C casing

penetration

1 2 3 4 no resistance ranging to refusal

water

10/1/98 water level on date shown

water inflow

water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

BOREHOLE GEOTLCOV24207AB.GPJ COFFEY.GDT 29.3.12

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Engineering Log - Borehole

Borehole No. **BH14**

Sheet 1 of 2

Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***14.3.2012***

Principal:

Date completed: ***14.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***AWJ/ JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model and mounting: Mobile Drill B8 Truck | Easting: 307154 | slope: -90° | R.L. Surface: 67.5

hole diameter: 100 mm | Northing 6260609 | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
ADV			None encountered		67	1			**FILL: Gravely SAND:** Fine grained, brown/ orange, with some fine to medium gravel.	D/M			FILL
HA									**FILL: Gravely SAND :** Fine grained, brown/ orange, fine to medium gravel, with some clay.	M			
									FILL: CLAY: High plasticity, brown/ grey, with some fine gravel.				
									FILL: SAND: Fine to medium grained, yellow brown, traces of clay.				
ADV				SPT 11,12,15 N*=27	66	2			**FILL: Silty SAND:** Fine grained, pale brown/ orange.	D			
ADT					65	3			**FILL: Sandy GRAVEL:** Medium to coarse grained, sub angular gravel, brown/ orange.				
				SPT 15/100mm N*=R	64	4							
					63	5							
					62	6			**SHALE:** Brown, dark grey, extremely weathered, verly low strength, remoulds to clay.				EXTREMELY WEATHERED SHALE
					61	7							
					60	8							

Borehole BH14 continued as cored hole

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

M mud N nil

C casing

penetration 1 2 3 4 — no resistance ranging to refusal

water

10/1/98 water level on date shown

water inflow

water outflow

Bulk and Bold tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

BOREHOLE GEOTLCOV24207AB.GPJ COFFEY.GDT 29.3.12

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Borehole No. **BH14**

Sheet 2 of 2

Project No: **GEOTLCOV24508AA**

Engineering Log - Cored Borehole

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***14.3.2012***

Principal:

Date completed: ***14.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***AWJ/ JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model & mounting: Mobile Drill B8 Truck | Easting: 307154 | slope: -90° | R.L. Surface: 67.5

hole diameter: 100 mm | Drilling fluid: | Northing: 6260609 | bearing: | datum: AHD

drilling information					material substance						rock mass defects		
method	core-lift	water	RL	depth metres	graphic log core recovery	material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	estimated strength VL L M H VH EH	$Is_{(50)}$ MPa D- diametral A- axial	RQD %	defect spacing mm 30 100 300 1000 3000	defect description: type, inclination, planarity, roughness, coating, thickness — particular	general
NMLC						Continued from non-cored borehole							
NMLC			59	9		**SHALE:** Dark grey, massive	XW			62		SM, PL, SO, clay, 250mm.	
												SM, clay, PL, 40mm	
							HW					Fracture zone 130mm	
												SM, PL, clay CO, high plasticity, dark grey, 100mm	
							MW		D 0.14 A 0.33			PT, closed, PL, SO, CN	
												PT, 0°, PL, SO, CN	
												PT, 0°, PL, SO, CN	
			58									SM, 0°, PL, clay CO, gravelly clay, high plasticity, dark grey, 150mm	
				10					D 0.28 A 0.36			PT, 0°, UN, clay CO	
						BH14 terminated at 10m							
			57	11									
			56	12									
			55	13									
			54	14									
			53	15									
			52	16									

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

coating

CN	clean
SN	stained
VN	veneer
CO	coating

drawn	**JW**	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	**Appian Group Pty Ltd**
approved	**VN**		project:	**BLACKTOWN HOSPITAL – ADDITIONAL SITE INVESTIGATION**
date	**26/3/2012**			
scale	**Not to scale**		title:	**ROCK CORE PHOTOGRAPH – BH14**
original size	**A4**		project no: **GEOTLCOV24508AA**	Photo no: **1 of 1**

coffey geotechnics

Engineering Log - Borehole

Borehole No. **BH15**

Sheet 1 of 2

Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***16.3.2012***

Principal:

Date completed: ***16.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model and mounting: Mobile Drill B8 Truck | Easting: 307223 | slope: -90° | R.L. Surface: 58.5

hole diameter: 100 mm | Northing 6260729 | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
ADV		C							**ASPHALT**	D			ASPHALT
					58				**FILL: Gravelly SAND :** medium to coarse grained, dark brown/brown, gravel is fine to medium				ROADBASE
						1		CH	**CLAY :** high plasticity, pale grey/orange brown with dark grey mottling	>Wp	St		RESIDUAL SOIL
					57								
				SPT 5,9,13 N*=22		2		CH	**Silty CLAY :** high plasticity, pale grey/orange brown, traces of iron oxide staining with some medium ironstone gravel		H	530 x 520 x	
					56								
						3							
ADT			None encountered	SPT 12,12/90 N*=R					**SHALE :** grey/orange brown, extremely weathered, very low strength, iron stained, remoulds to clay			550 x 510 x	XW SHALE SPT hammer bouncing
					55	4							
				SPT 9/70 N*=R	54				becoming pale yellow brown/grey				SPT hammer bouncing
						5							
					53								
				SPT 18,6/30 N*=R		6			becoming grey to dark grey				SPT hammer bouncing
					52								
						7							
				SPT 8/50 N*=R	51				same as above				SPT hammer bouncing
						8							

Borehole BH15 continued as cored hole

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

M mud N nil

C casing

penetration

1 2 3 4 no resistance ranging to refusal

water

10/1/98 water level on date shown

water inflow

water outflow

Notes, samples & tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

BOREHOLE GEOTLCOV24207AB.GPJ COFFEY.GDT 29.3.12

Form GEO 5.3 Issue 3 Rev 2

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Engineering Log - Cored Borehole

Borehole No. **BH15**

Sheet 2 of 2

Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***16.3.2012***

Principal:

Date completed: ***16.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model & mounting: Mobile Drill B8 Truck | Easting: 307223 | slope: -90° | R.L. Surface: 58.5

hole diameter: 100 mm | Drilling fluid: | Northing: 6260729 | bearing: | datum: AHD

drilling information					material substance						rock mass defects		
method	core-lift	water	RL	depth metres	graphic log core recovery	material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	estimated strength VL L M H VH EH	Is(50) MPa D- diametral A- axial	RQD %	defect spacing mm 30 100 300 1000 3000	defect description: type, inclination, planarity, roughness, coating, thickness — particular / general
NMLC			50	9		Continued from non-cored borehole Shale, dark grey, distinctly laminated at 0°-5°	XW					8m to 8.57m, Rock is extremely weathered with soil properties
							HW					PT, 0°-5°, PL, SO, FeSN
							MW/SW					PT, 0°, PL, SO, clay and gravel CO
												PT, 0°, PL,SO, FeSN
												Closely spaced PT, 0°, PL, SO, clay CO, 100mm
			49				XW		D A 0.3 0.24	11		PT, 0°, PL, SO, CN
				10								PT, 0°, PL, SO, CN
												9.2m to 10.13m, Rock is extremely weathered with soil properties
									D A 0 0			
			48	11		BH15 terminated at 10.13m						
			47	12								
			46	13								
			45	14								
			44	15								
			43	16								

CORED BOREHOLE GEOTLCOV24207AB.GPJ COFFEY.GDT 29.3.12

Form GEO 5.5 Issue 3 Rev. 3

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

coating

CN	clean
SN	stained
VN	veneer
CO	coating

drawn	**JW**	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client: **Appian Group Pty Ltd**	
approved	**VN**		project: **BLACKTOWN HOSPITAL – ADDITIONAL SITE INVESTIGATION**	
date	**26/3/2012**		title: **ROCK CORE PHOTOGRAPH – BH15**	
scale	**Not to scale**		project no: **GEOTLCOV24508AA**	Photo no: **1 of 1**
original size	**A4**			

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Engineering Log - Borehole

Borehole No. **BH16**
Sheet 1 of 2
Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***
Date started: ***16.3.2012***
Principal:
Date completed: ***16.3.2012***
Project: ***Blacktown Hospital Development***
Logged by: ***JW***
Borehole Location: ***Blacktown District Hospital Carpark***
Checked by: ***AJH***

drill model and mounting: Mobile Drill B8 Truck | Easting: 307169 | slope: -90° | R.L. Surface: 58.6
hole diameter: 100 mm | Northing 6260739 | bearing: | datum: AHD

drilling information							material substance						
method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
ADV					58	1		CH	**TOPSOIL : Sandy CLAY** low plasticity, dark brown with some grass rootlets	M >Wp	St		TOPSOIL
									CLAY : high plasticity, brown to orange brown/pale grey, iron stained				RESIDUAL SOIL
									becomes pale grey with some iron staining		St to Vst		
				SPT 10,15/120 N*=R	57							560	hammer bouncing
ADT			None encountered			2			**SHALE :** pale grey/red brown, extremely weathered to highly weathered, very low strength, with some iron staining, remoulds to clay				XW SHALE
					56	3			becoming pale grey to grey, extremely weathered to highly weathered, very low to low strength				hammer bouncing
				SPT 6/80 N*=R	55	4							
				SPT 10,21 N*=R	54	5			becoming dark grey with some iron staining, extremely weathered, very low strength, remoulds to clay				hammer bouncing
					53	6			same as above				hammer bouncing
				SPT 15/100 N*=R	52	7							
				SPT 15/110 N*=R	51	8			same as above				hammer bouncing

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing

penetration
1 2 3 4 no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No.	**BH16**
Sheet	2 of 2
Project No:	**GEOTLCOV24508AA**
Date started:	**16.3.2012**
Date completed:	**16.3.2012**
Logged by:	**JW**
Checked by:	**AJH**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Principal:

Project: ***Blacktown Hospital Development***

Borehole Location: ***Blacktown District Hospital Carpark***

drill model and mounting:	Mobile Drill B8 Truck	Easting:	307169	slope:	-90°	R.L. Surface:	58.6
hole diameter:	100 mm	Northing	6260739	bearing:		datum:	AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
ADT			None encountered	SPT 12/100 N*=R	50	9			**SHALE :** pale grey/red brown, extremely weathered to highly weathered, very low strength, with some iron staining, remoulds to clay *(continued)*				
					49	10							
					48	11							
					47	12			Borehole BH16 terminated at 11.3m				
					46	13							
					45	14							
					44	15							
					43	16							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

M mud N nil
C casing

penetration

1 2 3 4 no resistance ranging to refusal

water

10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No.	***BH17***
Sheet	1 of 3
Project No:	***GEOTLCOV24508AA***
Date started:	***15.3.2012***
Date completed:	***15.3.2012***
Logged by:	***JW***
Checked by:	***AJH***

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Principal:

Project: ***Blacktown Hospital Development***

Borehole Location: ***Blacktown District Hospital Carpark***

drill model and mounting: Mobile Drill B8 Truck | Easting: 307117 | slope: -90° | R.L. Surface: 58.5

hole diameter: 100 mm | Northing 6260743 | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa (100 200 300 400)	structure and additional observations
ADV									**ASPHALT**	D			ASPHALT
									FILL : Gravelly SAND : medium to coarse, brown to dark brown, gravel is fine to medium				ROADBASE
					58	1		CH	**CLAY:** High plasticity, brown/orange, traces of ironstone gravel and iron staining.	>Wp	St		RESIDUAL SOIL
					57								
				SPT 3,4,6 N*=10		2		CH	**Silty CLAY:** High plasticity, pale grey, traces of iron oxide staining and fine gravel.			× × × ×	
					56	3							
				SPT 8,11,15 N*=26				CH	**CLAY:** High plasticity, pale grey, with some medium ironstone gravel.		VSt	× ×	
ADT			None encountered		55	4							
					54				**SHALE:** Drak grey/ red brown, extremely weathered to highly weathered, very low strength, some iron staining.				EXTREMELY WEATHERED SHALE SPT hammer bouncing
				SPT 1,7/40mm N*=R		5							
					53								
						6							SPT hammer bouncing
				SPT 5/60mm N*=R	52								
						7							
					51								
						8			Borehole BH17 continued as cored hole				

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

M mud N nil
C casing

penetration

1 2 3 4 — no resistance ranging to refusal

water

10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Borehole No. **BH17**

Sheet 2 of 3

Engineering Log - Cored Borehole

Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***15.3.2012***

Principal:

Date completed: ***15.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model & mounting: Mobile Drill B8 Truck | Easting: 307117 | slope: -90° | R.L. Surface: 58.5

hole diameter: 100 mm | Drilling fluid: | Northing: 6260743 | bearing: | datum: AHD

drilling information					material substance							rock mass defects			
method	core-lift	water	RL	depth metres	graphic log / core recovery	material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	estimated strength (VL L M H VH EH)	$Is_{(50)}$ MPa D- diametral A- axial	RQD %	defect spacing mm (30 100 300 1000 3000)	defect description: type, inclination, planarity, roughness, coating, thickness (particular / general)
			58	1								
			57	2								
			56	3								
			55	4								
			54	5								
			53	6								
			52	7								
			51			Continued from non-cored borehole						
NMLC				8		**SHALE:** Dark grey with clay lamination.	HW			72		

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

coating

CN	clean
SN	stained
VN	veneer
CO	coating

coffey geotechnics

Borehole No. **BH17**

Sheet 3 of 3

Project No: **GEOTLCOV24508AA**

Engineering Log - Cored Borehole

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***15.3.2012***

Principal:

Date completed: ***15.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model & mounting: Mobile Drill B8 Truck | Easting: 307117 | slope: -90° | R.L. Surface: 58.5

hole diameter: 100 mm | Drilling fluid: | Northing: 6260743 | bearing: | datum: AHD

drilling information					material substance					rock mass defects			
method	core-lift	water	RL	depth metres	graphic log core recovery	material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	estimated strength VL L M H VH EH	$Is_{(50)}$ MPa D- diametral A- axial	RQD %	defect spacing mm 30 100 300 1000 3000	defect description: type, inclination, planarity, roughness, coating, thickness — particular	general
NMLC			50	9		**SHALE:** Dark grey, remoulds to clay, remoulds to clay.	XW		D 0.03 A 0.11	72			Rock is extremely weathered with soil properties
							HW						
			49	10			XW		D 0.09 A 0.18	30			
			48	11		BH17 terminated at 10.1m							
			47	12									
			46	13									
			45	14									
			44	15									
			43	16									

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

coating

CN	clean
SN	stained
VN	veneer
CO	coating

drawn	**JW**	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client: **Appian Group Pty Ltd**	
approved	**VN**		project: **BLACKTOWN HOSPITAL – ADDITIONAL SITE INVESTIGATION**	
date	**26/3/2012**			
scale	**Not to scale**		title: **ROCK CORE PHOTOGRAPH – BH17**	
original size	**A4**		project no: **GEOTLCOV24508AA**	Photo no: **1 of 1**

coffey geotechnics

Engineering Log - Borehole

Borehole No. **BH18**

Sheet 1 of 1

Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***15.3.2012***

Principal:

Date completed: ***15.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model and mounting: Mobile Drill B8 Truck | Easting: 307043 | slope: -90° | R.L. Surface: 67.7

hole diameter: 100 mm | Northing 6260576 | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
ADV / ADT			None encountered		67	1			**ASPHALT**	D			ASPHALT
									FILL : Gravelly SAND : medium to coarse, dark brown/brown, gravel is fine to medium	M			ROADBASE
									FILL : CLAY : low plasticity, grey/brown, traces of fine asphalt gravel	>Wp			FILL
									FILL : CLAY : high plasticity, brown/yellow brown, traces of iron oxide staining				
				SPT 17,14/100 N*=R	66	2			**FILL : Clayey SAND :** fine to medium grained, brown/yellow - orange brown, traces of dark grey pockets of clay				
					65	3							
				SPT 10,18,10/60 N*=R					**FILL : Clayey GRAVEL :** fine, dark grey and red brown, gravel is XW shale and with some iron staining				
					64	4							
				SPT 14/90 N*=R	63	5			**SHALE :** grey to dark grey, extremely weathered, very low strength, remoulds to clay				EXTREMELY WEATHERED SHALE hammer bouncing
					62	6			same as above				hammer bouncing
				SPT 13/110 N*=R	61	7							
				SPT 13/150 N*=R	60	8			becoming dark grey, highly weathered, very low strength with some iron staining				hammer bouncing
									Borehole BH18 terminated at 7.65m				

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

M mud N nil
C casing

penetration

1 2 3 4 no resistance ranging to refusal

water

10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

BOREHOLE GEOTLCOV24207AB.GPJ COFFEY.GDT 29.3.12

Form GEO 5.3 Issue 3 Rev.2

coffey geotechnics

Engineering Log - Borehole

Borehole No. **BH19**

Sheet 1 of 3

Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***15.3.2012***

Principal:

Date completed: ***15.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model and mounting: Mobile Drill B8 Truck | Easting: 307020 | slope: -90° | R.L. Surface: 68

hole diameter: 100 mm | Northing 6260554 | bearing: | datum: AHD

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa (100 200 300 400)	structure and additional observations
ADV		C							**ASPHALT**				ASPHALT
									FILL : Sandy GRAVEL : fine to medium, grey/dark grey becoming medium and coarse gravel	M			ROADBASE
									FILL : CLAY : high plasticity, dark brown - orange, traces of fine asphalt gravel				FILL
					67	1		CH	**FILL : CLAY :** high plasticity, orange, traces of fine gravel	>Wp			
				SPT 5,11,17 N*=28				SP	**FILL : Clayey SAND :** fine to medum grained, orange brown/grey/dark grey with clay	D			
ADT					66	2							
				SPT 16,15/90 N*=R	65	3			becoming yellow brown/brown with some clay and traces of fine gravel	D/M			
			None encountered		64	4							
				SPT 13,15/100 N*=R	63	5			**SHALE :** grey, extremely weathered, very low strength, traces of fine gravel and with some iron staining				EXTREMELY WEATHERED SHALE
				SPT 18,8/40 N*=R	62	6			as above but becoming dark grey, extremely weathered to highly weathered.				
					61	7							
									Borehole BH19 continued as cored hole				
					60	8							

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

M mud N nil

C casing

penetration

1 2 3 4 — no resistance ranging to refusal

water

10/1/98 water level on date shown

water inflow

water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Cored Borehole

Borehole No. **BH19**

Sheet 2 of 3

Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***15.3.2012***

Principal:

Date completed: ***15.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model & mounting: Mobile Drill B8 Truck | Easting: 307020 | slope: -90° | R.L. Surface: 68

hole diameter: 100 mm | Drilling fluid: | Northing: 6260554 | bearing: | datum: AHD

drilling information					material substance						rock mass defects			
method	core-lift	water	RL	depth metres	graphic log core recovery	material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	estimated strength VL L M H VH EH	$Is_{(50)}$ MPa D- diametral A- axial	RQD %	defect spacing mm 30 100 300 1000 3000	defect description: type, inclination, planarity, roughness, coating, thickness — particular	general
			67	1									
			66	2									
			65	3									
			64	4									
			63	5									
			62	6									
			61	7									
						Continued from non-cored borehole							
NMLC			60	8		**SHALE :** dark grey, distinctly laminated at 0°-5°	XW to HW		D 0 A 0.26	< 16			Extremely weathered rock with soil properties

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

planarity

PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

coating

CN	clean
SN	stained
VN	veneer
CO	coating

coffey geotechnics

Engineering Log - Cored Borehole

Borehole No. **BH19**

Sheet 3 of 3

Project No: **GEOTLCOV24508AA**

Client: ***Appian Group Pty Ltd (on behalf of Health Infrastructure NSW)***

Date started: ***15.3.2012***

Principal:

Date completed: ***15.3.2012***

Project: ***Blacktown Hospital Development***

Logged by: ***JW***

Borehole Location: ***Blacktown District Hospital Carpark***

Checked by: ***AJH***

drill model & mounting: Mobile Drill B8 Truck | Easting: 307020 | slope: -90° | R.L. Surface: 68

hole diameter: 100 mm | Drilling fluid: | Northing: 6260554 | bearing: | datum: AHD

drilling information					material substance					rock mass defects		
method	core-lift	water	RL	depth metres	graphic log / core recovery	material: rock type; grain characteristics, colour, structure, minor components	weathering alteration	estimated strength (VL L M H VH EH)	$Is_{(50)}$ MPa (D- diametral, A- axial)	RQD %	defect spacing mm (30 100 300 1000 3000)	defect description: type, inclination, planarity, roughness, coating, thickness (particular / general)
NMLC						**SHALE :** dark grey, distinctly laminated at 0°-5° *(continued)* from 8.17m to 8.22m becoming dark grey/brown	XW to HW			16		
			59	9		**SHALE :** dark grey with occasional clay laminations, indistinctly bedded at 0°-5°	MW to SW		D 0.1 A 0.31	48		PT, 0°, UN, SO, CN PT, 0°, PL, SO, CN Closely spaced PT, 0°-5°, PL, SO, clay CO, 130mm PT closed DB PT, 0°, UN, SO, CN DB Fractured zone, 130mm Fractured core with closely spaced partings and XW seams
			58	10					D 0.03 A 0.45			
						BH19 terminated at 10.06m						
			57	11								
			56	12								
			55	13								
			54	14								
			53	15								
			52	16								

method

DT	diatube
AS	auger screwing
AD	auger drilling
RR	roller/tricone
CB	claw or blade bit
NMLC	NMLC core
NQ, HQ, PQ	wireline core

core-lift

- casing used
- barrel withdrawn

graphic log/core recovery

- core recovered - graphic symbols indicate material
- no core recovered

water

- 10/1/98 water level on date shown
- water inflow
- partial drill fluid loss
- complete drill fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

weathering

FR	fresh
SW	slightly weathered
MW	moderately weathered
HW	highly weathered
XW	extremely weathered
DW	distinctly weathered (covers MW and HW)

strength

VL	very low
L	low
M	medium
H	high
VH	very high
EH	extremely high

defect type

JT	joint
PT	parting
SM	seam
SZ	sheared zone
SS	sheared surface
CS	crushed seam

planarity

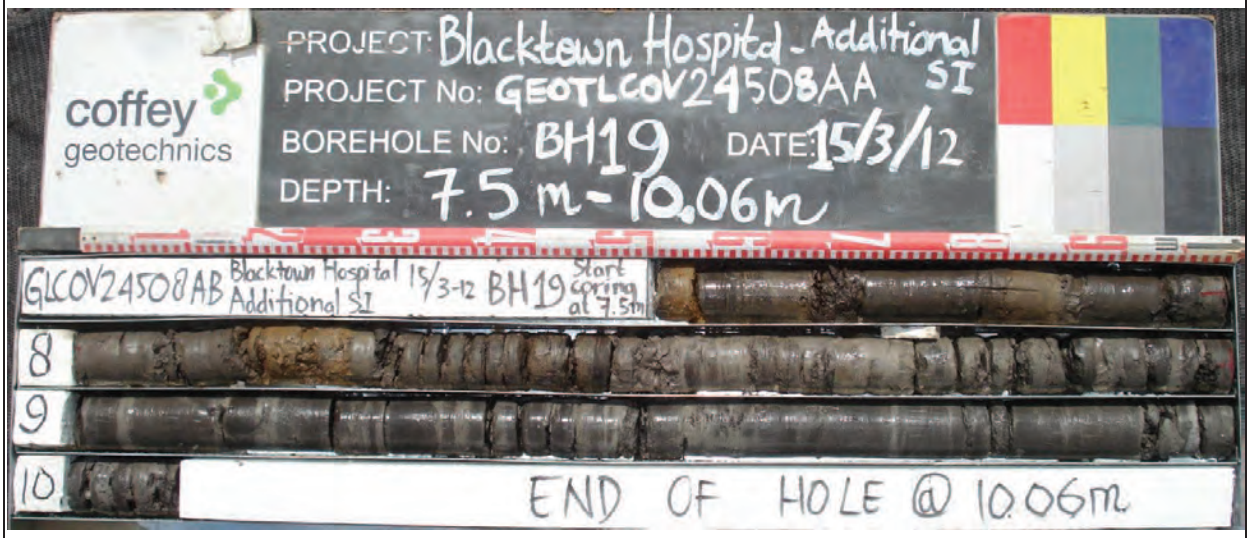
PL	planar
CU	curved
UN	undulating
ST	stepped
IR	irregular

roughness

VR	very rough
RO	rough
SO	smooth
SL	slickensided

coating

CN	clean
SN	stained
VN	veneer
CO	coating



drawn	**JW**	coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	**Appian Group Pty Ltd**
approved	**VN**		project:	**BLACKTOWN HOSPITAL – ADDITIONAL SITE INVESTIGATION**
date	**26/3/2012**			
scale	**Not to scale**		title:	**ROCK CORE PHOTOGRAPH – BH19**
original size	**A4**		project no: **GEOTLCOV24508AA**	Photo no: **1 of 1**

coffey

Soil Description Explanation Sheet (1 of 2)

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μm to 2.36 mm
	medium	200 μm to 600 μm
	fine	75 μm to 200 μm

MOISTURE CONDITION

Dry Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material	Structure and fabric of parent rock visible.
Residual soil	Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil	Deposited by wind.
Alluvial soil	Deposited by streams and rivers.
Colluvial soil	Deposited on slopes (transported downslope by gravity).
Fill	Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.
Lacustrine soil	Deposited by lakes.
Marine soil	Deposited in ocean basins, bays, beaches and estuaries.

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Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)							USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.36 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.			GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)			GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)			GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.36 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes			SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm			IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.					
			DRY STRENGTH	**DILATANCY**	**TOUGHNESS**			
		SILTS & CLAYS Liquid limit less than 50	None to Low	Quick to slow	None		ML	SILT
			Medium to High	None	Medium		CL	CLAY
			Low to medium	Slow to very slow	Low		OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium		MH	SILT
			High	None	High		CH	CLAY
			Medium to High	None	Low to medium		OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS			Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				Pt	PEAT

• Low plasticity – Liquid Limit w_L less than 35%. • Medium plasticity – w_L between 35% and 50%. • High plasticity – w_L greater than 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

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Rock Description Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance	In engineering terms rock substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.
Defect	Discontinuity or break in the continuity of a substance or substances.
Mass	Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME	Simple rock names are used rather than precise geological classification.
PARTICLE SIZE	Grain size terms for sandstone are:
Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mm to 0.6mm
Fine grained	Mainly 0.06mm (just visible) to 0.2mm
FABRIC	Terms for layering of penetrative fabric (eg. bedding, cleavage etc.) are:
Massive	No layering or penetrative fabric.
Indistinct	Layering or fabric just visible. Little effect on properties.
Distinct	Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	Definition
Residual Soil	**RS**	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Material	**XW**	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	**HW**	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	**MW**	The whole of the rock substance is discoloured, usually by iron staining or bleaching , to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	**SW**	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	**FR**	Rock substance unaffected by weathering.

Notes on Weathering:

1. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
2. Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

ROCK SUBSTANCE STRENGTH TERMS

Term	Abbrev-iation	Point Load Index, $I_{s(50)}$ (MPa)	Field Guide
Very Low	**VL**	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
Low	**L**	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	**M**	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	**H**	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	**VH**	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	**EH**	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

Notes on Rock Substance Strength:

1. In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
2. The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
3. The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index $I_{s(50)}$. The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

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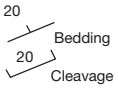
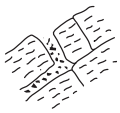
Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES

Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.			 (Note 2)
Joint	A surface or crack across which the rock has little or no tensile strength. but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.			 (Note 2)
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.			
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.			
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.			
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.			
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formad by weathering of the rock substance in place.			

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

DEFECT SHAPE TERMS

Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes of orientation

Note: The assessment of defect shape is partly influenced by the scale of the observation.

ROUGHNESS TERMS

Slickensided	Grooved or striated surface, usually polished
Polished	Shiny smooth surface
Smooth	Smooth to touch. Few or no surface irregularities
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS

Clean	No visible coating
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.

BLOCK SHAPE TERMS

Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greate than cross section

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Appendix B

Geotechnical Laboratory Testing Results

Lane Cove West, Sydney Laboratory

Coffey Information Pty Ltd
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8/12 Mars Road
Lane Cove West NSW 2066

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coffey information
SPECIALISTS IN SCIENTIFIC TESTING SOLUTIONS

Report No: LCOV12S-00401-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd P.O. Box 125 North Ryde NSW 1670
Principal:	HEALTH INFRASTRUCTURE, NSW/APPIAN GROUP LTD.
Project No.:	INFOLCOV00951AA
Project Name:	GEOTLCOV24508AA - BLACKTOWN HOSPITAL
Lot No.:	**TRN:**

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 30/04/2012

Sample Details

Sample ID:	LCOV12S-00401
Client Sample:	BH16
Date Sampled:	16/03/2012
Source:	Ex Job site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	BLACKTOWN HOSPITAL
Sample Location:	BH16 (1.50 to 1.70m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	11.6	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.0	
Mould Length (mm)		125	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	44	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	12	
Plasticity Index (%)	AS 1289.3.3.1	32	

Comments
N/A

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SPECIALISTS IN SCIENTIFIC TESTING SOLUTIONS

Report No: LCOV12S-00402-1
Issue No: 1

Material Test Report

Client:	Coffey Geotechnics Pty Ltd P.O. Box 125 North Ryde NSW 1670
Principal:	HEALTH INFRASTRUCTURE, NSW/APPIAN GROUP LTD.
Project No.:	INFOLCOV00951AA
Project Name:	GEOTLCOV24508AA - BLACKTOWN HOSPITAL
Lot No.:	**TRN:**

NATA
WORLD RECOGNISED ACCREDITATION

This document is issued in accordance with NATAs accreditation requirements. Accredited for compliance with ISO/IEC 17025.

Approved Signatory: Garry Collins
(Specialised Testing Manager)
NATA Accredited Laboratory Number:431
Date of Issue: 30/04/2012

Sample Details

Sample ID:	LCOV12S-00402
Client Sample:	BH18
Date Sampled:	15/03/2012
Source:	Ex Job site
Material:	Subgrade
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	BLACKTOWN HOSPITAL
Sample Location:	BH18 (1.50 to 1.95m)

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	11.9	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	7.0	
Mould Length (mm)		125	
Crumbling		No	
Curling		No	
Liquid Limit (%)	AS 1289.3.1.2	31	
Method		One Point	
Plastic Limit (%)	AS 1289.3.2.1	14	
Plasticity Index (%)	AS 1289.3.3.1	17	

Comments
N/A

Analytical Results

Sub-Matrix: SOIL

				LOCATION	MOUNT DRUITT HOSPITAL		BLACKTOWN HOSPITAL	
			Client sample ID	BH4(1.5-1.95M)	BH8(1.5-1.95)	BH7(0.2-0.7M)	BH 13(1.5-1.95M)	BH 14(3.0-3.1M)
			Client sampling date / time	26-APR-2012 15:00	26-APR-2012 15:00	26-APR-2012 15:00	26-APR-2012 15:00	26-APR-2012 15:00
Compound	CAS Number	LOR	Unit	ES1209976-001	ES1209976-002	ES1209976-003	ES1209976-004	ES1209976-005
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.0	4.6	5.3	7.4	9.2
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	17.3	18.6	17.1	8.0	5.7
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	330	800	150	80	100
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	1420	1180	240	<50	80

Analytical Results

LOCATION BLACKTOWN HOSPITAL

Sub-Matrix: SOIL

Compound	CAS Number	LOR	Unit	Client sample ID: BH 15(1.5-1.95M)	BH 18(1.5-1.95M)	----	----	----
				Client sampling date / time: 26-APR-2012 15:00	26-APR-2012 15:00	----	----	----
				ES1209976-006	ES1209976-007	----	----	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.1	8.9	----	----	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	15.3	9.8	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	200	10	----	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	970	<50	----	----	----