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Posted		
Faxed		
Emailed	X	david@nettcorp.net.au
Courier		
By Hand		
Contact:		Gray Taylor
Our Ref:		P1706171JC04V02
Pages:		5 + Attachments
cc.		

8 October 2019

NettCorp
Att: David De Angelis
By email

Dear David,

RE: PROPOSED NEPEAN GARDENS - WALLACIA GOLF COURSE, PARK ROAD, WALLACIA, NSW.

1.0 Overview

This letter provides a summary of groundwater level monitoring undertaken using wells previously installed to the west of the proposed development area by Martens and Associates Pty Ltd (MA). The groundwater conditions at the proposed development area are assumed to be similar to the area covered by the well locations. The letter should be read in conjunction with MA's preliminary geotechnical, groundwater and salinity assessment report for the site (Ref: P1706171JR01V02, October 2019) and MA's previous interim groundwater summary (ref: P1706171JC03V01, 14 January 2019).

2.0 Groundwater Monitoring Locations

On 22 September 2017, Boreholes (BHs) BH102, BH104, BH105, BH107, BH117 and BH119 were drilled to the west of the site and completed as groundwater monitoring wells (MW102, MW104, MW105, MW107, MW117 and MW119 respectively). The BHs were drilled for geotechnical and hydrogeological characterisation purposes. Refer to Attachment A for BH/MW locations, Attachment B for borehole and groundwater monitoring well logs and Table 1 for a summary of monitoring well details.

Table 1: MW details.

MW	Approximate Surface Level (mAHD) [1]	Depth of MW (mBGL) [2]	Approximate Base of MW (mAHD)	Screened Material
MW102	40	4.00	36	Clay
MW104	45	4.00	41	Sandy clay
MW105	45	3.00	42	Clay
MW107	53	3.00	50	Clay
MW117	49	3.00	46	Clay
MW119	38	4.00	34	Shale

Notes:
[1] Levels approximated based on survey plan (DSP, 2018) – MWs not surveyed.
[2] mBGL – metres below ground level.

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3.0 Groundwater Monitoring Period

Groundwater monitoring included periodic measurement of standing water levels (SWL) in each well using a dip meter and continuous measurement using data loggers installed in each well. The groundwater monitoring period covered by this letter is from 22 September 2017 to 5 December 2018 (inclusive), which is a period of 440 days. The monitoring was undertaken at a measurement frequency of 15 minutes. It is noted that data loggers at MW105, MW107 and MW117 (and barometric data logger) experienced logging errors over a 2-3 week period from the end of May to the middle of June, 2018. These data loggers were restarted and/or replaced on 18 June, 2018, however data was not recorded during this time.

4.0 Groundwater Level Monitoring Results

Groundwater levels obtained by dip meter are summarised in Table 2. The groundwater levels obtained by data loggers, are summarised below:

- MW102 data logger values – After heavy rainfall on 29 & 30 November 2018 (22 and 70 mm respectively), a water level rise of 0.47m (up to 3.53 mBGL) was measured. However, on inspection of the well, it appeared that the water level rise was likely associated with surface water inflow into the well (as indicated by debris and sediments surrounding the well). The well was subsequently bailed dry on 5 December 2018 to enable verification that if no groundwater recharge is observed in the future, it is likely that the rise in level was associated with surface water inflow. No other response to rainfall was recorded prior to December 2018. All manual measurements indicated the well was dry or had <100mm of water, likely associated with a sump at bottom of well that cannot free drain.
- MW104 data logger values – MW04 has had a declining standing water level with all manual measurements recorded as dry since 16 April, 2018. Data does not indicate responses to rainfall events, other than a 0.75m rise associated with 18mm of rainfall on 20.02.2018 noted in P1706171JC01V01.
- MW105 data logger values – No response to rainfall observed. All manual measurements were recorded as dry or <30 mm of water, likely associated with water in a sump at the bottom of well that cannot free drain.
- MW107 data logger values – No response to rainfall observed. All manual measurements recorded as dry or 100-150 mm of water, likely associated with water in a sump at the bottom of well that cannot free drain.
- MW117 data logger values – MW117 contained groundwater throughout the monitoring period. A response to rainfall during monitoring period included 150 - 200 mm rise as a result of March 2018 rainfall events and 50 - 100 mm rise due to rainfall events prior to November 2018. The SWL has declined since well installation, however, heavy rainfall in late November 2018 resulted in a groundwater level rise of approximately 200 mm up approximately 2.21 mBGL. The highest groundwater level recorded was 1.7 mBGL in October 2017.
- MW119 data logger values – No response to rainfall. All manual measurements were recorded as dry or <30 mm of water, likely associated with water in sump at the bottom of well that cannot free drain.

Table 2: Summary of groundwater levels from manual dip measurements.

	Groundwater Level (mBGL)					
Date	**MW102**	**MW104**	**MW105**	**MW107**	**MW117**	**MW119**
22/09/2017	3.4[1]	NR[2]	NR[2]	NR[2]	NR[2]	3.93[1]
29/09/2017	Dry	2.35	Dry	Dry	2.05	Dry
10/10/2017	3.92[3]	2.47	Dry	D	2.02	Dry
23/10/2017	3.9[3]	2.59	Dry	D	1.7	Dry
22/12/2017	4.0[3]	3.15	Dry	2.88[3]	2.06	Dry
25/01/2018	4.0[3]	3.46	Dry	2.87[3]	2.03	Dry
2/03/2018	3.9[3]	3.78	2.98[3]	2.85[3]	2.07	Dry
16/04/2018	Dry	Dry	Dry	2.87[3]	2.11	Dry
18/06/2018	Dry	Dry	2.97[3]	2.88[3]	2.34	Dry
12/07/2018	Dry	Dry	2.98[3]	2.88[3]	2.43	Dry
30/08/2018	Dry	Dry	Dry	Dry	2.51	Dry
25/10/2018	Dry	Dry	Dry	Dry	2.49	Dry
5/12/2018	3.69[5]	Dry	3.00[3]	Dry	2.42	Dry
28/2/2019	NR[6]	Dry	Dry	Dry	2.32	Dry

Notes:

[1]Levels assumed to have been influenced by inflow i.e. drilling water and / or water used for well installation which was not completely purged from boreholes, not natural groundwater level.
[2]Not recorded (NR).
[3]Represent dry or effectively dry MW (non-draining small sump at well base).
[4]Groundwater well locations and elevation to be surveyed to obtain more accurate groundwater data.
[5]Groundwater level likely influenced by surface water entering well. This is to be confirmed following next data collection.
[6]Unable to locate well due to soil and vegetation cover over well.

5.0 Rainfall

Rainfall data over the groundwater monitoring period is provided in Figure 1. Throughout the monitoring period there were 49 days with rain of equal to or greater than 5 mm, 31 days with rain of equal to or greater than 10 mm and 4 days with rain of equal to or greater than 25 mm. Maximum daily rainfall was 70 mm.

A cumulative monthly residual rain mass analysis was completed to assess recent rainfall trends during and leading up to the groundwater monitoring period. The analysis was based on observed rainfall data from Badgerys Creek AWS BOM Station (data from 1995 to present) and long term average rainfall from Badgerys Creek McMasters F.Stn BOM Station (data from 1936 - 1996). The analysis indicated generally below average rainfall from March 2017 onwards. Groundwater level trends are often influenced by cumulative

residual rain mass trends, which indicates groundwater levels in the region are likely to have been generally declining over the monitoring period.

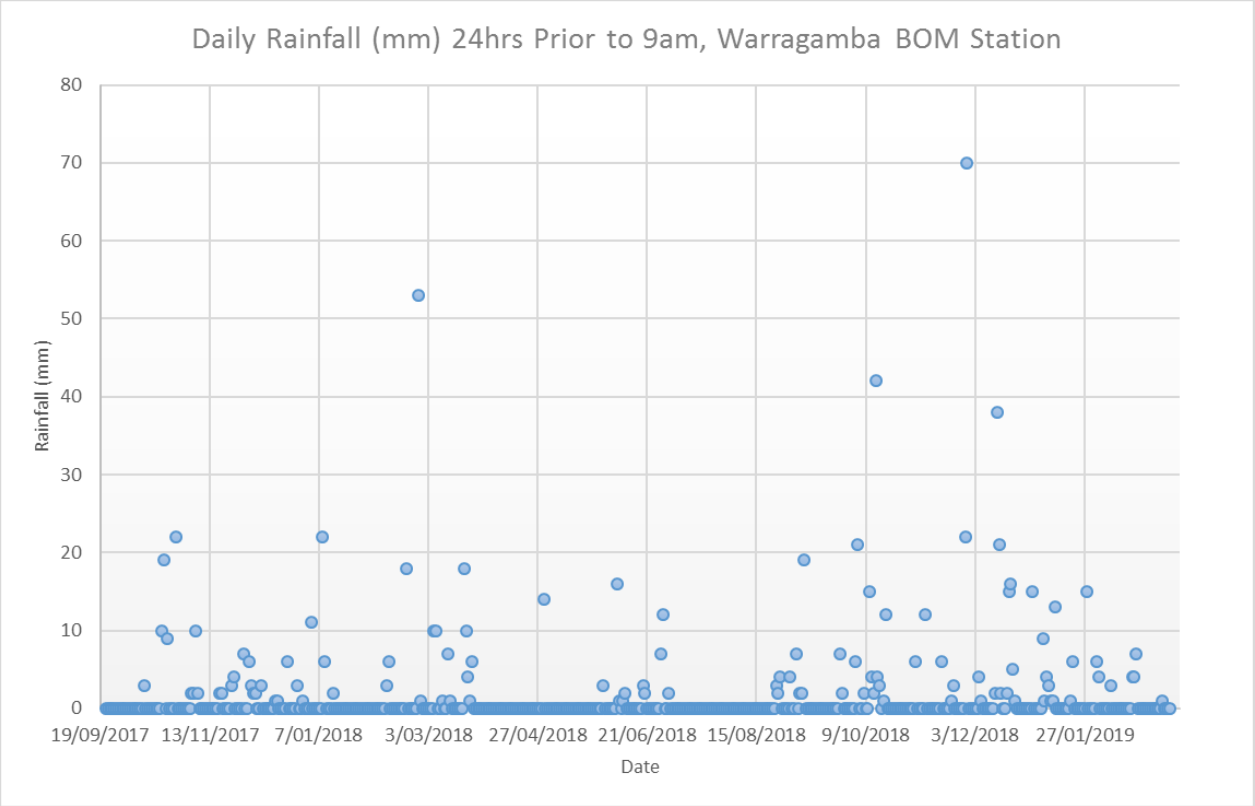


Figure 1: Rainfall over groundwater monitoring period (22 September 2017 to February 2019).

6.0 Conclusion and Recommendations

Groundwater monitoring indicates no shallow groundwater in wells MW105, MW107, MW119. MW102 which have been practically dry after installation, with exception after November 2018 rainfall events. However, the observed water level rise is more likely associated with surface water inflow into the well. MW104 contained groundwater initially at a depth of 2.35 mBGL. The level subsequently lowered. This well was dry since April 2018. MW117 contained groundwater with a level ranging from 1.7 - 2.52 mBGL.

Due to the lack of shallow groundwater being observed in most wells, we don't see the benefit in creating a groundwater model at this stage. Additionally, creating a groundwater model based on the current information we have for this site (i.e. only two locations with groundwater since monitoring began) and only one with continuous water, will likely be difficult and have poor modelling calibration, and therefore results of the model unreliable. Furthermore, these types of saturated and unsaturated shallow systems do not lend themselves to being modelled effectively.

We conclude that based on groundwater monitoring from September 2017 to February 2019, the lot has had constant groundwater in only one well (MW117). The burial plots will likely remain unaffected, with the exception of burial plots proposed in the vicinity of drainage depressions.

If you require any further information please contact our office.

For and on behalf of

MARTENS & ASSOCIATES PTY LTD

BE Engineering (Civil/Geotechnical)

CHRIS LI

References

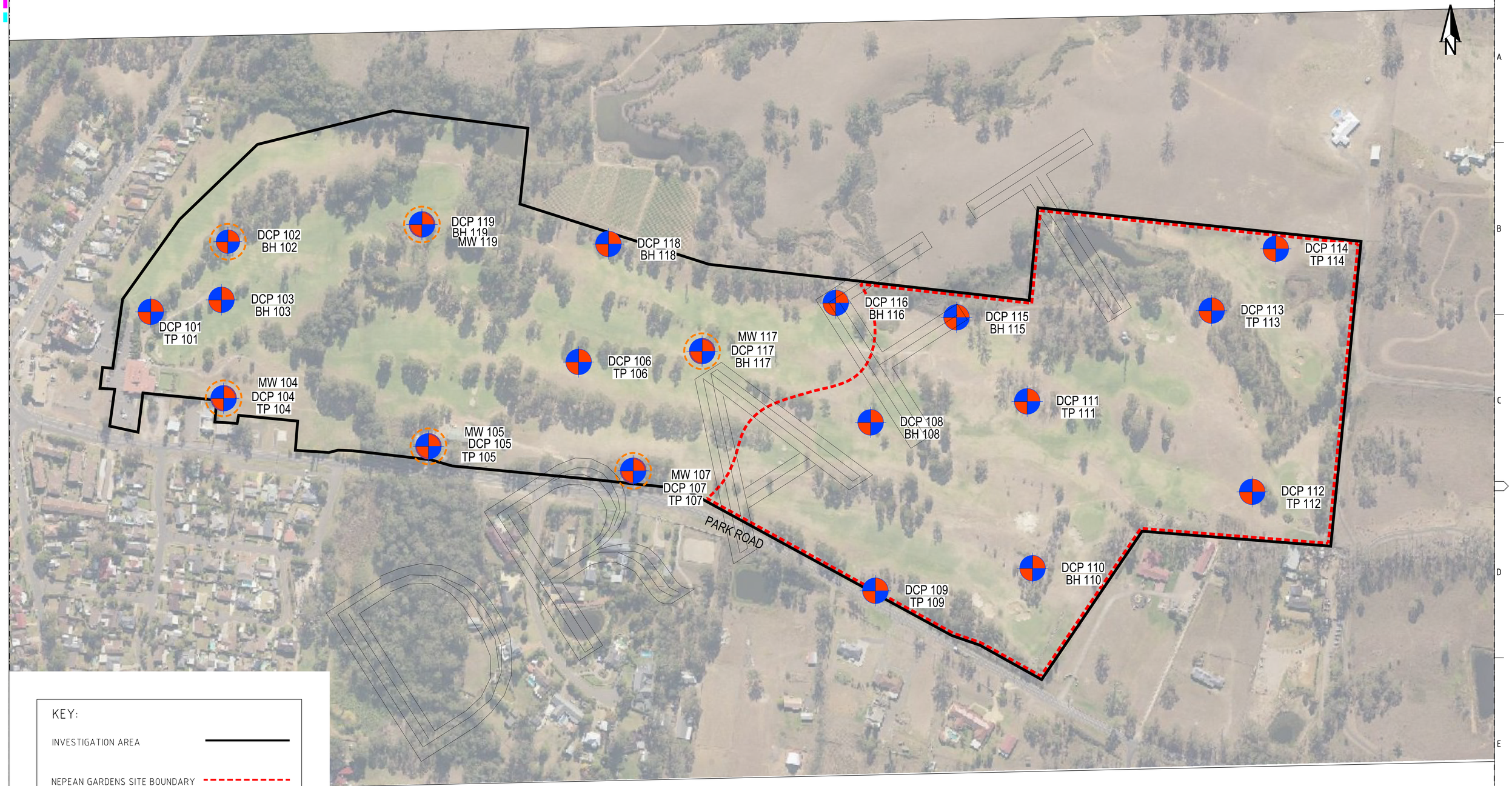
- Degotardi Smith and Partners (2018) – Plan showing detail and levels, Panthers Wallacia Golf Course, 13 Park Road, Wallacia, NSW, 2745. Drawing number 34820A02.DWGr (DSP, 2018).
- Martens and Associates Pty Ltd (2019) – P1706171JR01V02, October 2019 – *Preliminary Geotechnical, Groundwater and Salinity Assessment: Proposed Wallacia Cemetery, Wallacia, NSW*.
- Martens and Associates Pty Ltd (2018) – P1706171JC01V01, February 2018 – *Wallacia Memorial Park – 13-15 Park Road, Wallacia, NSW: Response to Councils Letter dated 23 February 2018 (REF:DA17/1092 ECM:8063701)*.
- Martens and Associates Pty Ltd (2018a) – P1706171JC03V01, January 2019 – Proposed Cemetery - Wallacia Memorial Park at Wallacia Golf Course, 13-15 Park Road, Wallacia, NSW.

Attachments

Attachment A – Borehole/Monitoring Well Locations

Attachment B – Borehole/Monitoring Well Logs

Attachment A – Borehole/Groundwater Monitoring Well Locations



KEY:

INVESTIGATION AREA

NEPEAN GARDENS SITE BOUNDARY

GROUNDWATER MONITORING WELL

INDICATIVE MA BORE HOLE /
DCP / TEST PIT LOCATION

SOURCE:
DOUGLAS PARTNERS, PROJECT 76652.01 (JUNE 2017)

DEVELOPMENT APPLICATION

REV	DESCRIPTION	DATE	DRAWN	DESIGNED	CHECKED	APPRVD
A	INITIAL RELEASE	26/09/2019	GM	CGL	CGL	GT

SCALE
0 20 40 60 80 100 120 140 160 180 200 METRES
A1 (A3) 1:2,000 (1:4,000)

GRID	DATUM	PROJECT MANAGER
MGA	mAHD	GT

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CLIENT
CATHOLIC METRO. CEMETERIES TR.

PROJECT NAME/PLANSET TITLE
PROPOSED NEPEAN GARDENS
GEOTECHNICAL GROUNDWATER AND SALINITY MAPPING
WALLACIA GOLF COURSE, PARK ROAD,
WALLACIA, NSW

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Consulting Engineers
Environment
Water
Geotechnical
Civil
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DRAWING TITLE
GEOTECHNICAL SITE INVESTIGATION LOCATIONS
(AERIAL IMAGE)

PROJECT NO.	PLANSET NO.	RELEASE NO.	DRAWING NO.	REVISION
P1706171	PS02	R01	PS02-J100	A

DRAWING ID: P1706171-PS02-R01-J100

PRINTED: 24.10.2017 - USER: HSHAW
A1 / A3 LANDSCAPE (A1LC_v02.0.01)

Attachment B – Borehole/Groundwater Monitoring Well Logs

CLIENT	Catholic Metropolitan Cemeteries Trust		COMMENCED	22/09/2017	COMPLETED	22/09/2017	**REF MW102**
PROJECT	Prelim. geotechnical, groundwater & salinity assessment		LOGGED	OT	CHECKED	RE	Sheet 1 OF 1
SITE	Proposed Cemetery, Wallacia, NSW		GEOLOGY	Bringelly Shale	VEGETATION	Grass	PROJECT NO. P1706171
EQUIPMENT		4WD ute-mounted hydraulic dril rig	EASTING		RL SURFACE	40 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø75 mm x 4.00 m depth	NORTHING		ASPECT	Northeast	SLOPE 10%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V				40.00				ML	TOPSOIL: SILT, low liquid limit, brown, with some clay, trace gravel.	D	VSt	TOPSOIL
				0.60 39.40				CH	Sandy CLAY, high plasticity, orange, brown.			RESIDUAL SOIL
	M		1	*1.00* 39.00				CH	CLAY, high plasticity, red, grey, with some sand, trace gravel.		VSt and H	
			2	*2.00* 38.00					From 2.0 m: More grey.	M		
	H		3								H	
		23/10/2017 10/10/2017	4	*4.00*					Hole Terminated at 4.00 m (Target depth reached)			
			5									

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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CLIENT	Catholic Metropolitan Cemeteries Trust	COMMENCED	22/09/2017	COMPLETED	22/09/2017	**REF MW104**
PROJECT	Prelim. geotechnical, groundwater & salinity assessment	LOGGED	OT	CHECKED	RE	Sheet 1 OF 1
SITE	Proposed Cemetery, Wallacia, NSW	GEOLOGY	Bringelly Shale	VEGETATION	Grass	PROJECT NO. P1706171
EQUIPMENT	4WD ute-mounted hydraulic dril rig	EASTING		RL SURFACE	45 m	DATUM AHD
EXCAVATION DIMENSIONS	Ø75 mm x 4.00 m depth	NORTHING		ASPECT	North	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	L			45.00				ML	TOPSOIL: SILT, low liquid limit, dark brown, with some clay.	D	St	TOPSOIL
				0.20								
				44.80				CH	Sandy CLAY, high plasticity, red brown, with some gravel.			RESIDUAL SOIL
	M		1								VSt and H	
AD/V			2	*2.00* 43.00					From 2.0 m: Red and grey.	M		
		29/09/2017										
		10/10/2017										
		23/10/2017										
	H		3								H	
			4	*4.00*					Hole Terminated at 4.00 m (Target depth reached)			
			5									

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CLIENT	Catholic Metropolitan Cemeteries Trust		COMMENCED	22/09/2017	COMPLETED	22/09/2017	**REF MW105**
PROJECT	Prelim. geotechnical, groundwater & salinity assessment		LOGGED	OT	CHECKED	RE	Sheet 1 OF 1
SITE	Proposed Cemetery, Wallacia, NSW		GEOLOGY	Bringelly Shale	VEGETATION	Grass	PROJECT NO. P1706171
EQUIPMENT		4WD ute-mounted hydraulic dril rig	EASTING		RL SURFACE	45 m	DATUM AHD
EXCAVATION DIMENSIONS		ø75 mm x 3.00 m depth	NORTHING		ASPECT	North	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				45.00				ML	FILL: SILT, with fine sand, light brown, concrete rubble (<20mm).	D		FILL
	M			*1.00*								
AD/V		Not Encountered	1	44.00				CH	CLAY, high plasticity, red brown, trace silt.	M	H	RESIDUAL SOIL
	H		2									
			3	*3.00*					Hole Terminated at 3.00 m (Target depth reached)			
			4									
			5									

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CLIENT	Catholic Metropolitan Cemeteries Trust		COMMENCED	22/09/2017	COMPLETED	22/09/2017	**REF MW107**
PROJECT	Prelim. geotechnical, groundwater & salinity assessment		LOGGED	OT	CHECKED	RE	Sheet 1 OF 1
SITE	Proposed Cemetery, Wallacia, NSW		GEOLOGY	Bringelly Shale	VEGETATION	Grass	PROJECT NO. P1706171
EQUIPMENT		4WD ute-mounted hydraulic dril rig	EASTING		RL SURFACE	53 m	DATUM AHD
EXCAVATION DIMENSIONS		ø75 mm x 3.00 m depth	NORTHING		ASPECT	North	SLOPE 5%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V		Not Encountered		53.00				ML	TOPSOIL: SILT, low liquid limit, brown.	D		TOPSOIL
				0.20								
				52.80				CH	CLAY, high plasticity, red with grey mottled, with some gravel.		VSt	RESIDUAL SOIL
	M		1	*1.00* 52.00					Grey and red.	M		
			2								H	
	H		3	*3.00*					Hole Terminated at 3.00 m (Target depth reached)			
			4									
			5									

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CLIENT	Catholic Metropolitan Cemeteries Trust		COMMENCED	22/09/2017	COMPLETED	18/09/2017	**REF MW117**
PROJECT	Prelim. geotechnical, groundwater & salinity assessment		LOGGED	OT	CHECKED	RE	Sheet 1 OF 1
SITE	Proposed Cemetery, Wallacia, NSW		GEOLOGY	Bringelly Shale	VEGETATION	Grass	PROJECT NO. P1706171
EQUIPMENT		4WD ute-mounted hydraulic dril rig	EASTING		RL SURFACE	49 m	DATUM AHD
EXCAVATION DIMENSIONS		ø75 mm x 3.00 m depth	NORTHING		ASPECT	North	SLOPE 15%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
				49.00								
AD/V	L			*0.20*				MH	TOPSOIL: Clayey SILT, high liquid limit, dark brown, trace gravel.	D		TOPSOIL
				48.80				CH	CLAY, high plasticity, grey, red, trace gravel.		F	RESIDUAL SOIL
											St - VSt	
			1	*1.00* 48.00					From 1.00 m: More grey.			
	M	23/10/17									VSt	
										M		
		10/10/2017 29/09/2017									VSt - H	
			2									
				2.30 46.70					From 2.30 m: Dark grey.		H	
	H											
				2.80 46.20					SHALE, dark grey, inferred low strength, distinctly weathered.			WEATHERED ROCK 2.80: V-bit refusal.
AD/T			3	*3.00*					Hole Terminated at 3.00 m (Target depth reached)			3.00: TC-bit refusal on inferred medium strength shale. Well and diver installed for groundwater monitoring.
			4									
			5									

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CLIENT	Catholic Metropolitan Cemeteries Trust		COMMENCED	22/09/2017	COMPLETED	22/09/2017	**REF MW119**
PROJECT	Prelim. geotechnical, groundwater & salinity assessment		LOGGED	OT	CHECKED	RE	Sheet 1 OF 1
SITE	Proposed Cemetery, Wallacia, NSW		GEOLOGY	Bringelly Shale	VEGETATION	Grass	PROJECT NO. P1706171
EQUIPMENT		4WD ute-mounted hydraulic dril rig	EASTING		RL SURFACE	38 m	DATUM AHD
EXCAVATION DIMENSIONS		Ø75 mm x 4.00 m depth	NORTHING		ASPECT	East	SLOPE 10%

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS / ASCS CLASSIFICATION	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	M	Not Encountered	1	38.00				ML	TOPSOIL:SILT, low liquid limit, brown, trace gravel.	D		TOPSOIL
				0.30 37.70				CH	Gravelly CLAY, high plasticity, red, trace sand.			RESIDUAL SOIL
				0.90 37.10					From 0.9 m: Grey, red, trace gravel.	M	H - VSt	
			2	*2.00* 36.00					From 2.0 m: More grey.		H	
AD/T			3	*2.70* 35.30					SHALE, grey, inferred low strength, distinctly weathered.			WEATHERED ROCK 2.70: V-bit refusal on inferred low strength shale.
			4	*4.00*					Hole Terminated at 4.00 m (Target depth reached)			
			5									

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