
Report on Updated Desktop Groundwater Assessment

Proposed Residential Development

1B Glover Street, Belmont

**Prepared for Oak Tree Retirement Village
Belmont Pty Ltd**

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

Signature

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Report on Updated Desktop Groundwater Assessment Proposed Residential Development 1B Glover Street, Belmont

1. Introduction

This report presents the results of an Updated Groundwater Assessment undertaken for the proposed residential development at 1B Glover Street, Belmont, New South Wales (NSW). The investigation was commissioned by Oak Tree Retirement Village Belmont Pty Ltd and was undertaken in line with Douglas Partners Pty Ltd (Douglas) proposals 205363.02.P.001.Rev0 dated 10 February 2022 and 205363.07.P.003.Rev0 dated 11 March 2025.

It is understood that the proposed residential development will comprise a four-storey building with single level fully tanked basement. The basement will require excavations up to about 3.0 m deep and require dewatering during construction (i.e. temporary dewatering).

This report has been updated for the proposed modification to the existing approved development, in particular, the extended footprint area for the proposed basement. The updated report also includes additional groundwater level and quality monitoring data which has since been collected. This report therefore supersedes Revision 0 report dated 15 March 2022.

Lake Macquarie City Council and Water NSW require a groundwater assessment for the proposed single-storey basement as it will require excavation below the groundwater table. Under the requirements of the NSW Department of Planning Industry and Environment (DPIE), the *“Minimum Requirements for building site groundwater investigations and reporting – information for developers and consultants”* (January 2021) guideline is relevant in the assessment of this basement.

The scope of this assessment was the following:

- Desktop review of the environmental setting, including topography, soil mapping, existing registered water bores and mapped groundwater dependent ecosystems (GDEs) in the surrounding areas and potential impacts from the development;
- Hydrogeological review of the previous investigations at the site and surrounds followed by development of a conceptual groundwater model (CHM);
- Summary of groundwater levels recorded in groundwater monitoring bores from 2022 to January 2025 and brief comment/comparison against proposed basement levels;
- 2D seepage analysis to estimate the construction seepage inflow rates. This included a sensitivity analysis to account for uncertainty with input parameters;
- Brief comments on groundwater quality based on previous testing by Douglas and disposal options; and
- Preparation of this report.

This assessment has utilised the results of subsurface information obtained by Douglas in previous contamination and geotechnical investigations for the proposed development (Douglas, 2021a; 2022a). Further details are provided in Section 5. A full list of previous reports by Douglas are included in Section 12.

For the purpose of this assessment, the client provided CKDS Architecture and Northrop plans. Relevant information is included in Appendix C.

2. Proposed Development

It is understood that the proposed development will comprise the following:

- Construction of a four-storey residential building;
- Construction of a one level basement which is fully tanked (i.e. no long term water take following completion of construction dewatering);
- A sheet pile cut off wall will be installed to facilitate basement construction. Detailed design of the sheet pile wall has not been completed at the time of this report. For the purposes of this groundwater modelling, the following cases has been considered:
 - o Case 1 – installation of sheet piles to a depth of 12 m ie 1 m into residual clay;
 - o Case 2 – installation depth of approximately 6 m below ground level (i.e. approximately 3 m below basement or -1.5 AHD). This indicative depth was provided by the structural civil designers (Northrop) although it is recommended that the piles are installed below the soft clay to ensure adequate penetration of the Unit 3a clay. This would require sheet piles to be installed below RL -1.4 AHD.
- The basement is to have a finished floor level of 2.2 AHD. Taking into account slab thickness and site preparation, the bulk excavation level could be around 1.6 AHD. This is expected to require excavations up to about 3.0 m depth below current site levels, not including localised deeper excavations for lift wells / sumps / services and the like. The anticipated dewatering level is 0.6 AHD (i.e. 1 m below bulk excavation level);
- The majority of the excavated soils are to be removed from site.

Development plans are provided in Appendix C.

3. Site Description

Site Address	1B Glover Street, Belmont, NSW
Legal Description	Lot 202 Deposited Plan 1236307
Area	9,793 m ²
Zoning	Zone B5 Business Development
	Zone SP2 Infrastructure (Classified Road)
Local Council Area	Lake Macquarie City Council
Current Use	Vacant

The site is bounded by Maude Street to the north, sporting fields to the east and residential development to south and to the west. The Belmont Sporties Club previously occupied the site during initial investigations in 2022 and shown in Figure 1. The club has since been demolished and the site is now vacant. A current aerial photograph of the site is shown on the Test Location Plan on Drawing 2 in Appendix C.



Figure 1: Approximate site boundary outlined in yellow. Image sourced from Google Earth (2022).

4. Desktop Review

4.1 Environmental Setting

Regional Topography	Slight fall to the west of the Pacific Highway towards Lake Macquarie and to the east towards low-lying swamp areas. The site is to the east of the Pacific Highway.
Site Topography	The site is relatively level with a surface level of about RL 4 to 4.5 m AHD.
Geology	Reference to the Newcastle Coalfields Surface Geology Sheet, published by BHP, indicates that the site is underlain by Quaternary coastal sands which is further underlain by rocks (in descending order) of the Boolaroo Sub-Group, Adamstown Sub-Group and Lambton Sub-Group; all belonging to the Newcastle Coal Measures. The Newcastle Coal Measures are of Permian age and typically comprise sandstone, conglomerate, siltstone, claystone, coal and tuff. The mined coal seams (Victoria Tunnel and Borehole Seam) are within the lower sequence the Lambton Sub-Group. The NSW Seamless Geology map indicates that the site is in an area of anthropological deposits, noting possible concrete and demolition rubble.
Soil Landscape	Woy Woy. Characterised by level to gently undulating non-tidal sand flats and beach ridges on marine sands, with deep (>200 cm) Siliceous Sands. Limitations include permanently high water tables, localised flooding, periodic waterlogging in depressions, very low to low soil fertility, localised areas of high soil erosion hazard.
Acid Sulfate Soils (ASS)	High probability of ASS between 1 m and 3 m below the ground surface.
Surface Water	An unnamed creek located approximately 450 m east of the site, along with low-lying swamp area is considered to be the nearest sensitive receptor.
Groundwater	Two registered groundwater bores within 500 m of the site. The groundwater bores, registered as monitoring wells are both located approximately 450 m west of the site, located on Maude Street. Standing water level in the wells was 0.85 m below ground level
Groundwater Dependant Ecosystems (GDE)	A review of the Bureau of Meteorology GDE Atlas indicates the following mapped GDEs nearby the site: - Wetland area (approximately 400 m east) as high potential of terrestrial and aquatic GDE; and - Lake Macquarie (approximately 700 m west) as moderate potential of aquatic GDE.

4.2 Water Regulations

The *Water Sharing Plan for the North Coast Coastal Sand Groundwater Sources 2016* is applicable to the site.

It is understood that Water NSW has issued a General Terms of Approval (GTA) for the Water Supply Work Approval, reference number IDAS1142581 on 10 May 2022 pertaining to the initial proposed development and smaller basement footprint.

The GTA indicated that dewatering for temporary construction dewatering was permitted, and includes a number of terms and conditions particularly in regard to volume limits (3 ML annually) and requirements for a construction dewatering management plan (DMP).

It is noted that the approval lapsed on 10 May 2022 and therefore new application would be required for the current modified development.

A copy of the GTAs issued 10 May 2022 are included in Appendix D.

5. Previous Investigations

5.1 Preliminary Contamination and ASS Assessment – Coffey (Coffey, 2020)

A Phase 1 Preliminary Site Assessment and Acid Sulfate Assessment was conducted by Coffey for the subject site in December 2020. The investigation was undertaken for a seniors housing development which was proposed at that time.

The investigation comprised a desktop review for contamination, inspection and limited intrusive investigation at five bores (BH01 to BH05) drilled to depths of up to 2.7 m. Relevant findings to this investigation are generally as follows:

- Upper fill materials including building waste materials in some bores;
- Generally sand profile underlying fill materials to termination depths. Lenses of “sandy siltstone” / “silty sandstone” were noted within the sand layer which differ from subsequent investigations by Douglas (2021a; 2022a) as discussed below;
- An inferred groundwater depth of about 2.4 m to 2.7 m below ground level, based on the depths recorded for borehole collapse;
- A low potential for ASS in the top 2.0 m of the soil profile. Some potential ASS results were observed in screening and detailed testing, however the results of detailed ASS testing indicated chromium reducible sulfur and net acidity below the adopted ASS action criteria.

The investigation recommended further assessment of soil for contamination and ASS which was subsequently undertaken for the current proposed development and the results are summarised in Section 5.2 below.

5.2 Contamination, ASS Testing and Geotechnical Investigation – Douglas Partners (Douglas, 2021a; 2022a)

5.2.1 Overview

Further contamination and ASS testing was undertaken by Douglas in July 2021 (Douglas, 2021a), following on from the results and recommendations in the previous assessment (Coffey, 2020). The work was undertaken concurrently with a geotechnical investigation (Douglas, 2022a). The investigations were undertaken for the proposed three-storey apartment development with basement excavation. As discussed in Section 2, the current development includes an extended basement footprint.

The field work for the investigations comprised the following:

- Drilling of seven boreholes (Bores 1 to 7) to depths of up to 4.0 m below ground level using a track mounted drill rig and hand auger;
- Installation of groundwater wells in three boreholes (Bores 5 to 7);
- Testing of selected soil samples for an assessment of contamination, waste classification and ASS;
- Testing of groundwater samples to establish baseline groundwater conditions and assess groundwater levels;
- Four cone penetration tests (CPT) designated CPT 101 to 103 and 102A to depths of between 9 m and 14.7 m for the geotechnical investigation.

The test locations are shown on Drawing 1 in Appendix C.

5.2.2 Subsurface Conditions

Subsurface conditions encountered in the bores/CPTs are summarised in Table 1.

Table 1: Generalised Summary of Subsurface Conditions (Douglas, 2021b)

Unit	Description	Depth range (m bgl) to base of unit	RL range to base of unit (AHD)
Unit 1	Fill	0.15 to 0.4	4.5 to 3.9
Unit 2	Alluvial Sand (Typically Loose to Medium Dense)	4.32 to 4.45	3.9 to -0.2
Unit 3.1	Alluvial Clay	5.79 to 5.87	-0.2 to -1.4
Unit 3.2	Alluvial Sand and Clay Layers	7.85 to 10.8	-1.4 to -6.5
Unit 4	Residual Clay (Very Stiff to Hard)	>9.0 to >14.7	< -6.5 to < -10.5

Notes to Table 1:

m bgl – metres below ground level

5.2.3 Groundwater Levels

Groundwater observations at the time of field work were as follows:

- At depths of approximately 1.8 m and 1.9 m below ground level (2.3 AHD and 2.7 AHD) in completed CPT holes (5 July 2021);
- At depths between 1.6 m and 2.0 m (2.4 AHD to 2.8 AHD) in Bores 3 to 7 during drilling (21 July 2021);
- At depths of 1.4 to 1.6 m below ground level (2.6 AHD to 2.7 AHD) in groundwater monitoring wells during sampling (29 July 2021).

The maximum groundwater level measured in wells during this investigation was 2.7 AHD. It should be noted that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

5.2.4 Groundwater Quality

Groundwater purging and sampling was undertaken from three monitoring wells (Bores 5 to 7). The locations were selected based on the presence of groundwater and the site coverage. It should be noted that the testing was limited to testing of the identified potential contaminants, rather than a broad assessment of water quality parameters for groundwater disposal assessment.

The results of field, laboratory testing and laboratory report sheets are shown in Appendix B.

Pertinent results of the groundwater testing are as follows:

- Contaminant concentrations were generally low. Total recoverable hydrocarbons (TRH) and polycyclic aromatics hydrocarbons (PAH) were not detected above laboratory limit of reporting (LOR). Toluene was identified in groundwater for Bore 6 at a concentration equal to the LOR;
- All groundwater samples were below the adopted ANZG (2018) freshwater default guideline values (DGV) for slightly to moderately disturbed systems except for slightly exceedances of:
 - o Dissolved nickel in Bore 5; and
 - o Dissolved zinc in Bores 5 and 6.
- The concentrations of metals in groundwater were considered to most likely represent background concentrations of groundwater, attributed to mineralogy of the soils and underlying rock.

5.2.5 Acid Sulfate Soils

Acid sulfate soil testing indicated the presence of ASS at the site, likely to be at levels below 1.0 AHD. Soils excavated from at or below this depth as part of construction works would be subject to treatment and management as per the site-specific acid sulfate soil management plan (ASSMP) (Douglas, 2022b). The ASSMP noted that effects of dewatering and temporary lowering of the groundwater table require consideration in both the ASSMP and dewatering management plan (DMP).

5.3 Groundwater level monitoring 2022 to 2025 – Douglas Partners

Groundwater level monitoring has been undertaken from May 2022 to present to assess baseline groundwater levels prior to construction and confirm the assumptions made in the initial Desktop Groundwater Assessment report and Dewatering Management Plan. Pre-construction monitoring is also a requirement of a Water Supply Work Approval for temporary dewatering during construction.

Monitoring comprised manual measurement of groundwater levels in monitoring wells installed in conjunction with previous investigations (Douglas, 2021a; 2022a) as well as installation of automated loggers to record groundwater level changes at 20 minute intervals.

Loggers were initially installed in BH5, BH6 and BH7 from May 2022 to July 2022. Logger monitoring continued in BH7, BH203 and BH204 from July 2022 to October 2023 and March 2024 to present (April 2025). These wells were positioned within the proposed basement excavation and exterior to provide pre- construction data and for comparison during construction.

Well locations and the proposed basement are shown on Drawings 1 and 2 in Appendix C. A plot of water level (pressure) versus time for installed loggers and manual gauging levels is shown on Figure C1 in Appendix C. The data is shown against daily rainfall data recorded at Newcastle Nobbys Bureau of Meteorology weather station. Groundwater pressures have been corrected for barometric pressure influences.

It is noted that the monitoring period captured a number of significant rainfall events, including a two-week period from 2 to 15 July 2022 of persistent daily rainfall totalling 233 mm. A daily rainfall event of 107.4 mm also occurred on 6 May 2024. Peak water levels were recorded on 11 July 2022.

Table 2 summarises the minimum, maximum and range of water levels logged during the monitoring period within the bores.

Table 2: Range of groundwater Level in bores – May 2022 to January 2025

Well ID	Groundwater Depth			Groundwater Level		Estimated Bulk Excavation Level
	Minimum	Maximum	Fluctuation	Minimum	Maximum	
	m bgl	m bgl	m	AHD	AHD	
5	0.75	1.86	1.11	2.46	3.56	1.6
6	0.72	1.70	0.98	2.55	4.18	
7	0.70	1.68	0.98	2.42	3.40	
203	0.74	1.93	1.18	2.35	3.54	
204	0.86	1.93	1.06	2.48	3.54	

Notes to Table:
 m bgl metres below ground level

It is noted that the above groundwater levels are not considered a design groundwater level as defined in Structural Design Actions Standard AS1170.1, 2002.

The results of monitoring indicated the following:

- Sharp increases in groundwater levels generally occur for rainfall events greater than 50 mm, or where sustained daily rainfall events occur. Sharper responses were apparent in 2024 following removal of the building structure and an increase in the available area for rainfall infiltration;
- More generally, groundwater levels increased slowly in response to typical daily rainfall events, possibly from flows from upgradient / unsealed sites, as evidenced during the initial monitoring period in 2022 and 2023 where the site was paved and not subject to direct infiltration;
- Groundwater levels increased by 0.83 m for 14 to 15 March 2023 for Wells 203 and 204 only, with a lesser increase of 0.15 m for Bore 5 several days later. Only 13.4 mm of total rainfall was recorded for 13, 14 and 15 March, which suggests the levels are possibly spurious on the basis that Bore 5 typically demonstrated a similar response to rainfall as Bore 203 and 204.

It is noted that the maximum groundwater level of 3.56 AHD was slightly higher than the value used for the groundwater inflow modelling analysis which used RL 3.2 AHD. It is considered that a groundwater level of 3.2 AHD is adequate for the seepage inflow analysis because seepage analysis was for temporary construction activities and groundwater levels over most of the monitoring period were generally below this level with an average level of about 2.8 AHD.

Groundwater levels affected by factors such as climatic conditions and soil permeability and will therefore vary with time.

6. Preliminary Conceptual Hydrogeological Model

On the basis of the desktop review and previous subsurface investigations, the following preliminary conceptual hydrogeological (CHM) model has been prepared. The subsurface profile and material permeabilities are based on the results of the previous investigations by Douglas (Douglas, 2021a; Douglas, 2022a) in Section 5 and subsequent groundwater level monitoring shown on Figure C1 in Appendix C.

Based on published literature by Fetter (2001) and Douglas experience with similar soils, the estimated range of hydraulic conductivities for the site are presented in Table 3.

Table 3: Soil Units and Hydraulic Conductivity Parameters

Unit	Level (AHD)	Description	Permeability (m/s) Table 3.7 (Fetter, 2001)	Adopted Permeability (m/s)
1	4.5 to 3.9	Fill	NA – above water table	-
2	3.9 to -0.2	Sand (loose to dense)	1×10^{-4} to 1×10^{-2} Fetter Table 3.7 – Well graded sand	5×10^{-5} to 1×10^{-4} Based on experience in the area ⁽¹⁾
3a	-0.2 to -1.4	Clay (soft to firm / firm to stiff)	1×10^{-9} to 1×10^{-6} Fetter Table 3.7 – Clay	1×10^{-9} to 1×10^{-7}
3b	-1.4 to -6.5	Interlayered sand (loose to medium dense) and clay (stiff to very stiff)	1×10^{-7} to 1×10^{-5} Fetter Table 3.7 – Clayey sand	1×10^{-7} to 1×10^{-5} Based on experience in the area
4	-6.5 to -10.5	Residual Clay – typically very stiff to hard.	1×10^{-9} to 1×10^{-7} Fetter Table 3.7 – Clay	1×10^{-9} to 1×10^{-7}

Notes to Table 3:

(1) Permeability testing of sands at George Fire Trail (approximately 500 m south) using Hazen method

Unit 1 and Unit 2 are considered to represent an unconfined aquifer and therefore the water levels in these layers are expected to fluctuate with climatic and near surface drainage conditions.

Unit 3 layer consists of clay and is considered to represent the base of the unconfined aquifer. The results of the geotechnical investigation identified that this layer was present in each test. The analysis has been based on the Unit 3 layer being present across the full width of the site. It should be noted that there is a risk that this layer may not be continuous across the site because it has been deposited in an alluvial environment which can be highly variable. If the layer is not continuous across the full width of the site, groundwater flows into the basement could be substantially higher than estimated for Case 2. Additional CPTs could be completed now that building structures have been removed to further understand the risks associated with the uniformity of this layer.

Unit 3b layer consists interbedded sand and clay layers, given the presence of clay layers, and without site specific permeability data, permeability of this layer is considered to be similar to clayey sands as described by Fetter (2001).

It is noted that the permeabilities of Unit 4 is considered the critical parameter for assessing seepage flows for Case 1. A sensitivity analysis has been undertaken to assess the effect of seepage rates based on the range of parameters.

Subsurface conditions are expected to be primarily sandy and would therefore likely be of relatively high permeability. Lower permeability layers or lenses, comprising silt or clay may also be present, but these are not expected to be confining layers but can affect the efficiency of spear point wells if used during construction.

As per the provided site section plan (CKDS drawing A-13001 in Appendix C), the proposed top of basement level is at 2.2 AHD. The expected bulk excavation level could be around 1.6 AHD and will be situated into Unit 2 sand.

Dewatering will be required for basement construction to provide a surface for placement of a granular working layer. For the purposes of this report, groundwater levels on the inside of the basement has been based on 1 m below underside of the anticipated bulk earthworks level, i.e. 0.6 AHD.

7. Groundwater Inflow Analysis

7.1 Methods and Assumptions

The groundwater inflow into the proposed excavation level was estimated using the 2D groundwater seepage computer program SEEP/W. The model was based on subsurface conditions and design parameters as described in Section 6.

Given that a perimeter wall will be installed below the Unit 3a clay layer, dewatering by a combination of excavated sumps and submersible pumps inside the sheet pile wall perimeter are expected to be used to dewater the proposed basement excavation.

The estimated inflow into the proposed site excavation was estimated based on the following assumptions:

- One single excavation (see Figure 2);
- Model based on a 'critical' cross section, i.e. widest section across the excavation (see Figure 2);
- Subsurface profile based on the CHM is as described in Section 6 and Table 3, with subsurface soil units continuous below the site based on previous investigations (Douglas, 2022a);
- Groundwater level around the outside perimeter of the sheet pile wall was modelled as 3.2 AHD, a conservative level which is higher than the average groundwater level which generally remains below RL 2.8 for average conditions. This should not be considered the design groundwater level for the long term basement construction;
- Water table within the basement excavation modelled to be drawn down to 1 m below the base of the bulk excavation (0.6 AHD);
- Basement wall perimeter measured off the plans (see Figure 2) has been considered to be 290 m (75 m by 70 m) which takes into account the irregular shape of the excavation and is therefore a conservative assessment;
- Perimeter wall installed to a depth of 12 m below ground level ie at least 1 m inter Unit 4 clay for a 'Case 1' scenario;
- Perimeter wall installed to a depth of 6 m below ground level for a 'Case 2' scenario (indicative depth advised by structural designers);

- Vertical to horizontal permeability ratio K_v/K_h was modelled at a ratio of 0.5 for all layers (typical value).

It should be noted that Case 2 inflow rates are largely dependent on permeabilities of Unit 2 (sand), Unit 3a (clay) and Unit 3b (clayey sand). In lieu of site-specific soil permeability data, conservative values have been assumed.

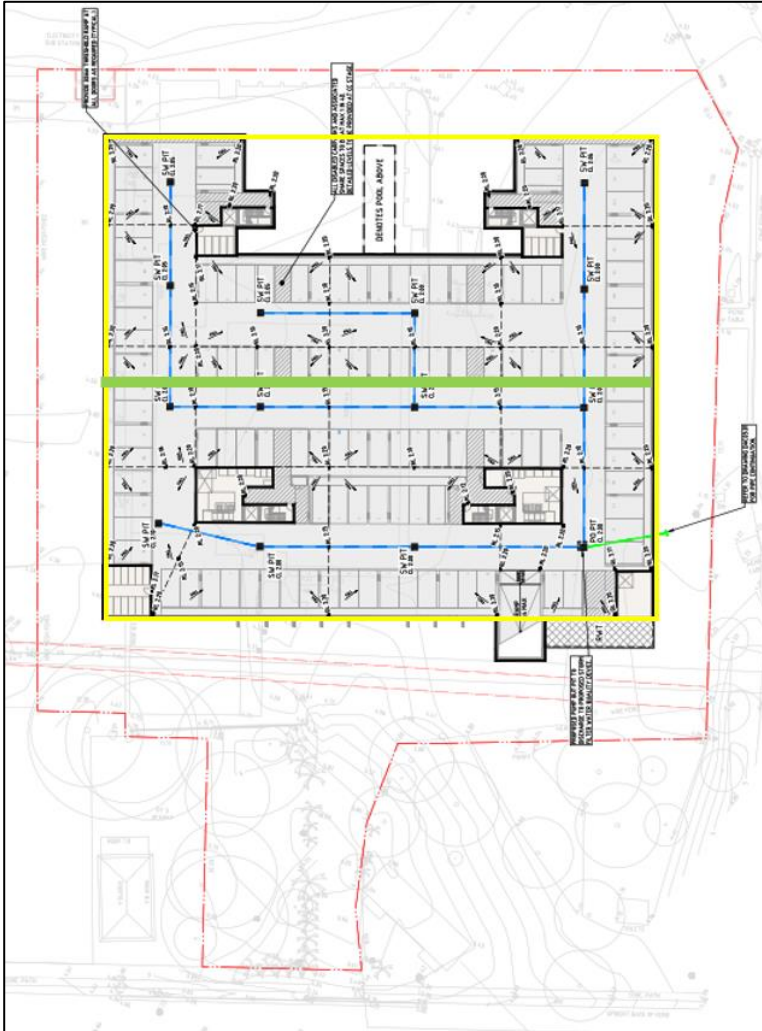


Figure 2: Modelled excavation shown in yellow, critical section shown in green, site boundary shown in red (figure adapted from Northrop drawing DA1-C04.01 revision A).

7.2 Geometry

A transient model in SEEP/W was run for time steps of 1 day, 14 days and 182 days (6 months) using subsurface materials and parameters discussed above. The geometric models for Cases 1 and 2 are shown in Figure 3 and Figure 4.

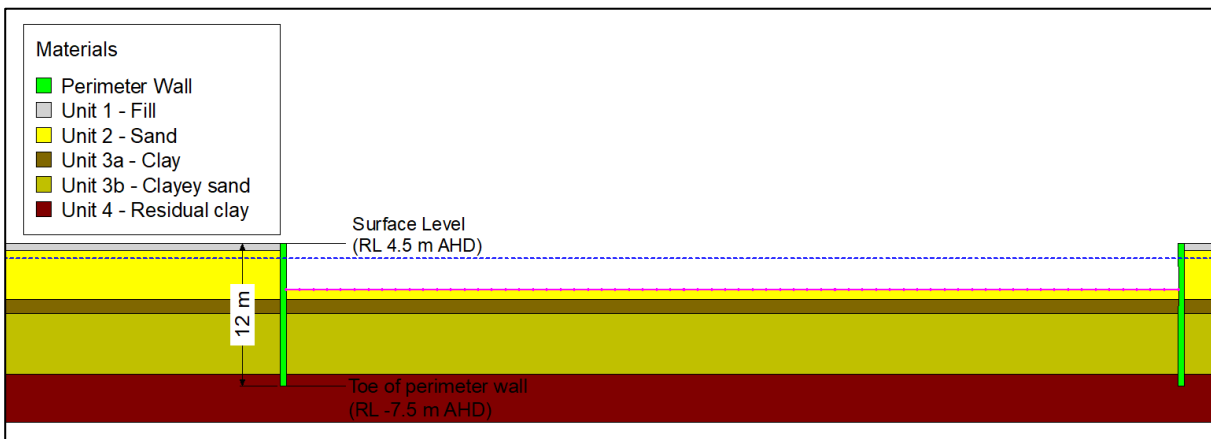


Figure 3: Geometric Model – Case 1 (All time steps)

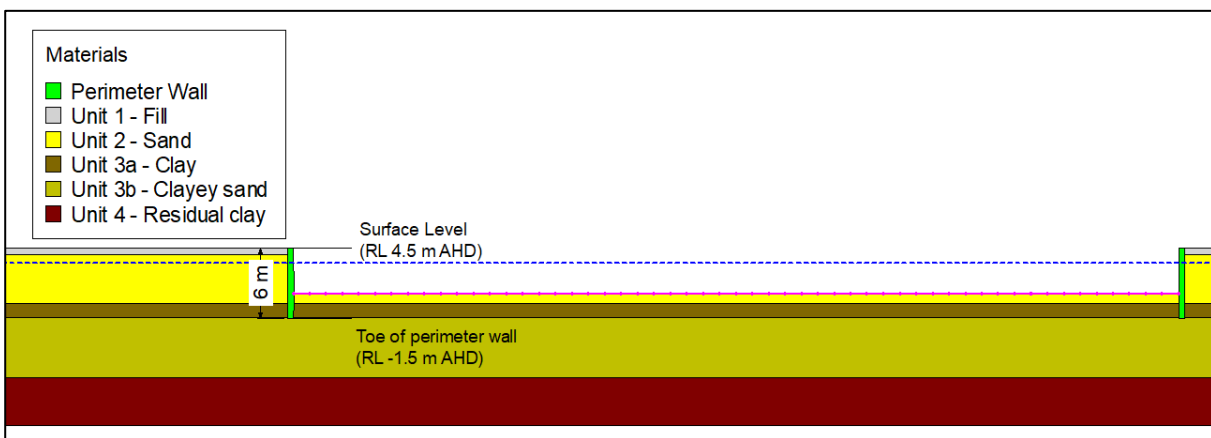


Figure 4: Geometric Model – Case 2 (All time steps)

7.3 Results

The pressure distribution for the models for the 182 day (6 month) time step are shown in Figure 5 and Figure 6 for Case 1 and Case 2 respectively.

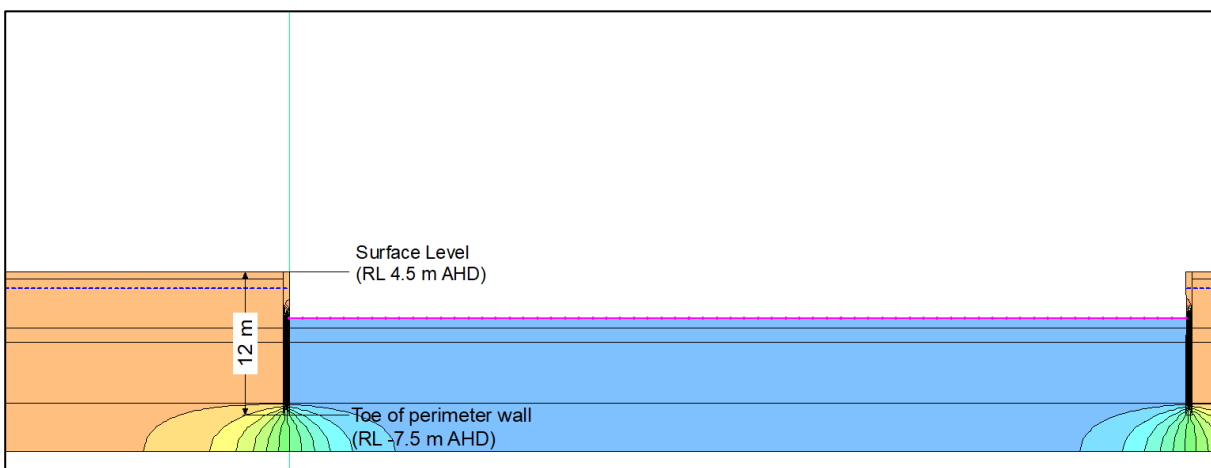


Figure 5: Pressure Distribution – Case 1 (182 day time timestep)

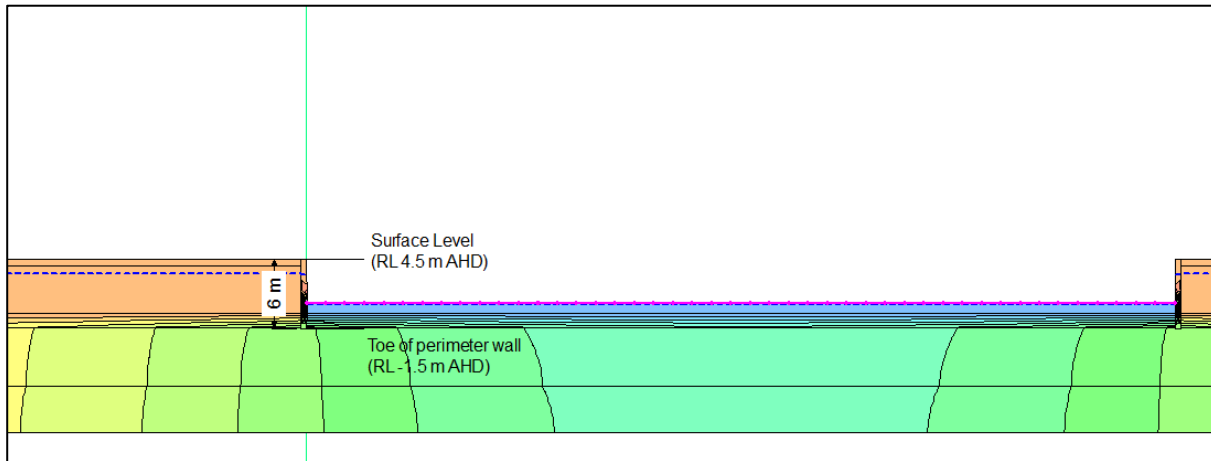


Figure 6: Pressure Distribution – Case 1 (182 day time timestep)

The model estimates groundwater inflows for a 1 m thick slice through the site. Given that the basement has a perimeter of approximately 290 m (75 m by 70 m), this inflow is multiplied by half the basement perimeter to approximate inflows for the entire basement. The estimated basement inflows for the time step periods are summarised below in Table 4.

Table 4: Results of Groundwater Inflow Modelling

Case	Description	Inflow rate		
		1 day	2 weeks	6 months
		kL / day	kL / day	kL / day
Case 1 - 12 m sheet piles (socketed into residual clay)	75 m by 70 m basement excavation – perimeter wall installed 12 m below ground level (-7.5 AHD)	0.4 to 17.8	0.11 to 6.2	0.11 to 5.5
Case 2 – 6 m sheet piles (socketed into clay/clayey sand)	75 m by 70 m basement excavation – perimeter wall installed 6 m below ground level (-1.5 AHD)	0.62 to 40.9	0.44 to 39	0.43 to 32.9

The above analysis does not include leakage through the perimeter wall, which depends on contractor expertise and tightness of joints, hence some excess capacity in removing water would be advisable.

8. Groundwater Changes During Construction

Drawdown due to dewatering at distances of 5 m, 10 m and 25 m from the perimeter walls based on the modelling is shown in Table 5.

Table 5: Estimated Drawdown Based on Modelling

Case	Description of Perimeter Wall	Estimated Drawdown from outside perimeter (m)		
		5 m distance	10 m distance	25 m distance
Case 1 - 12 m sheet piles (socketed into residual clay)	75 m by 70 m basement excavation – perimeter wall installed 12 m below ground level (-7.5 AHD)	<0.1	<0.1	<0.1
Case 2 – 6 m sheet piles (socketed into clay/clayey sand)	75 m by 70 m basement excavation – perimeter wall installed 6 m below ground level (-1.5 AHD)	<0.1 to 0.8	<0.1 to 0.8	<0.1 to 0.8

Notes to Table 5:

Drawdown taken from model at 6-month time step (182 days)

Provided over-pumping is not undertaken, and dewatering is completed inside the sheet piles, the modelling suggests that widespread lowering of the unconfined aquifer is unlikely for Case 1 and minor for Case 2.

Analysis of Case 1 indicates the change in the groundwater head as modelled is commensurate with the changes in groundwater which can be naturally expected on site.

Analysis of Case 2 indicates a change in groundwater head of less than 1 m is expected at distances greater than 5 m from the excavation. A change in head of 1 m is equivalent of an increase in effective stress of up to about 10 kPa which is expected to result in a total settlement of up to about 10 mm to 15 mm which reduces with distance from the excavation.

Smaller (negligible) settlements could be expected as the site may have experienced dewatering or changes in groundwater levels in the past due to natural groundwater changes or previous dewatering activities, such as for the installation of services such as sewer or water.

9. Groundwater Extraction Estimates

Groundwater extraction estimates were based on 2D groundwater seepage modelling (SEEP/W) and subsurface conditions from previous investigations. The results are shown in Table 6, below.

Table 6: Summary of Groundwater Extraction Volumes

Stage	Estimated Duration	Estimated Rate (kL per day)	Estimated Volume (ML)
Case 1 – 12 m sheet piles (socketed into residual clay)			
Initial Dewatering – commencement i.e. two times initial dewatering rate	2 weeks	0.8 to 35.6	0.011 to 0.50
Daily dewatering – during construction	6 months	0.11 to 5.5	0.02 to 1.0
Daily dewatering – during construction (contingency)	2 months	0.11 to 5.5	0.01 to 0.33
Leakage through perimeter wall	Duration of project	Difficult to determine	Not estimated
Total estimate	6 to 8.5 months		0.04 to 1.83
Case 2 – 6 m sheet piles (socketed into clay/clayey sand)			
Stage	Estimated Duration	Estimated Rate (kL per day)	Estimated Volume (ML)
Initial Dewatering – commencement i.e. two times initial dewatering rate	2 weeks	1.24 to 81.8	0.01 to 1.15
Daily dewatering – during construction	6 months	0.43 to 32.9	0.08 to 5.92
Daily dewatering – during construction (contingency)	2 months	0.43 to 32.9	0.03 to 1.97
Leakage through perimeter wall	Duration of project	Difficult to determine	Not estimated
Total estimate	6 to 8.5 months		0.12 to 9.04

The modelling estimates indicate that groundwater take during the construction period is likely to be relatively minor for Case 1. The total volume would be expected is less than the 3 ML in an annual period and as such a water access licence exemption should be applicable for the site.

For Case 2, groundwater inflows would be higher and the total volume would be expected greater than 3 ML (predicted inflow of up to 9 ML for an 8.5 month period and higher if construction is longer). This scenario would require a groundwater licence.

10. Dewatering Strategy and Water Management

Dewatering activities should be undertaken in a controlled manner. The dewatering strategy will be confirmed by the dewatering contractor subject to the final design of the basement, building construction methodology and timing, and being dependent on the results of this groundwater assessment.

Based on previous experience, the following general set-up may be applicable:

- Install perimeter sheet piles;
- The effectiveness of dewatering spears is expected to be limited given the proximity of the soft clay below the base of the bulk excavation level. Accordingly, dewatering is expected to consist of a combination of internal sumps / submersible pumps and dewatering spears installed internally to the perimeter walls. The depth and spacing of the wells would require design by the contractor;
- The spear array could be connected to a manifold at the surface for collective discharge into a multicell holding tank. Water from the submersible pumps should also be collected in the tank;
- A flow meter could be attached after the holding tank inlet to record flow volumes;
- The holding tank would allow for monitoring of the water quality, dosing/pH adjustment or removal of sediments, if required;
- Extracted groundwater could be discharged to suitable location, such as a nominated stormwater location subject to regulatory approvals.

The final design should be confirmed by the dewatering contractor based on groundwater parameters, expected flow and subject to regulatory approvals.

Excavations and the effects of dewatering and temporary lowering of the groundwater table should also consider the presence of ASS. Excavation methods should therefore be considered with reference to the requirement for a site specific ASSMP as discussed in Section 5.2.5.

The procedures for dewatering should be undertaken in accordance with the following documents:

- *Dewatering Management Plan for Construction (Temporary Dewatering for Tanked Basement)* (Douglas, 2025b) prepared as per Water NSW requirements;
- *Remediation Action Plan* (Douglas, 2025a) prepared for the excavation and disposal of unsuitable upper fill materials;
- *Acid Sulfate Soil Management Plan* (Douglas, 2022b) prepared for the excavation and management of ASS below RL 1 and dewatering during basement construction.

Reference should be made to the updated DMP (Douglas, 2025b) which details the monitoring procedures for during construction (levels / quality / volumes), assessment criteria, reporting requirements and contingencies.

11. Conclusion

This updated desktop groundwater assessment was undertaken to estimate temporary water takes to facilitate basement construction. The assessment was undertaken using the results of the previous investigations by Douglas (Douglas, 2021a; Douglas, 2022a) and others (Coffey, 2020) and has considered the results of groundwater level monitoring undertaken from 2022 to 2025.

Two scenarios were modelled (Cases 1 and 2), comprising sheet piles respectively installed to depths of 12 m and 6 m.

From the groundwater model based on the CHM described in Section 6 and for an estimated construction period of 6 to 8.5 months, groundwater inflows into the basement during construction could be in the order of:

- Case 1 – 0.04 ML to 1.83 ML;
- Case 2 – 0.12 ML to 9.04 ML.

The preferred approach on the basis of minimising groundwater flows, and eligibility for a new or updated Water Supply Work Approval and water access licence exemption, is therefore Case 1.

The groundwater model and inflows for Case 1 are based on installation of sheet piles into Unit 4 residual clay. This layer is assumed to be continuous on the basis of subsurface investigation to date (DP, 2021a; 2021b). As a precautionary measure, it is recommended that additional subsurface investigation via CPTs is undertaken following building removal to confirm the presence and depth of the Unit 3a clay and depths for sheet pile installation.

Reference should be made to the updated DMP (Douglas, 2025b) which details the monitoring procedures for during construction (levels / quality / volumes), assessment criteria, reporting requirements, contingencies.

A new or revised application to Water NSW will be required for a Water Supply Work Approval and updated General Terms of Approval (GTA) given that the existing approval has lapsed. Dewatering during construction will need to adhere to the conditions of such approvals and the updated DMP (Douglas, 2025b).

12. References

Coffey. (2020). *Phase I Preliminary Site Assessment and Acid Sulfate Soil, 2a Maude Street, Belmont NSW (Lot 202, DP1236307)*. Ref: 754-NTLEN280678-R01: Coffey Services Australia Pty Ltd.

Douglas. (2021a). *Report of Contamination Testing, Proposed Residential Development, 2A Maude Street, Belmont*. Ref: 205363.00.R.002.Rev0: Douglas Partners Pty Ltd.

Douglas. (2022a). *Report of Preliminary Geotechnical Investigation, Proposed Residential Development, 2A Maude Street, Belmont*. Ref: 205363.00.R.003.Rev1: Douglas Partners Pty Ltd.

Douglas. (2022b). *Acid Sulfate Soil Management Plan, Proposed Residential Development, 2A Maude Street, Belmont*. Ref 205363.03.R.001.Rev0.ASSMP: Douglas Partners Pty Ltd.

Douglas. (2024). *Additional Contamination Testing, Proposed Residential Development, 2A Maude Street Belmont, prepared for Oak Tree Group Pty Ltd*. 205363.05.R.001.Rev0: Douglas Partners Pty Ltd.

Douglas. (2025a). *Dewatering Management Plan for Construction (Temporary Dewatering for Tanked Basement)*. 205363.04.R.001.Rev1.DMP: Douglas Partners Pty Ltd.

Douglas. (2025b). *Report on Supplementary Contamination Testing*. 205363.07.R.001.Rev0: Douglas Partners Pty Ltd.

Douglas. (2025c). *Remediation Action Plan, Proposed Residential Development, 1B Glover Street, Belmont*. 205363.07.R.001.Rev0.RAP: Douglas Partners Pty Ltd.

Fetter. (2001). *Applied Hydrogeology 4th Edition*. Upper Saddle River, New Jersey: Prentice Hall.

13. Limitations

Douglas Partners (Douglas) has prepared this report for this project at 1B Glover Street, Belmont in accordance with Douglas proposal 205363.02.P.001.Rev0 dated 10 February 2022 and 205363.07.P.003.Rev0 dated 11 March 2025. The work was carried out under a Consultancy Agreement between Douglas Partners Pty Ltd and Oak Tree Retirement Village Belmont Pty Ltd (Ref 3466-0215-9673, v. 1). This report is provided for the exclusive use of Oak Tree Retirement Village Belmont Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of Douglas, does so entirely at its own risk and without recourse to Douglas for any loss or damage. In preparing this report Douglas has necessarily relied upon information provided by the client and/or their agents.

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

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

The assessment of atypical safety hazards arising from this advice is restricted to the groundwater components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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

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

Appendix A

About This Report

Sampling Methods

Soil Descriptions

Symbols and Abbreviations

Information on Cone Penetration Tests

Borehole Logs (Bores 1 to 7) (DP, 2021a)

Cone Penetration Tests (CPT101, 102, 102A and CPT103) (DP, 2022a)

About this Report

Douglas Partners



Introduction

This note has been provided to assist DPM report in regard to classification of geotechnical field procedures and the corresponding sections not all are necessarily relevant to all reports.

DPM reports are based on information gained from limited surface exploration and a limited knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents intended to provide a general indication of information on which they are based.

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Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the nature of borehole or test pit frequency of sampling and the possibility of other than straight line variation between the test locations.

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open.

- Localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels may vary from time to time due to season or recent weather changes. They may not be the same at the time of construction and are indicated in the report and.
- The use of water or mud as a drilling fluid may add and groundwater inflow may water may be drawn out of the hole and drilling fluid may be pumped out of the hole if water permeability are to be made.

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

Reports

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

Great care is taken in the report and its relation to interpretation of surface conditions and conditions of geotechnical and environmental aspects and recommendations or suggestions for design and construction. However DPM cannot always anticipate or advise on recommendations for:

- Unexpected variation in ground conditions. The potential for this will depend partly on borehole or test pit location and sampling frequency.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of contractor responding to commercial pressures.

If these occur DPM will be pleased to assist in investigation or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on the defined construction appear to vary from those which were expected from the information contained in the report, Do request that it be immediately notified. Most problems are quickly more readily resolved when conditions are exposed rather than at some later date well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information including the written report and documentation be made available in circumstances where the documentation or content is not relevant to the contractual situation. It may be appropriate to prepare a specially edited document. Do could be cleared to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

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

Sampling Methods

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Sampling

Sampling is carried out during drilling or test pits to allow engineering evaluation and laboratory testing where required of the soil or rock.

Disturbed samples taken during drilling provide information on colour, texture, inclination and depending upon the degree of disturbance provide information on strength and structure.

Undisturbed samples are taken by pushing a thin pointed sampler into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are shallow excavated pits in a face or an excavation allowing close examination of the in situ soil. It is safe to enter into the pit. The depth of excavation is limited to about 1m for a face and 2m to 3m for a large excavation. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Coreholes can be drilled using a rotating plate or short spiral augers. Generally, 100mm or larger in diameter can only be drilled on a standard tripod rig. The cuttings are returned to the surface at intervals. Generally, not more than 100mm and are disturbed. It is difficult to obtain in situ strength content. Identification of soil strata is generally more reliable than in continuous spiral flight augers and in small samples. It is possible to obtain occasional undisturbed test samples.

Continuous Spiral Flight Augers

The corehole is advanced using a continuous diameter continuous spiral flight auger. Samples are withdrawn at intervals to allow sampling or in situ testing. This is a relatively economical means of drilling in clay and sand above the water table. Samples are returned to the surface or can be collected after withdrawal of the auger. Disturbed test samples are obtained and can be used for soil from the side of the hole. Information from the drilling is distinct from specific sampling. SPT or undisturbed samples are of relatively low

reliability due to the reconditioning of soil or softening of a deep groundwater.

Non-core Rotary Drilling

The corehole is advanced using a rotary bit in water or drilling mud. The bit is pushed down the drill rod and returned to the annulus carrying the drill cuttings. Only a few changes in stratification can be determined from the cuttings to get a rough idea of information from the rate of penetration. Where drilling mud is used, it can mask the cuttings and reliable identification is only possible from separate sampling. SPT.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel. The barrel is a hollow internal diameter, provided full core recovery is achieved. It is not always possible in weak rock and granular soils. The technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soil and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard Method of Testing Soil for Engineering Purposes. Test Method.

The test is carried out in a corehole or driven a 50mm diameter test hole under the impact of a 63.5kg hammer from a free fall of 762mm. It is normal for the hammer to be driven in three successive blows. The increments and the blow count are taken as the number of blows for the last blow in dense sand and for hard clay or weak rock the full blow count penetration may not be practicable and the test is discontinued.

The test results are reported in the following format:

- in the case where full penetration is obtained the blow count for each blow is of 100mm and 100mm
- in the case where the test is discontinued before the full penetration is reached after 10 blows for the first 100mm and 10 blows for the next 100mm and

Sampling Methods

The result of the SOT test can be related equivalently to the engineering properties of the soil.

Dynamic Cone Penetrometer Tests /

Perth Sand Penetrometer Tests

Dna c penetrometer test DC or S are carried out by driving a steel rod into the ground with a standard weight of 100 lb falling a specified distance. The rod penetrates the soil. The number of blows required to penetrate each 100 mm are recorded. For all there is a definition of the test. The test is extended in certain conditions. The test of penetration rod. The test of penetrometer are commonly used.

- **ERT** and **ENETROETER** a **daeter** flat ended rod **drten** a **aer drotn** **S** **Test** **T** **test** a **deceloed** for **teint** **the denit** of **and** and **anl** **eed n** **randlar** **ol** and **filln**
- **Cone ENETROETER** a **daeter** rod **ta** **daeter** cone end **drten** **a** **aer drotn** **S** **Test** **T** **test** a **deceloed** **ntall** for **aceent** **rade** **neitation** and correlation of **the test** **reult** **it** **California** **earn** **Ratio** **ate** **een** **eed** **ar** **oad** **at** **ortie**



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

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

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

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

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 – 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

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

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 – 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)

- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)

- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

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

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

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

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

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

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;

- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
Soil tends to stick together.
Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w < PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL' (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w > PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈ LL' (i.e. near the liquid limit).
- 'Wet' or 'w > LL' (i.e. wet of the liquid limit).

Rock Descriptions

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Rock Strength

Rock strength is defined as the unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass which can be considerably weaker due to defects.

The Point Load Strength index is used only as a guide to provide an estimate of the rock strength and the specific correlation should be developed to allow UCS values to be determined. The point load strength test procedure is described in Australian Standard AS 1562. The terms used to describe rock strength are as follows:

Strength Term	Correlation	Unconfined Compressive Strength Mpa	Point Load Index Mpa
Very low	VL	0-5	0-10
Low	L	5-10	10-20
Medium	M	10-20	20-30
High	H	20-30	30-40
Very high	VH	30-40	40-50
Extremely high	EH	40-50	50-60

When using a ratio of UCS to σ_{pl} it should be noted that the UCS to σ_{pl} ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Correlation	Description
Residual Soil	RS	Material is weathered to such an extent that it has lost properties. Mass structure and material texture and fabric of original rock are no longer identifiable. The soil has not been significantly transported.
Extremely weathered	EH	Material is weathered to such an extent that it has lost properties. Mass structure and material texture and fabric of original rock are still visible.
Highly weathered	H	The whole of the rock material is discoloured, all iron staining or leaching to the extent that the colour of the original rock is not recognizable. Rock strength is significantly changed by weathering. Some or all mineral grains are weathered to clay mineral, porosity is increased by leaching or may be decreased due to deposition of weathered product in pores.
Moderately weathered	M	The whole of the rock material is discoloured, all iron staining or leaching to the extent that the colour of the original rock is not recognizable, but some little or no change of strength from fresh rock.
Slightly weathered	S	Rock is partially discoloured, iron staining or leaching along joints but some little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
<i>Note: If HW and MW cannot be differentiated use DW (see below)</i>		
Distinctly weathered	D	Rock strength is all changed by weathering. The rock may be discoloured, all iron staining, porosity is increased by leaching or may be decreased due to deposition of weathered product in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the degree of natural fractures in diamond drill core. It includes bedding plane partings, joints and other defects that exclude drilling areas.

Term	Description
Fractured	Fracture of 1 to 2
Slightly Fractured	Core length of 1 to 2 with occasional fractures
Fractured	Core length of 1 to 2 with occasional shorter and longer sections
Slightly Fractured	Core length of 1 to 2 or longer with occasional sections of 1 to 2
Unbroken	Core contains perfect fracture

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index defined as:

$$RQD = \frac{\text{Cumulative length of sound core sections} \geq 10 \text{ cm}}{\text{total drilled length of section examined}}$$

Where sound rock is defined to be rock of low strength or fracture. The RQD applies only to natural fractures. If the core is broken by drilling or handling, the drilling area, then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rock the following terms are used to describe the degree of bedding partings.

Term	Separation of Stratification plane
Thin laminated	1 to 2
Laminated	2 to 5
Coarsely bedded	5 to 10
Thin bedded	1 to 2
Medium bedded	2 to 5
Thick bedded	5 to 10
Coarsely bedded	10 to 20

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General



alt



Road base



Concrete



Fill

Soils



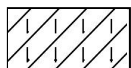
Topsoil



Peat



Clay



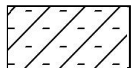
Silt clay



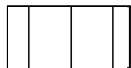
Sand clay



Gravel clay



Silty clay



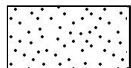
Silt



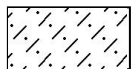
Clayey silt



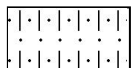
Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Coarse gravel



Talus

Sedimentary Rocks



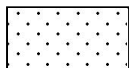
Boulder conglomerate



Conglomerate



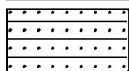
Conglomerate sandstone



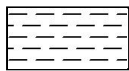
Sandstone



Siltstone



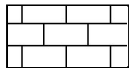
Laminite



Mudstone/claystone/siltstone

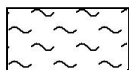


Coal

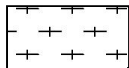


Limestone

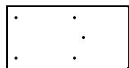
Metamorphic Rocks



Slate

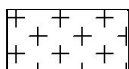


Gneiss



Quartzite

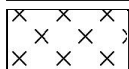
Igneous Rocks



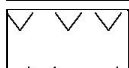
Granite



Dolerite/diabase/andesite



Dacite/diabase



Tuffaceous



Porphyry

Cone Penetration Tests

Douglas Partners



Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in situ. A special cone shaped probe is pushed into the soil and connected to a digital data acquisition system. The cone and additional sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soil.

The soil parameters measured depend on the type of cone used. In addition to the above, the following can be measured:

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination from vertical θ
- Depth below ground z

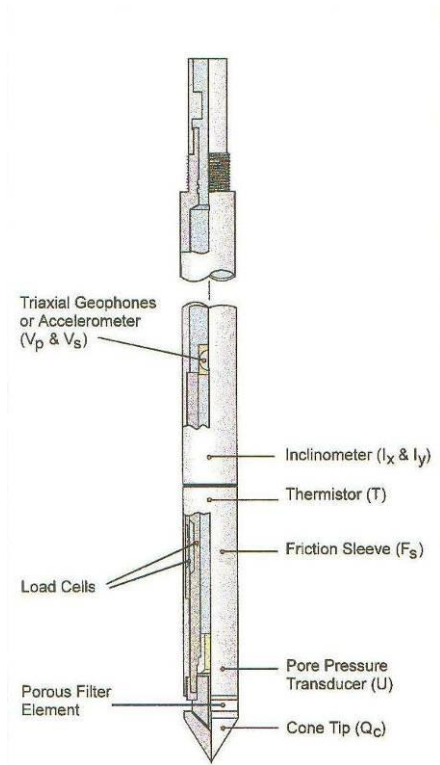


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and if required, the vertical depth can be corrected.

The cone is pushed into the ground at a steady rate of about 10 mm/sec. The data is recorded at a rate of a typical CPT rig or a drilling rig. The test is carried out in accordance with the International Standard ISO 15765-1.



Figure 2: Typical CPT rig

The CPT can penetrate soft soils and in particular, is used to all types of soil able to detect fine layering and strength variations. It is sufficient to push the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse fill, bedrock, to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 100m.

Types of CPTs

Douglas Partners and its specialist Ground Testing team can operate the following types of CPT cone:

Type	Measure
Standard	Basic parameters: q_c and f_s
Seismic Cone	Dynamic Cone Resistance (DCR) and Sleeve Friction (SF) rate consolidation parameters
Conductivity	Soil electrical conductivity (EC) and basic parameters
Seismic	Shear wave velocity (V_s) and compression wave velocity (V_p) basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour. The SPT is based on normalised values of cone resistance q_c and friction ratio f_s . These are used in conjunction with soil classification charts as the one below after Robertson (1999).

Cone Penetration Tests

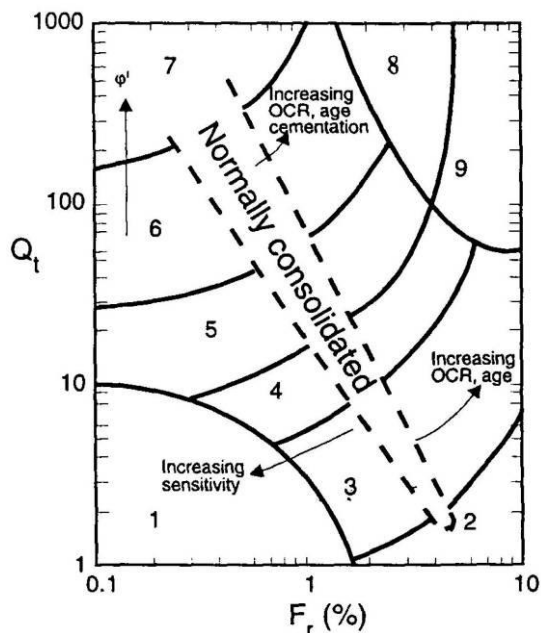


Figure 10.1 Soil Classification Chart

Dynamic Cone Penetration Tests (DCPT) are a rapid, cost-effective method for assessing soil strength and bearing capacity. They are commonly used for quality control and assurance in construction projects. The test involves driving a cone into the soil at a constant rate, and the resistance is measured. The results are used to estimate the soil's strength and bearing capacity.

DCPT data can be used to estimate the soil's strength and bearing capacity. The test results are compared to empirical relationships between DCPT resistance and soil strength. This allows engineers to estimate the soil's strength and bearing capacity without the need for more expensive tests like CPT or SPT.

Engineering Applications

There are many applications for CPT data. The main applications are in the design and construction of foundations, pavements, and other structures. CPT data can be used to estimate the soil's strength and bearing capacity, which is essential for the design of these structures.

Settlement

CPT provides a continuous profile of soil strength and bearing capacity along the length of the test. This allows engineers to identify areas of weak soil and estimate the potential for settlement. CPT data can also be used to estimate the soil's consolidation coefficient, which is a key parameter in settlement analysis.

Pile Capacity

The cone test is a direct method for estimating the capacity of a pile. The test involves driving a cone into the soil at a constant rate, and the resistance is measured. The results are used to estimate the pile's capacity. This method is particularly useful for piles in soft soils, where traditional methods like SPT or CPT may be less accurate.

Dynamic or Earthquake Analysis

CPT and other dynamic tests are used to estimate the soil's strength and bearing capacity for dynamic analysis. This is important for the design of structures that are subjected to seismic loads. CPT data can be used to estimate the soil's strength and bearing capacity, which is essential for the design of these structures.

Other Applications

Other applications of CPT include the detection of voids and defects in concrete structures. CPT can be used to detect voids and defects in concrete structures, which is important for the maintenance and repair of these structures. CPT can also be used to estimate the soil's strength and bearing capacity for the design of foundations and other structures.

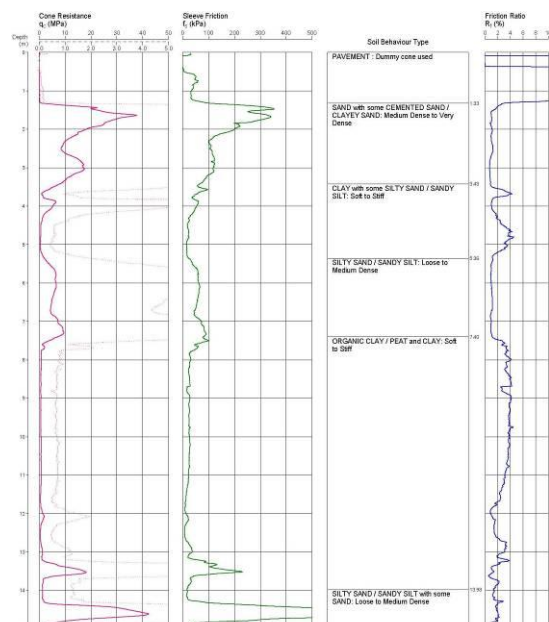


Figure 10.2 Sample Cone Plot

BOREHOLE LOG

CLIENT: Oak Tree Retirement Villages
PROJECT: Proposed Residential Development
LOCATION: 2A Maude Street, Belmont

SURFACE LEVEL: 6.2 AHD
EASTING: 375257
NORTHING: 6344045.1
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 205363.00
DATE: 18/6/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
		FILL / SAND (SP) - Fine to medium grained, brown, with silt, trace rootlets, roots, fine subangular/subrounded, brick, coal reject, dry		D	0.1	E	PID<1			
	0.4	SAND (SP) - Fine to medium grained, pale grey, dry to moist		D	0.5	E	PID<1			
	1			D	1.0	E	PID<1			
	1.5	Bore discontinued at 1.5m, limit of investigation		D	1.5	E	PID<1			
	2									
	3									
	4									

RIG: Hand tools

DRILLER: Kramer

LOGGED: Kramer

CASING: Uncased

TYPE OF BORING: Hand auger to 1.5m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

BOREHOLE LOG

CLIENT: Oak Tree Retirement Villages
PROJECT: Proposed Residential Development
LOCATION: 2A Maude Street, Belmont

SURFACE LEVEL: 4.5 AHD
EASTING: 375293.2
NORTHING: 6344105.9
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 205363.00
DATE: 18/6/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.2	FILL / SAND (SP) - Fine to medium grained, pale grey/brown, trace fine to coarse subangular/subrounded (crushd natural rock), dry to moist		D	0.1	E	PID<1			
	0.35	FILL / Clayey GRAVEL (GP) - Fine to coarse subangular/subrounded gravel (crushed natural rock), brown, trace fine to medium grained sand, moist		D	0.3	E	PID<1			
	0.7	SAND (SP) - Fine to medium grained, dark brown, with silt, trace rootlets, moist (possible indurated sand)		D	0.5	E	PID<1			
	1.0	SAND (SP) - Fine to medium grained, brown, moist		D	1.0	E	PID<1			
	1.5	Bore discontinued at 1.5m, limit of investigation		D	1.5	E	PID<1			
	2.0									
	2.5									
	3.0									
	3.5									
	4.0									
	4.5									
	5.0									
	5.5									
	6.0									
	6.5									
	7.0									
	7.5									
	8.0									
	8.5									
	9.0									
	9.5									
	10.0									

RIG: Hand tools

DRILLER: Kramer

LOGGED: Kramer

CASING: Uncased

TYPE OF BORING: Hand auger to 1.5m

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

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

BOREHOLE LOG

CLIENT: Oak Tree Retirement Villages
PROJECT: Proposed Residential Development
LOCATION: 2A Maude Street, Belmont

SURFACE LEVEL: 4.4 AHD
EASTING: 385301.6
NORTHING: 6344124.6
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 205363.00
DATE: 21/6/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.02	ASPHALT		D	0.05	E	PID<1			
	0.22	FILL / Clayey Sandy GRAVEL (GP) - Fine to medium subangular / subrounded gravels, pale brown, with fine to medium grained sand, silt, moist (road base materials)								
		SAND (SP) - Fine to medium grained, brown, with silt, moist, medium dense		D	0.5	E	PID<1			
	1			D	1.0	E	PID<1		1	
					1.2					
				S	1.5	E	5,6,8 N = 14 PID<1			
					1.65					
	2	From 2.0m, brown		D	2.0	E	PID<1	▼	2	
					2.2					
				S	2.5	E	3,2,5 N = 7 PID<1			
				D	2.65					
	3	From 2.9, pale brown		D	3.0	E	PID<1		3	
	3.2	Bore discontinued at 3.2m, limit of investigation								
	4								4	

RIG: Geoprobe 7822DT

DRILLER: Terratest (Warren)

LOGGED: Kramer

CASING: Uncased

TYPE OF BORING: Push tube to 3.2m

WATER OBSERVATIONS: Free groundwater at 2.0m

REMARKS:

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

BOREHOLE LOG

CLIENT: Oak Tree Retirement Villages
PROJECT: Proposed Residential Development
LOCATION: 2A Maude Street, Belmont

SURFACE LEVEL: 4.4 AHD
EASTING: 375277
NORTHING: 6344059
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 205363.00
DATE: 21/6/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.05	ASPHALT		D	0.1	E	PID<1			
	0.25	FILL / Clayey Sandy GRAVEL (GP) - Fine to medium subangular / subrounded gravels, pale brown, with fine to medium grained sand, silt, moist (road base materials)		D	0.28	E	PID<1			
	0.3	SAND (SP) - Fine to medium grained, brown, with silt, trace fine to medium rounded gravels, moist		D	0.5	E	PID<1			
		SAND (SP) - Fine to medium grained, grey, medium dense, moist								
		From 0.6m, brown - pale brown								
	1			D	1.0	E	PID<1			
					1.2					
				S						
				D	1.5	E	5,8,10 N = 18 PID<1			
		From 1.6m, dark brown			1.65					
	2			D	2.0	E	PID<1			
					2.2					
				S						
				D	2.5	E	2,3,4 N = 7 PID<1			
		From 2.6m, pale grey - grey			2.65					
	3			D	3.0	E	PID<1			
	3.2	Bore discontinued at 3.2m, limit of investigation								
	4									

RIG: Geoprobe 7822DT

DRILLER: Terratest (Warren)

LOGGED: Kramer

CASING: Uncased

TYPE OF BORING: Push tube to 3.2m

WATER OBSERVATIONS: Free groundwater at 1.6m

REMARKS: D2/JRK @ 0.5m

SAMPLING & IN SITU TESTING LEGEND

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

BOREHOLE LOG

CLIENT: Oak Tree Retirement Villages
PROJECT: Proposed Residential Development
LOCATION: 2A Maude Street, Belmont

SURFACE LEVEL: 4.4 AHD
EASTING: 375318.2
NORTHING: 6344113.2
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 205363.00
DATE: 21/6/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction	
				Type	Depth	Sample	Results & Comments		Gastic cover	Details
	0.05	ASPHALT		D	0.1	E	PID<1			From 0.0m to 0.1m, concrete
	0.15	FILL / Clayey Sandy GRAVEL (GP) - Fine to medium subangular / subrounded gravels, pale brown, with fine to medium grained sand, silt, moist (road base materials)		D	0.5	E	PID<1			From 0.1m to 0.2m, backfill
		SAND (SP) - Fine to medium grained, brown / grey, moist, medium dense		D	1.0	E	PID<1			From 0.2m to 0.5m, bentonite
		From 0.3m, pale grey								
		From 0.7m, dark brown / brown with silt								
	1			D	1.2	E	PID<1			
		From 1.2m to 2.0m, intermixed bands of sand and indurated sand		S	1.5	E	2,4,10 N = 14 PID<1			
				D	1.65					
		From 1.7m, wet								
	2			D	2.0	E	PID<1			
		SAND (SP) - Brown, fine to medium grained, wet			2.2					From 0.5m to 4.0m, 5mm gravel filter
				S	2.5	E	2,3,5 N = 8 PID<1			From 1.0m to 4.0m, Class 18 casing
				D	2.65					From 1.0m to 4.0m, Class 18 PVC screen
	3			D	3.0	E	PID<1			
				D	3.5	E	PID<1			
	4			D	4.0	E	PID<1			End cap
	4.0	Bore discontinued at 4.0m, limit of investigation								

RIG: Geoprobe 7822DT

DRILLER: Terratest (Warren)

LOGGED: Kramer

CASING: Uncased

TYPE OF BORING: Push tube to 4.0m

WATER OBSERVATIONS: Free groundwater at 1.7m

REMARKS: Bore collapse @ 3.2m. No SPT taken

SAMPLING & IN SITU TESTING LEGEND

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

BOREHOLE LOG

CLIENT: Oak Tree Retirement Villages
PROJECT: Proposed Residential Development
LOCATION: 2A Maude Street, Belmont

SURFACE LEVEL: 4.3 AHD
EASTING: 375303.6
NORTHING: 6344903.7
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 205363.00
DATE: 21/6/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction	
				Type	Depth	Sample	Results & Comments		Gactic cover	Details
	0.025	ASPHALT								
	0.125	FILL / Clayey Sandy GRAVEL (GP) - Fine to medium subangular / subrounded gravels, pale brown, with fine to medium grained sand, silt, moist (road base materials)		D	0.1		PID<1			From 0.0m to 0.1m, concrete
		SAND (SP) - Fine to medium grained, brown, dry to moist, medium dense		D	0.5		PID<1			From 0.1m to 0.25m, backfill
				D	1.0		PID<1			From 0.25m to 0.6m, bentonite
				S	1.2					From 0m to 1.0m, Class 18 casing
				D	1.5		4,4,8 N = 12 PID<1			
	1.7	SAND (SP) - Fine to medium grained, dark brown, with silt, moist to wet (possible indurated sand)			1.65					
				D	2.0		PID<1			
	2.2	SAND (SP) - Fine to medium grained, pale brown, wet			2.2					
				S	2.5		3,7,8 N = 15 PID<1			From 0.6m to 4.0m, 5mm gravel filter
				D	2.65					From 1.0m to 4.0m, Class 18 PVC screen
				D	3.0		PID<1			
				D	3.5		PID<1			
	4.0	Bore discontinued at 4.0m, limit of investigation		D	4.0		PID<1			End cap

RIG: Geoprobe 7822DT

DRILLER: Terratest (Warren)

LOGGED: Kramer

CASING: Uncased

TYPE OF BORING: Push tube to 4.0m

WATER OBSERVATIONS: Free groundwater at 1.6 - 1.7m

REMARKS: Bore collapse @ 3.2m. No SPT taken. D3/JRK @ 0.5m

SAMPLING & IN SITU TESTING LEGEND

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

BOREHOLE LOG

CLIENT: Oak Tree Retirement Villages
PROJECT: Proposed Residential Development
LOCATION: 2A Maude Street, Belmont

SURFACE LEVEL: 4.3 AHD
EASTING: 375298.5
NORTHING: 6344055.7
DIP/AZIMUTH: 90°/-

BORE No: 7
PROJECT No: 205363.00
DATE: 21/6/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction	
				Type	Depth	Sample	Results & Comments		Gastic cover	Details
	0.05	ASPHALT		D	0.1	E	PID<1			From 0.0m to 0.1m, concrete
	0.2	FILL / Clayey Sandy GRAVEL (GP) - Fine to medium subangular / subrounded gravels, pale brown, with fine to medium grained sand, silt, moist (road base)		D	0.3	E	PID<1			From 0.1m to 0.2m, backfill
	0.36	FILL / Silty SAND (SP) - Fine to medium grained, dark grey, with coal / coal reject, moist		D	0.5	E	PID<1			From 0.2m to 0.45m, bentonite
		SAND (SP) - Fine to medium grained, grey, dry								From 0.0m to 1.0m, Class 18 casing
1	1.0	Silty SAND (SP) - Fine to medium grained, dark brown, moist, loose		D	1.0	E	PID<1			
					1.2					
				S	1.5	E	2,1,0 N = 1 PID<1			
		From 1.6m, wet			1.65					
2		From 1.9m, dark brown - grey		D	2.0	E	PID<1			
					2.2					From 0.45m to 4.0m, 5mm gravel filter
	2.4	SAND (SP) - Fine to medium grained, pale grey, wet, medium dense		S	2.5	E	4,8,10 N = 18 PID<1			From 1.0m to 4.0m, Class 18 PVC screen
				D	2.65					
3				D	3.0	E	PID<1			
		From 3.3m, brown, with silt								
				D	3.5	E	PID<1			
4	4.0	Bore discontinued at 4.0m, limit of investigation		D	4.0	E	PID<1			End cap

RIG: Geoprobe 7822DT

DRILLER: Terratest (Warren)

LOGGED: Kramer

CASING: Uncased

TYPE OF BORING: Push tube to 4.0m

WATER OBSERVATIONS: Free groundwater at 1.6

REMARKS: Bore collapse @ 3.2m. No SPT taken.

SAMPLING & IN SITU TESTING LEGEND

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

CONE PENETRATION TEST

CLIENT: OAK TREE RETIREMENT VILLAGES

PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT

LOCATION: 2A MAUDE STREET, BELMONT

REDUCED LEVEL: 4.3

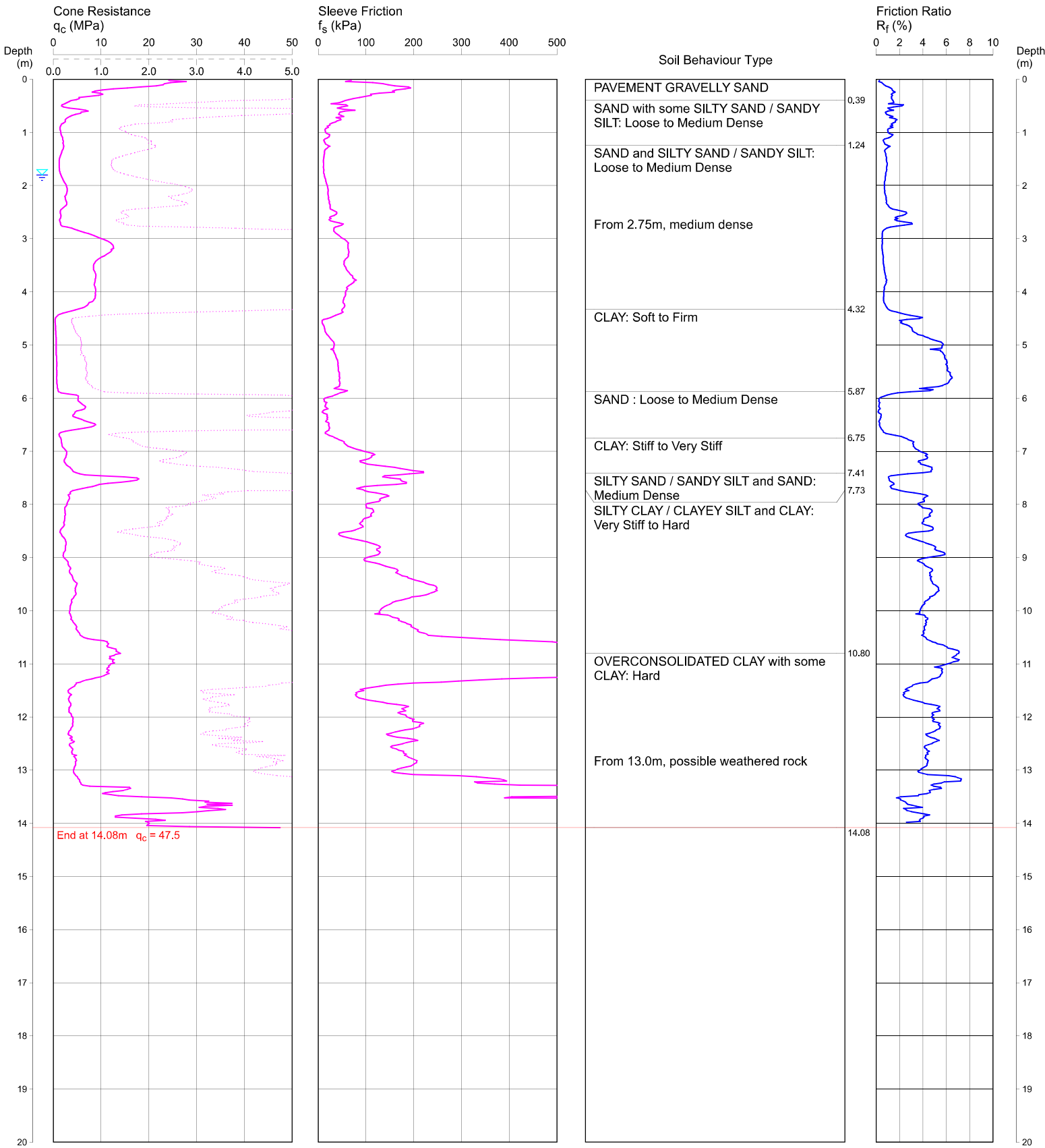
COORDINATES: 375313.9E 6344053.3N

CPT101

Page 1 of 1

DATE 05/07/2021

PROJECT No: 205363



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
GROUNDWATER OBSERVED AT 1.8m AFTER WITHDRAWAL OF RODS

Water depth after test: 1.8m

File: P:\205363.00 - BELMONT, 2A Maude St, Lot 201\4.0 Field Work\4.2 Testing\2020.07.05 - 205363.00 - Belmont\2020.07.05 - 205363.00 - Belmont\CPT101.CP5

Cone ID: 170706 Type: I-CFXY-10

ConePlot Version 5.9.2
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CONE PENETRATION TEST

CLIENT: OAK TREE RETIREMENT VILLAGES

PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT

LOCATION: 2A MAUDE STREET, BELMONT

REDUCED LEVEL: 4.4

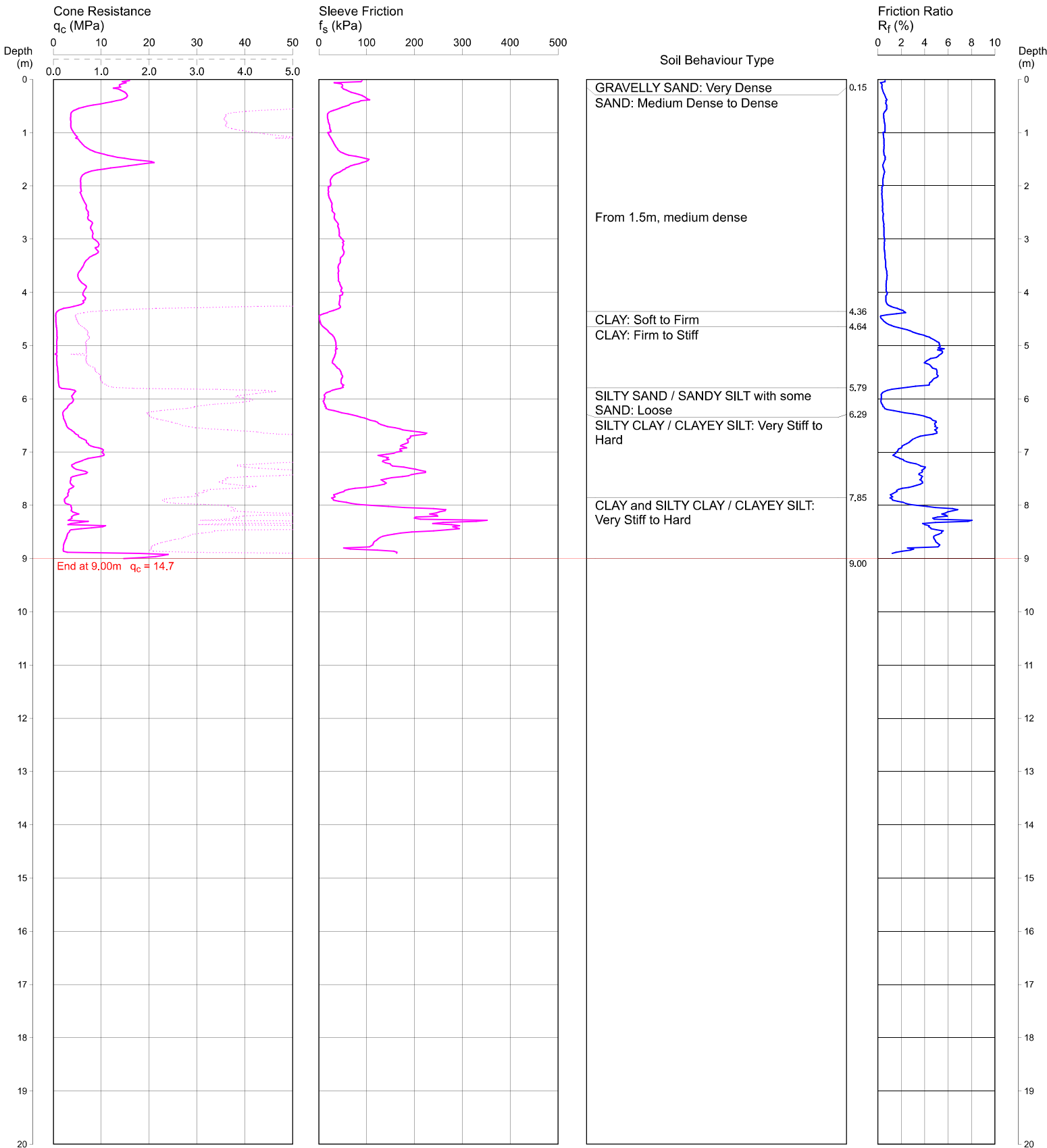
COORDINATES:

CPT102

Page 1 of 1

DATE 05/07/2021

PROJECT No: 205363



REMARKS: TEST DISCONTINUED DUE TO SUDDEN CONE BENDING
HOLE COLLAPSED AT 1.5m AFTER WITHDRAWAL OF RODS

CONE PENETRATION TEST

CLIENT: OAK TREE RETIREMENT VILLAGES

PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT

LOCATION: 2A MAUDE STREET, BELMONT

REDUCED LEVEL: 4.4

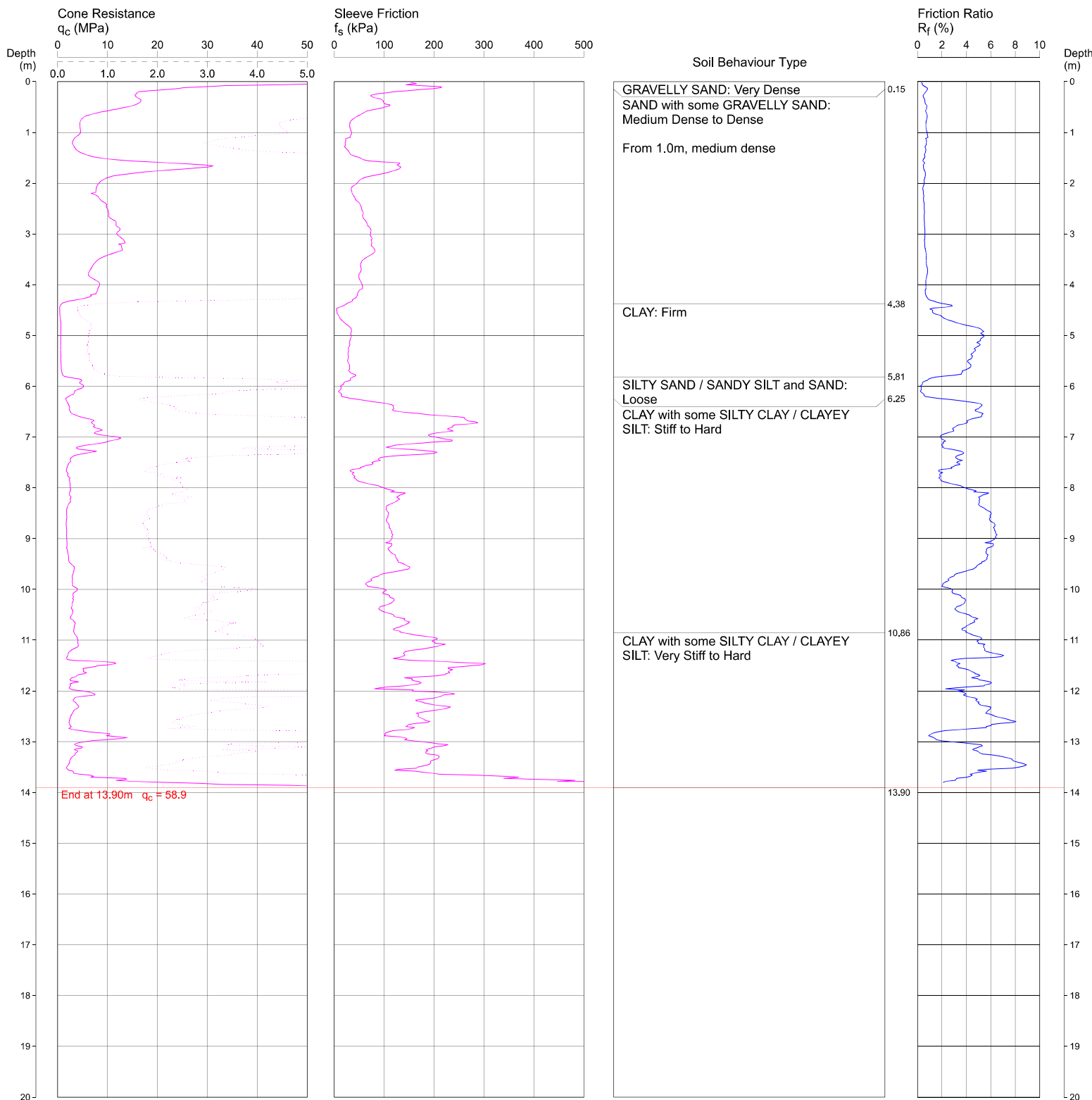
COORDINATES: 375319.6E 6344116.3N

CPT102A

Page 1 of 1

DATE 05/07/2021

PROJECT No: 205363



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
HOLE COLLAPSED AT 1.4m AFTER WITHDRAWAL OF RODS

File: P:\205363.00 - BELMONT, 2A Maude St, Lot 201\4.0 Field Work\4.2 Testing\2020.07.05 - 205363.00 - Belmont\2020.07.05 - 205363.00 - Belmont\CPT102A.CP5
Cone ID: 170706 Type: I-CFXY-10

ConePlot Version 5.9.2
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CONE PENETRATION TEST

CLIENT: OAK TREE RETIREMENT VILLAGES

PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT

LOCATION: 2A MAUDE STREET, BELMONT

REDUCED LEVEL: 4.3

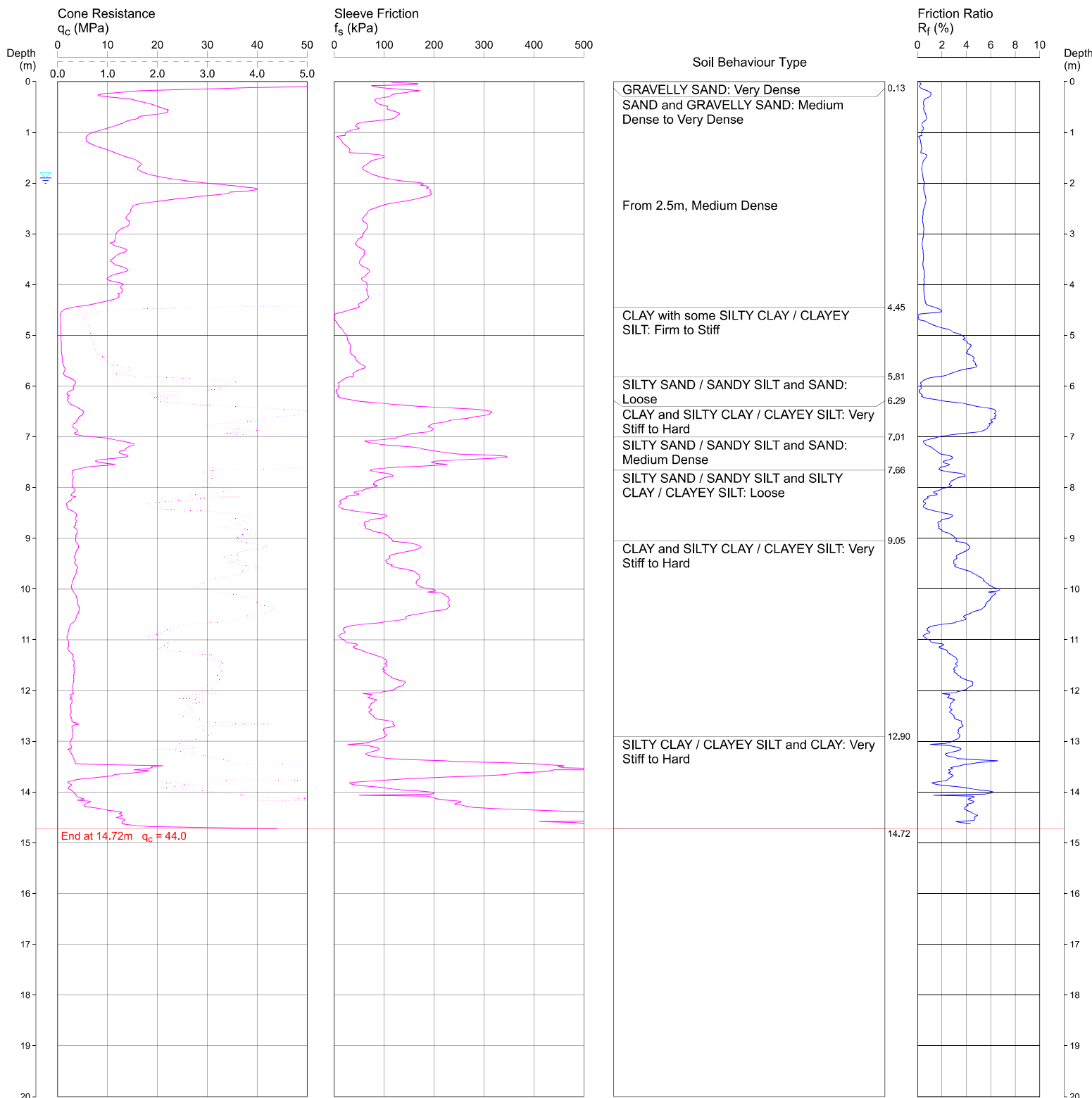
COORDINATES: 375294.1E 6344086.5N

CPT103

Page 1 of 1

DATE 05/07/2021

PROJECT No: 205363



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED WEATHERED ROCK
GROUNDWATER OBSERVED AT 1.9m AFTER WITHDRAWAL OF RODS

Water depth after test: 1.9m

File: P:\205363.00 - BELMONT, 2A Maude St, Lot 201\4.0 Field Work\4.2 Testing\2020.07.05 - 205363.00 - Belmont\2020.07.05 - 205363.00 - Belmont\CPT103.CP5

Cone ID: 170706

Type: I-CFXY-10

ConePlot Version 5.9.2

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Appendix B

Table B1: Summary of Field Testing of Groundwater During Purging and Sampling (DP, 2021a)

Table B2: Summary of Results of Groundwater Analysis (from Douglas, 2021a)

Laboratory Report Sheets for Groundwater Testing (Envirolab Report 272957)

Table B1: Summary of Field Testing of Groundwater During Purging and Sampling (DP, 2021a)

Well ID	Date Sampled	pH	EC (mS/cm)	ORP (mV)	DO (mg/L)	Turbidity (NTU)	Temp. (°C)	Volume Purged (L)	Comments
1	20210101	7.5	150	100	1.0	0.5	15.0	10	Darwin Creek at road no odor
2	20210101	7.5	150	100	1.0	0.5	15.0	10	Darwin Creek at road for odor
3	20210101	7.5	150	100	1.0	0.5	15.0	10	Darwin Creek at road for odor

Note to Table B1

DO Dissolved Oxygen

EC Electrical Conductivity

Temp Groundwater

TOC Total Organic Carbon

ORP Oxidation Reduction Potential

ID Identification Detector

Carton Per Million

TOC Total of Carbon

Table B2: Summary of Results of Groundwater Analysis (DP, 2021a)

Analyte	Units	PQL	ANZG (2018) Fresh water DGVs #	ANZG (2018) Marine water DGVs #	NEPM 2013 Table 1A(4) Res HSL A & B GW for Vapour Intrusion, Sand			NEPM 2013 Table 1C GILs, Marine Waters	Field ID	5	6	7
									Sample Date	29/06/2021	29/06/2021	29/06/2021
Metals (Dissolved)												
Arsenic	mg/L	0.001	0.024	□						0.002	<0.001	0.005
Cadmium	mg/L	0.0001	0.0002	0.0055				0.0007		<0.0001	<0.0001	<0.0001
Chromium (III+VI)	mg/L	0.001	0.0043	0.031				0.044		<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0014	0.0013				0.0013		0.001	<0.001	<0.001
Iron	mg/L	0.01								1.4	1.3	1.9
Lead	mg/L	0.001	0.0034	0.0044				0.0044		<0.001	<0.001	<0.001
Manganese	mg/L	0.005	19	0.08						0.044	0.024	0.085
Mercury	mg/L	0.00005	0.0006	0.0004				0.0001		<0.00005	<0.00005	<0.00005
Nickel	mg/L	0.001	0.011	0.07				0.007		0.024	0.009	0.006
Zinc	mg/L	0.001	0.008	0.015				0.015		0.015	0.01	0.006
TRH												
C10-C16	mg/L	0.05								<0.05	<0.05	<0.05
C16-C34	mg/L	0.1								<0.1	<0.1	<0.1
C34-C40	mg/L	0.1								<0.1	<0.1	<0.1
F2-NAPHTHALENE	mg/L	0.05			1	1	1			<0.05	<0.05	<0.05
C6 - C9	mg/L	0.01								<0.01	<0.01	<0.01
C10 - C14	mg/L	0.05								<0.05	<0.05	<0.05
C15 - C28	mg/L	0.1								<0.1	<0.1	<0.1
C29-C36	mg/L	0.1								<0.1	<0.1	<0.1
C6-C10 less BTEX (F1)	mg/L	0.01			1	1	1			<0.01	<0.01	<0.01
C6-C10	mg/L	0.01								<0.01	<0.01	<0.01
BTEX												
Benzene	mg/L	0.001	0.95	0.7	0.8	0.8	0.9	0.5		<0.001	<0.001	<0.001
Ethylbenzene	mg/L	0.001	0.08	0.08	NL	NL	NL			<0.001	<0.001	<0.001
Toluene	mg/L	0.001	0.18	0.18	NL	NL	NL			<0.001	0.001	<0.001
Xylene (m & p)	mg/L	0.002	0.275	0.075						<0.002	<0.002	<0.002
Xylene (o)	mg/L	0.001	0.35	-						<0.001	<0.001	<0.001
PAH (low level)												
Total Positive PAHs	mg/L	0.0001								<0.0001	<0.0001	<0.0001
Acenaphthene	mg/L	0.0001								<0.0001	<0.0001	<0.0001
Acenaphthylene	mg/L	0.0001								<0.0001	<0.0001	<0.0001
Anthracene	mg/L	0.0001	0.00001	0.00001						<0.0001	<0.0001	<0.0001
Benz(a)anthracene	mg/L	0.0001								<0.0001	<0.0001	<0.0001
Benzo(a) pyrene	mg/L	0.0001	0.0001	0.0001						<0.0001	<0.0001	<0.0001
Benzo(b,j,k)fluoranthene	mg/L	0.0002								<0.0002	<0.0002	<0.0002
Benzo(g,h,i)perylene	mg/L	0.0001								<0.0001	<0.0001	<0.0001
Chrysene	mg/L	0.0001								<0.0001	<0.0001	<0.0001
Dibenz(a,h)anthracene	mg/L	0.0001								<0.0001	<0.0001	<0.0001
Fluoranthene	mg/L	0.0001	0.001	0.001						<0.0001	<0.0001	<0.0001
Fluorene	mg/L	0.0001								<0.0001	<0.0001	<0.0001
Indeno(1,2,3-c,d)pyrene	mg/L	0.0001								<0.0001	<0.0001	<0.0001
Naphthalene	mg/L	0.0002	0.016	0.07	NL	NL	NL	0.05		<0.0002	<0.0002	<0.0002
Phenanthrene	mg/L	0.0001	0.0006	0.0006						<0.0001	<0.0001	<0.0001
Pyrene	mg/L	0.0001								<0.0001	<0.0001	<0.0001

Notes:

As (V) criteria used for Total As

Cr(VI) criteria used for Total Cr

- For Slightly to Moderately Disturbed Ecosystems

CERTIFICATE OF ANALYSIS 272957

Client Details

Client	Douglas Partners Newcastle
Attention	Patrick Heads
Address	Box 324 Hunter Region Mail Centre, Newcastle, NSW, 2310

Sample Details

Your Reference	<u>205363.00, Belmont</u>
Number of Samples	3 Water
Date samples received	30/06/2021
Date completed instructions received	30/06/2021

Analysis Details

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

Report Details

Date results requested by	07/07/2021
Date of Issue	06/07/2021
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. Tests not covered by NATA are denoted with *	

Results Approved By

Dragana Tomas, Senior Chemist
Giovanni Agosti, Group Technical Manager

Authorised By



Nancy Zhang, Laboratory Manager

vTRH(C6-C10)/BTEXN in Water				
Our Reference		272957-1	272957-2	272957-3
Your Reference	UNITS	5	6	7
Date Sampled		29/06/2021	29/06/2021	29/06/2021
Type of sample		Water	Water	Water
Date extracted	-	02/07/2021	02/07/2021	02/07/2021
Date analysed	-	02/07/2021	02/07/2021	02/07/2021
TRH C ₆ - C ₉	µg/L	<10	<10	<10
TRH C ₆ - C ₁₀	µg/L	<10	<10	<10
TRH C ₆ - C ₁₀ less BTEX (F1)	µg/L	<10	<10	<10
Benzene	µg/L	<1	<1	<1
Toluene	µg/L	<1	1	<1
Ethylbenzene	µg/L	<1	<1	<1
m+p-xylene	µg/L	<2	<2	<2
o-xylene	µg/L	<1	<1	<1
Naphthalene	µg/L	<1	<1	<1
Surrogate Dibromofluoromethane	%	101	100	100
Surrogate toluene-d8	%	99	100	98
Surrogate 4-BFB	%	99	99	98

svTRH (C10-C40) in Water				
Our Reference		272957-1	272957-2	272957-3
Your Reference	UNITS	5	6	7
Date Sampled		29/06/2021	29/06/2021	29/06/2021
Type of sample		Water	Water	Water
Date extracted	-	02/07/2021	02/07/2021	02/07/2021
Date analysed	-	02/07/2021	02/07/2021	02/07/2021
TRH C ₁₀ - C ₁₄	µg/L	<50	<50	<50
TRH C ₁₅ - C ₂₈	µg/L	<100	<100	<100
TRH C ₂₉ - C ₃₆	µg/L	<100	<100	<100
TRH >C ₁₀ - C ₁₆	µg/L	<50	<50	<50
TRH >C ₁₀ - C ₁₆ less Naphthalene (F2)	µg/L	<50	<50	<50
TRH >C ₁₆ - C ₃₄	µg/L	<100	<100	<100
TRH >C ₃₄ - C ₄₀	µg/L	<100	<100	<100
Surrogate o-Terphenyl	%	70	76	75

PAHs in Water - Low Level				
Our Reference		272957-1	272957-2	272957-3
Your Reference	UNITS	5	6	7
Date Sampled		29/06/2021	29/06/2021	29/06/2021
Type of sample		Water	Water	Water
Date extracted	-	02/07/2021	02/07/2021	02/07/2021
Date analysed	-	06/07/2021	06/07/2021	06/07/2021
Naphthalene	µg/L	<0.2	<0.2	<0.2
Acenaphthylene	µg/L	<0.1	<0.1	<0.1
Acenaphthene	µg/L	<0.1	<0.1	<0.1
Fluorene	µg/L	<0.1	<0.1	<0.1
Phenanthrene	µg/L	<0.1	<0.1	<0.1
Anthracene	µg/L	<0.1	<0.1	<0.1
Fluoranthene	µg/L	<0.1	<0.1	<0.1
Pyrene	µg/L	<0.1	<0.1	<0.1
Benzo(a)anthracene	µg/L	<0.1	<0.1	<0.1
Chrysene	µg/L	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	µg/L	<0.2	<0.2	<0.2
Benzo(a)pyrene	µg/L	<0.1	<0.1	<0.1
Indeno(1,2,3-c,d)pyrene	µg/L	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	µg/L	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	µg/L	<0.1	<0.1	<0.1
Benzo(a)pyrene TEQ	µg/L	<0.5	<0.5	<0.5
Total +ve PAH's	µg/L	<0.1	<0.1	<0.1
Surrogate <i>p</i> -Terphenyl-d14	%	103	101	104

HM in water - dissolved				
Our Reference		272957-1	272957-2	272957-3
Your Reference	UNITS	5	6	7
Date Sampled		29/06/2021	29/06/2021	29/06/2021
Type of sample		Water	Water	Water
Date prepared	-	02/07/2021	02/07/2021	02/07/2021
Date analysed	-	02/07/2021	02/07/2021	02/07/2021
Arsenic-Dissolved	µg/L	2	<1	5
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	<1
Copper-Dissolved	µg/L	1	<1	<1
Lead-Dissolved	µg/L	<1	<1	<1
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	24	9	6
Zinc-Dissolved	µg/L	15	10	6
Manganese-Dissolved	µg/L	44	24	85
Iron-Dissolved	µg/L	1,400	1,300	1,900

Method ID	Methodology Summary
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.
Org-020	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-022/025	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS/GC-MSMS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.
Org-023	Water samples are analysed directly by purge and trap GC-MS.
Org-023	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Water					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W4	[NT]
Date extracted	-			02/07/2021	2	02/07/2021	05/07/2021		02/07/2021	[NT]
Date analysed	-			02/07/2021	2	02/07/2021	05/07/2021		02/07/2021	[NT]
TRH C ₆ - C ₉	µg/L	10	Org-023	<10	2	<10	<10	0	100	[NT]
TRH C ₆ - C ₁₀	µg/L	10	Org-023	<10	2	<10	<10	0	100	[NT]
Benzene	µg/L	1	Org-023	<1	2	<1	<1	0	99	[NT]
Toluene	µg/L	1	Org-023	<1	2	1	1	0	98	[NT]
Ethylbenzene	µg/L	1	Org-023	<1	2	<1	<1	0	100	[NT]
m+p-xylene	µg/L	2	Org-023	<2	2	<2	<2	0	101	[NT]
o-xylene	µg/L	1	Org-023	<1	2	<1	<1	0	97	[NT]
Naphthalene	µg/L	1	Org-023	<1	2	<1	<1	0	[NT]	[NT]
Surrogate Dibromofluoromethane	%		Org-023	104	2	100	100	0	100	[NT]
Surrogate toluene-d8	%		Org-023	100	2	100	99	1	101	[NT]
Surrogate 4-BFB	%		Org-023	99	2	99	100	1	96	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Water					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	272957-2
Date extracted	-			02/07/2021	1	02/07/2021	02/07/2021		02/07/2021	02/07/2021
Date analysed	-			02/07/2021	1	02/07/2021	02/07/2021		02/07/2021	02/07/2021
TRH C ₁₀ - C ₁₄	µg/L	50	Org-020	<50	1	<50	<50	0	120	98
TRH C ₁₅ - C ₂₈	µg/L	100	Org-020	<100	1	<100	<100	0	120	95
TRH C ₂₉ - C ₃₆	µg/L	100	Org-020	<100	1	<100	<100	0	116	78
TRH >C ₁₀ - C ₁₆	µg/L	50	Org-020	<50	1	<50	<50	0	120	98
TRH >C ₁₆ - C ₃₄	µg/L	100	Org-020	<100	1	<100	<100	0	120	95
TRH >C ₃₄ - C ₄₀	µg/L	100	Org-020	<100	1	<100	<100	0	116	78
Surrogate o-Terphenyl	%		Org-020	74	1	70	79	12	82	76

QUALITY CONTROL: PAHs in Water - Low Level					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	272957-3
Date extracted	-			02/07/2021	1	02/07/2021	02/07/2021		02/07/2021	02/07/2021
Date analysed	-			06/07/2021	1	06/07/2021	06/07/2021		06/07/2021	06/07/2021
Naphthalene	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	78	87
Acenaphthylene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Acenaphthene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	65	68
Fluorene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	77	77
Phenanthrene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	92	92
Anthracene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Fluoranthene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	71	69
Pyrene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	73	73
Benzo(a)anthracene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Chrysene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	68	68
Benzo(b,j+k)fluoranthene	µg/L	0.2	Org-022/025	<0.2	1	<0.2	<0.2	0	[NT]	[NT]
Benzo(a)pyrene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	97	90
Indeno(1,2,3-c,d)pyrene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	µg/L	0.1	Org-022/025	<0.1	1	<0.1	<0.1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-022/025	106	1	103	102	1	98	89

QUALITY CONTROL: HM in water - dissolved					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	272957-2
Date prepared	-			02/07/2021	1	02/07/2021	02/07/2021		02/07/2021	02/07/2021
Date analysed	-			02/07/2021	1	02/07/2021	02/07/2021		02/07/2021	02/07/2021
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	2	2	0	115	89
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	116	91
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	116	89
Copper-Dissolved	µg/L	1	Metals-022	<1	1	1	1	0	113	88
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	105	85
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	[NT]		104	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	24	24	0	113	89
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	15	16	6	115	93
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	44	45	2	116	94
Iron-Dissolved	µg/L	10	Metals-022	<10	1	1400	1400	0	105	#

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.	
Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2	

Laboratory Acceptance Criteria

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

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

8 HM in water - dissolved - # Percent recovery is not applicable due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

Appendix C

Drawing 1 – Site and Test Location Plan (Douglas, 2021a; 2021b)

Drawing 2 – Basement Overlay with Test Locations

Drawing DA1-C04.01 – Basement Concept Stormwater Management and Level Plan (Northrop -Project NL183048-01, Revision A, dated 11 April 2025)

Drawing A-1101 – Basement Plan (CKDS Project 20120, Issue 01, dated 7 April 2025)

Drawing A-13001 – Sections A to C, Project 2 (CKDS Project 20120, Issue 01, dated 7 April 2025)



SITE LOCATION

LEGEND

- Borehole Location (current)
- Test Pit Location (205363.05)
- Borehole Location (205363.04)
- CPT Location (205363.00)
- Borehole Location (205363.00)
- Site Boundary
- Basement Footprint

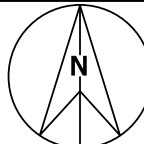
0 10 20 30 40 50 m

NOTE:
1. Drawing projection in GDA2020 / MGA zone 56, adapted from aerial imagery from Metromap Image dated 15.10.2023.
2. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage



CLIENT: Mostyn Copper Group Pty Ltd
OFFICE: Newcastle DRAWN BY: PLH
SCALE: 1:600 @A3 DATE: 16.April.2025

TITLE: **Test Location Plan**
Proposed Residential Subdivision
1B Glover Street, Belmont, NSW



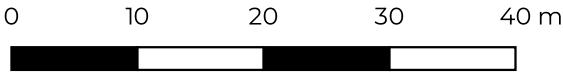
PROJECT: 205363.07
DRAWING No: 1
REVISION: 0



SITE LOCATION

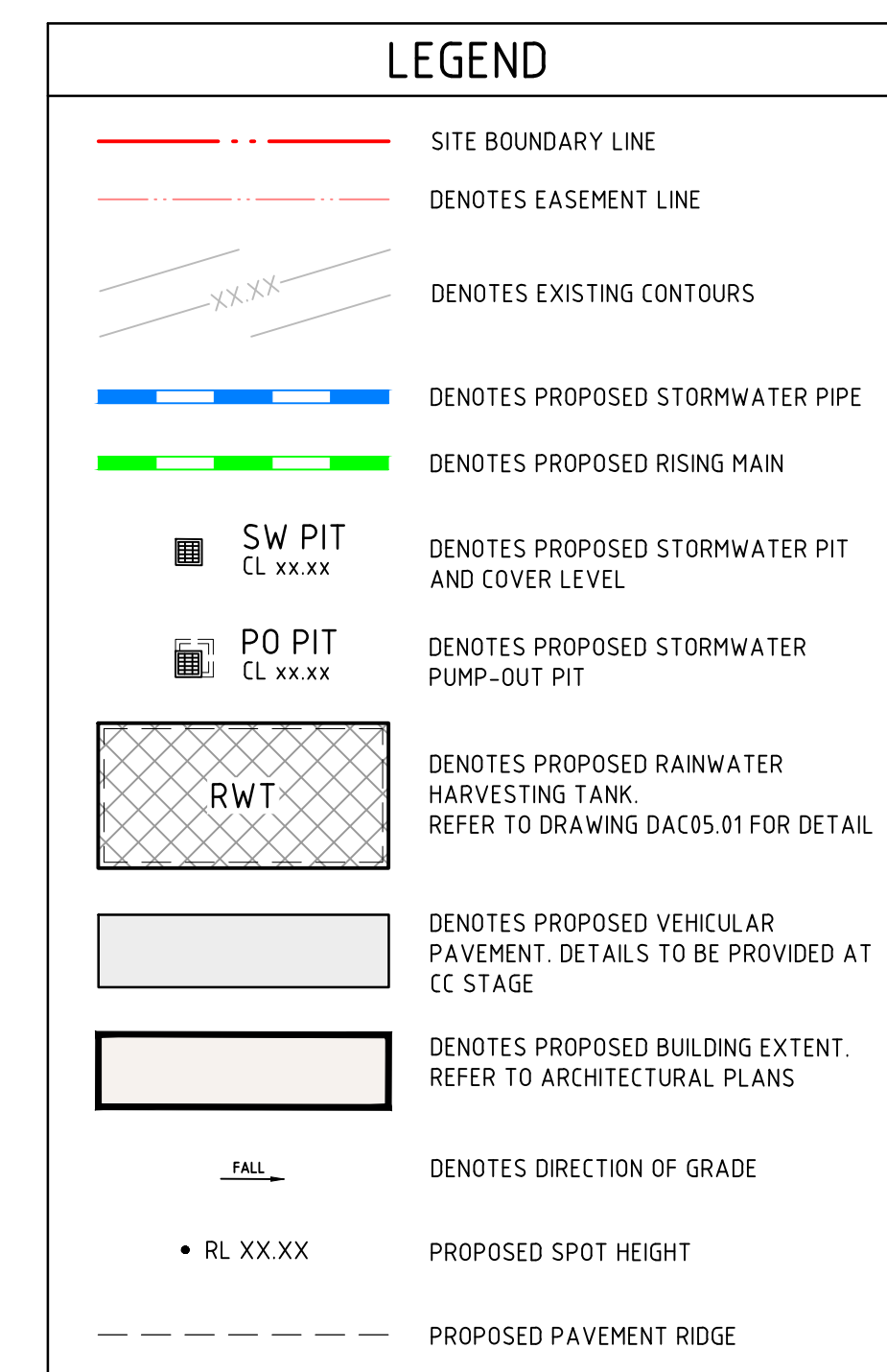
LEGEND

- Borehole Location (205363.04)
- CPT Location (205363.00)
- Borehole Location (205363.00)
- Site Boundary
- Indicative Location of Well for Monitoring during Dewatering
- Monitoring Well Installed in Bore



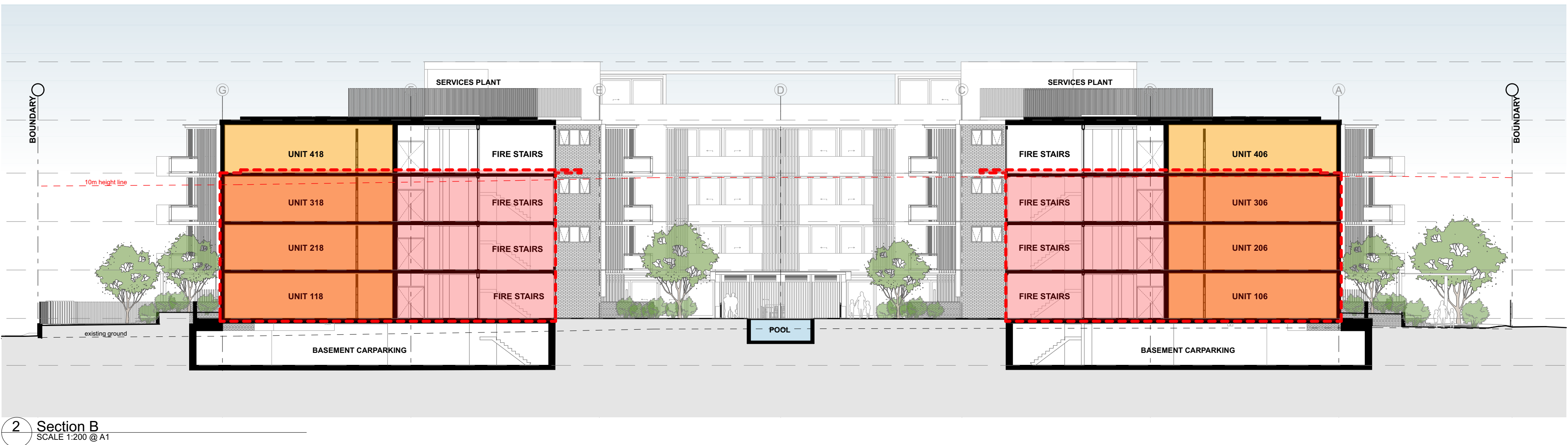
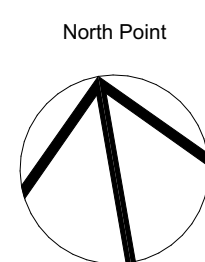
NOTE:
1. Drawing projection in GDA2020 / MGA zone 56, adapted from aerial imagery from Metromap Image dated 21.07.2024 and plan by Northrop, Ref NL183048-1, Drawing Number DA1-C04.01, Rev A.
2. Test locations are approximate only and were located using differential GPS typically accurate to ± 0.1 m depending on satellite coverage

	CLIENT:Oak Tree Retirement Village Belmont Pty Ltd		TITLE: Basement Overlay with Test Locations Proposed Residential Development 1B Glover Street, Belmont, NSW		PROJECT: 205363.04	
	OFFICE: Newcastle	DRAWN BY: PLH			DRAWING No: 2	
	SCALE: 1:600 @A3	DATE: 16.April.2025			REVISION: 1	



DRAWN: R. DUGGAN DESIGNED: E. GEARING JOB MANAGER: K. SNICLAIR VERIFIER: K. SNICLAIR

REVISION	DESCRIPTION	ISSUED	VER'D	APP'D	DATE	CLIENT	ARCHITECT			PROJECT	DRAWING TITLE	JOB NUMBER	
A	ISSUED FOR \$4.55 APPROVAL	RDU	-	EG	11.04.25				ALL DIMENSIONS TO BE VERIFIED ON SITE BEFORE COMMENCING WORK. NORTHROP ACCEPTS NO RESPONSIBILITY FOR THE USABILITY, COMPLETENESS OR SCALE OF DRAWINGS TRANSFERRED ELECTRONICALLY. THIS DRAWING MAY HAVE BEEN PREPARED USING COLOUR, AND MAY BE INCOMPLETE IF COPIED TO BLACK & WHITE.	PROPOSED AGED CARE FACILITY	CIVIL ENGINEERING PACKAGE	NL183048-01	
						DRAWING NOT TO BE USED FOR CONSTRUCTION UNLESS VERIFICATION SIGNATURE HAS BEEN ADDED	THE COPYRIGHT OF THIS DRAWING REMAINS WITH NORTHROP CONSULTING ENGINEERS PTY LTD.	SCALE 1:250 @ A1		1B GLOVER STREET BELMONT NSW 2280	CONCEPT STORMWATER MANAGEMENT AND LEVEL PLAN - BASEMENT	DRAWING NUMBER DA1-C04.01	REVISION A
												DRAWING SHEET SIZE = A1	

[illegible]

Appendix D

Water NSW General Terms of Approval
(10 May 2022)



Contact: Amanda Herringe
Email: amanda.herringe@waternsw.com.au

General Manager
Lake Macquarie City Council

Our ref: IDAS1142581
Our file: A-35287
Your ref: DA/2294/2021

gkeech@lakemac.nsw.gov.au

10 May 2022

Dear Sir/Madam

Re: Integrated Development Referral – General Terms of Approval
Dev Ref: DA/2294/2021
Description: 80mm submersible pump
Location: 2A Maude Street, Belmont NSW 2280

I refer to your recent letter regarding an integrated Development Application (DA) proposed for the above location. Attached, please find the WaterNSW General Terms of Approval (GTA) for part of the proposed development requiring a Water Supply Work approval under the *Water Management Act 2000* (WM Act), as detailed in the subject DA.

Please note Council's statutory obligations under section 4.47 (3) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) which requires a consent, granted by a consent authority, to be consistent with the general terms of any approval proposed to be granted by the approval body.

If the proposed development is approved by Council, WaterNSW requests these GTA be included (in their entirety) in Council's development consent. Please also note WaterNSW requests notification:

- if any plans or documents are amended and these amendments significantly change the proposed development or result in additional works or activities that relate to any excavation which interferes with an aquifer.
WaterNSW will ascertain from the notification if the amended plans require review of the GTA. This requirement applies even if the amendment is part of Council's proposed consent conditions and do not appear in the original documentation.

General Terms of Approval

for proposed development requiring approval
under s89, 90 or 91 of the Water Management Act 2000

Reference Number: IDAS1142581

Issue date of GTA: 10 May 2022

Type of Approval: Water Supply Work

Description: 80mm submersible pump

Location of work/activity: 2A MAUDE STREET BELMONT 2280

DA Number: DA/2294/2021

LGA: Lake Macquarie City Council

Water Sharing Plan Area: North Coast Coastal Sands Groundwater Sources 2016

The GTA issued by WaterNSW do not constitute an approval under the *Water Management Act 2000*. The development consent holder must apply to WaterNSW for the relevant approval **after** development consent has been issued by Council **and before** the commencement of any work or activity.

Condition Number	Details
	Dewatering
GT0115-00001	Groundwater must only be pumped or extracted for the purpose of temporary construction dewatering at the site identified in the development application. For clarity, the purpose for which this approval is granted is only for dewatering that is required for the construction phase of the development and not for any dewatering that is required once construction is completed.
GT0116-00001	Before any construction certificate is issued for any excavation under the development consent, the applicant must: 1. apply to WaterNSW for, and obtain, an approval under the Water Management Act 2000 or Water Act 1912, for any water supply works required by the development; and 2. notify WaterNSW of the programme for the dewatering activity to include the commencement and proposed completion date of the dewatering activity. Advisory Note: 3. An approval under the Water Management Act 2000 is required to construct and/or install the water supply works. For the avoidance of doubt, these General Terms of Approval do not represent any authorisation for the take of groundwater, nor do they constitute the grant or the indication of an intention to grant, any required Water Access Licence (WAL). A WAL is required to lawfully take more than 3ML of water per water year as part of the dewatering activity. 4. A water use approval may also be required, unless the use of the water is for a purpose for which a development consent is in force.
GT0117-00001	A water access licence, for the relevant water source, must be obtained prior to extracting more than 3ML per water year of water as part of the construction dewatering activity. Advisory Notes: 1. This approval is not a water access licence. 2. A water year commences on 1 July each year. 3. This approval may contain an extraction limit which may also restrict the ability to take more than 3ML per water year without further information being provided to WaterNSW. 4. Note that certain water sources may be exempted from this requirement - see paragraph 17A, Schedule 4 of the Water Management (General) Regulation 2018.
GT0118-00001	If no water access licence is obtained for the first 3ML / year (or less) of water extracted, then, in accordance with clause 21(6), Water Management (General) Regulation 2018, the applicant must: (a) record water taken for which the exemption is claimed, and (b) record the take of water not later than 24 hours after water is taken, and (c) make the record on WAL exemption form located on WaterNSW website "Record of groundwater take under exemption", and (d) keep the record for a period of 5 years, and (e) give the record to WaterNSW either via email to Customer.Helpdesk@waternsw.com.au or post completed forms to - PO Box 398 Parramatta NSW 2124 (i) not later than 28 days after the end of

General Terms of Approval

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Type of Approval:	Water Supply Work
Description:	80mm submersible pump
Location of work/activity:	2A MAUDE STREET BELMONT 2280
DA Number:	DA/2294/2021
LGA:	Lake Macquarie City Council
Water Sharing Plan Area:	North Coast Coastal Sands Groundwater Sources 2016
	the water year (being 30 June) in which the water was taken, or (ii) if WaterNSW directs the person in writing to give the record to WaterNSW on an earlier date, by that date.
GT0119-00001	All extracted groundwater must be discharged from the site in accordance with Council requirements for stormwater drainage or in accordance with any applicable trade waste agreement.
GT0120-00001	The design and construction of the building must prevent: (a) any take of groundwater, following the grant of an occupation certificate (and completion of construction of development), by making any below-ground levels that may be impacted by any water table fully watertight for the anticipated life of the building. Waterproofing of below-ground levels must be sufficiently extensive to incorporate adequate provision for unforeseen high water table elevations to prevent potential future inundation; (b) obstruction to groundwater flow, by using sufficient permanent drainage beneath and around the outside of the watertight structure to ensure that any groundwater mounding shall not be greater than 10 % above the pre-development level; and (c) any elevated water table from rising to within 1.0 m below the natural ground surface.
GT0121-00001	Construction phase monitoring bore requirements GTA: a) A minimum of three monitoring bore locations are required at or around the subject property, unless otherwise agreed by WaterNSW. b) The location and number of proposed monitoring bores must be submitted for approval, to WaterNSW with the water supply work application. c) The monitoring bores must be installed and maintained as required by the water supply work approval. d) The monitoring bores must be protected from construction damage.
GT0122-00001	Construction Phase Monitoring programme and content: a) A monitoring programme must be submitted, for approval, to WaterNSW with the water supply work application. The monitoring programme must, unless agreed otherwise in writing by WaterNSW, include matters set out in any Guide published by the NSW Department of Planning Industry and Environment in relation to groundwater investigations and monitoring. Where no Guide is current or published, the monitoring programme must include the following (unless otherwise agreed in writing by WaterNSW): i. Pre-application measurement requirements: The results of groundwater measurements on or around the site, with a minimum of 3 bore locations, over a minimum period of 3 months in the six months prior to the submission of the approval to WaterNSW. ii. Field measurements: Include provision for testing electrical conductivity; temperature; pH; redox potential and standing water level of the groundwater; iii. Water quality: Include a programme for water quality testing which includes testing for those analytes as required by WaterNSW; iv. QA: Include details of quality assurance and control v. Lab assurance: Include a requirement for the testing by National Association of Testing Authorities accredited laboratories. b) The applicant must comply with the monitoring programme as approved by WaterNSW for the duration of the water supply work approval (Approved Monitoring Programme)
GT0123-00001	(a) Prior to the issuing of the occupation certificate, and following the completion

General Terms of Approval

for proposed development requiring approval
under s89, 90 or 91 of the Water Management Act 2000

Reference Number: IDAS1142581

Issue date of GTA: 10 May 2022

Type of Approval: Water Supply Work

Description: 80mm submersible pump

Location of work/activity: 2A MAUDE STREET BELMONT 2280

DA Number: DA/2294/2021

LGA: Lake Macquarie City Council

Water Sharing Plan Area: North Coast Coastal Sands Groundwater Sources 2016

of the dewatering activity, and any monitoring required under the Approved Monitoring Programme, the applicant must submit a completion report to WaterNSW. (b) The completion report must, unless agreed otherwise in writing by WaterNSW, include matters set out in any guideline published by the NSW Department of Planning Industry and Environment in relation to groundwater investigations and monitoring. Where no guideline is current or published, the completion report must include the following (unless otherwise agreed in writing by WaterNSW): 1) All results from the Approved Monitoring Programme; and 2) Any other information required on the WaterNSW completion report form as updated from time to time on the WaterNSW website. c) The completion report must be submitted using "Completion Report for Dewatering work form" located on WaterNSW website www.watarnsw.com.au/customer-service/water-licensing/dewatering

- GT0150-00001 The extraction limit shall be set at a total of 3ML per water year (being from 1 July to 30 June). The applicant may apply to WaterNSW to increase the extraction limit under this condition. Any application to increase the extraction limit must be in writing and provide all information required for a hydrogeological assessment. Advisory note: Any application to increase the extraction limit should include the following: - Groundwater investigation report describing the groundwater conditions beneath and around the site and subsurface conceptualisation - Survey plan showing ground surface elevation across the site - Architectural drawings showing basement dimensions - Environmental site assessment report for any sites containing contaminated soil or groundwater (apart from acid sulphate soils (ASS)) - Laboratory test results for soil sampling testing for ASS - If ASS, details of proposed management and treatment of soil and groundwater. Testing and management should align with the NSW Acid Sulphate Soil Manual
- GT0151-00001 Any dewatering activity approved under this approval shall cease after a period of two (2) years from the date of this approval, unless otherwise agreed in writing by WaterNSW (Term of the dewatering approval). Advisory note: an extension of this approval may be applied for within 6 months of the expiry of Term.
- GT0152-00001 This approval must be surrendered after compliance with all conditions of this approval, and prior to the expiry of the Term of the dewatering approval, in condition GT0151-00001. Advisory note: an extension of this approval may be applied for within 6 months of the expiry of Term.
- GT0155-00001 The following construction phase monitoring requirements apply (Works Approval): a. The monitoring bores must be installed in accordance with the number and location shown, as modified by this approval, unless otherwise agreed in writing with WaterNSW. b. The applicant must comply with the monitoring programme as amended by this approval (Approved Monitoring Programme). c. The applicant must submit all results from the Approved Monitoring Programme, to WaterNSW, as part of the Completion Report

SCHEDULE 1

The plans and associated documentation listed in this schedule are referred to in general terms of approval (GTA) issued by WaterNSW for integrated development associated with DA/2294/2021 as provided by Council:

- Douglas Partners Desktop Groundwater - 2A Maude Street, Belmont

- if Council receives an application under s4.55 of the EP&A Act to modify the development consent and the modifications change the proposed work or activities described in the original DA.
- of any legal challenge to the consent.

As the proposed work or activity cannot commence before the applicant applies for and obtains an approval, WaterNSW recommends the following condition be included in the development consent:

The attached GTA issued by WaterNSW do not constitute an approval under the Water Management Act 2000. The development consent holder must apply to WaterNSW for a Water Supply Work approval **after consent** has been issued by Council **and before** the commencement of any work or activity.

A completed application form must be submitted to WaterNSW together with any required plans, documents, application fee, and proof of Council's development consent.

Application forms are available from the WaterNSW website which can be found [here](#).

WaterNSW requests that Council provide a copy of this letter to the development consent holder.

WaterNSW also requests a copy of the determination for this development application be provided by Council as required under section 4.47 (6) of the EP&A Act.

Information to the proponent:

- An extraction limit will be determined by the Department of Planning and Environment following a further hydrogeological assessment and included on the conditions applied to the approval for the dewatering activity.
- Detailed information required to permit the hydrogeological assessment to be carried out is to be provided by the applicant otherwise the issue of the approval will be subject to delay—the Minimum requirements for building site groundwater investigations and reporting (DPIE, 2021) identify what data needs to be collected and supplied.
- The approval will be issued for the purpose of temporary construction dewatering only and it does not constitute any form of permission for ongoing pumping of groundwater from basement levels after the building is issued an occupation certificate.
- The basement construction should be clearly stated by the proponent. The application documents are ambiguous regarding whether the basement is tanked or not tanked.

Yours Sincerely

Amanda Herringe

Amanda Herringe
Water Regulation Officer
WaterNSW