Douglas Partners
Geotechnics / Environment / Groundwater

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Lee 4 Pty Ltd
4/3 Sydney Avenue
BARTON ACT 2600

Project 91303.00
14 June 2018
R.002.Rev2
SAM:jah

Attention: Chris Farrington

Email: chris@domagroup.com.au

Dear Sirs

Groundwater Inflow Analysis for Proposed Basement
Huntington
35 Honeysuckle Drive, Newcastle

1. Introduction

This report presents the results of groundwater modelling in connection with the proposed basement excavations as part of construction works for a proposed residential tower development to be located at 35 Honeysuckle Drive, Newcastle, New South Wales. The work was undertaken at the request of Lee 4 Pty Ltd.

The purpose of the analysis was to assess potential groundwater inflows during construction and the potential water level changes beneath surrounding properties. In addition, this report provides comment on the following:

- Estimated water take quantities with reference to the Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources 2016, both during and post-construction;
- Potential impacts of the proposal against the provisions of the NSW Aquifer Interference Policy (2012).

It is understood that the development of the site will include:

- Two seven-storey residential towers, with two basement levels across the site, below both towers; and
- Existing ground levels range from about RL2.3 (AHD) to RL2.9. The proposed level of the basement is about RL-3.1. Localised deeper excavations (about 1 m below basement level) are anticipated for lift pit construction.

A section of the proposed development is presented in Figure 1 below.

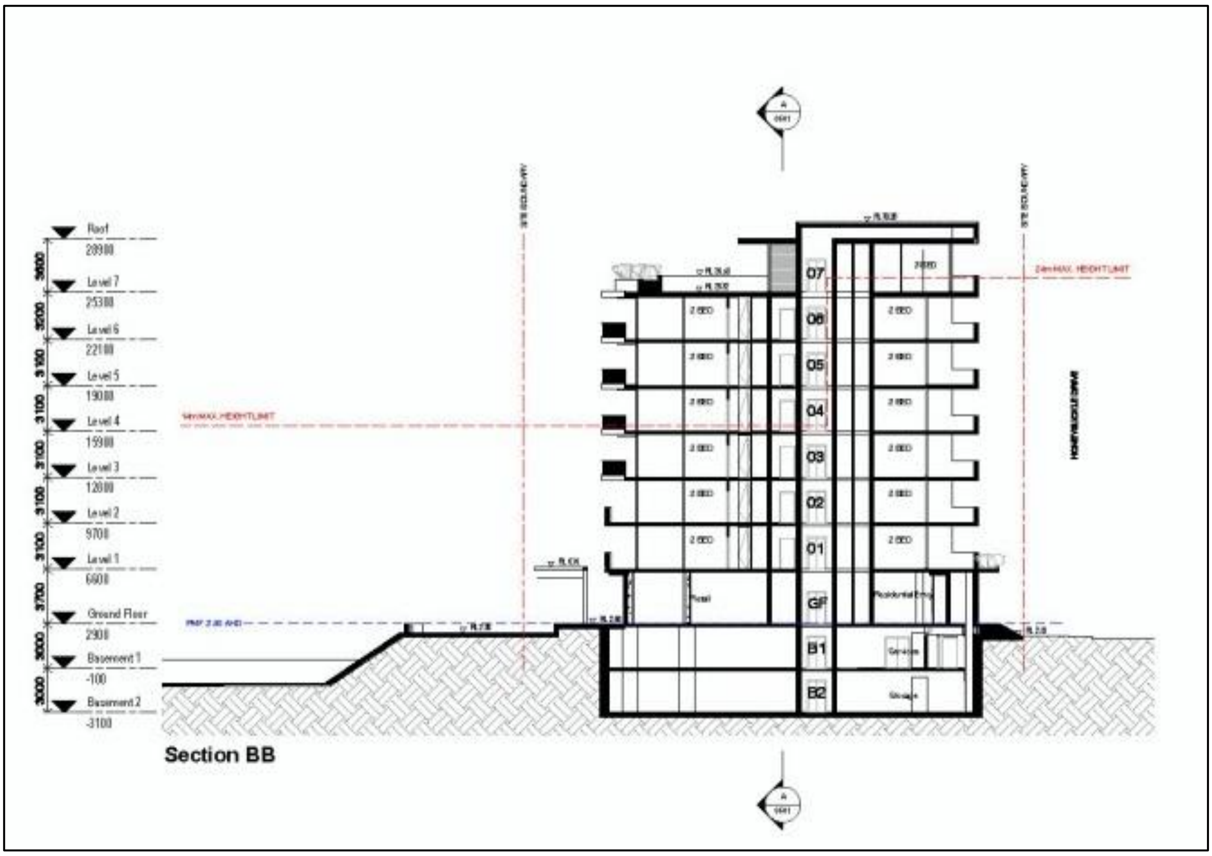

Figure 1: Section of proposed development (SJB Architects, DA-A-0601, Rev 3)

The scope of works for the assessment comprised the following:

- Brief review of previous investigations and assessments conducted at the site and adjacent site (Ref 1 to 5);
- Development of a conceptual groundwater model;
- Analysis using the 2D groundwater seepage program SEEP/W;
- Provide comment on potential water level changes around the perimeter of the excavation during construction and estimate potential settlement around the perimeter caused by lowering the groundwater; and
- Provision of a brief report presenting the results of the assessment.

2. Site Description

The site is described as 35 Honeysuckle Drive, Newcastle. The development site is roughly rectangular in shape (120 m long by 46 m to 50 m wide) and has an approximated plan area of 4700 m^2. The site is bounded to the south by Honeysuckle Drive, to the east by 21 Honeysuckle Drive and to the north and west by undeveloped land. Newcastle Harbour lies about 5 m to 10 m to the north of the site.

It is almost fully occupied by a bitumen-sealed carpark which is currently disused. The location and aerial view of the site is shown in Figure 2.

Figure 2: Site Location - 35 Honeysuckle Drive, Newcastle (Photo dated 7 April 2018, Nearmap)

3. Geotechnical Model

The geotechnical model for the subsurface conditions at the site is based on subsurface investigation (Ref 1).

Based on the results of the previous investigations, the site is within an alluvial soil profile which has been partially reclaimed using predominately granular materials. The geotechnical subsurface conditions are summarised below and are indicated on Section A-A' attached (reproduced from Ref 1):

Table 1: Summary of Geotechnical Subsurface Profile

Unit	Description	Range at Base of Stratum[1]	
		Depth (m)	RL (AHD)
1.1	Upper Fill: pavement materials, gravelly sand, rubble	0.32 to 1.0	2.58 to 1.9
1.2	Lower Fill: sand, silty sand, some gravelly sand,	0.51 to 4.0	2.39 to -1.10
2	SILTY CLAY/CLAYEY SILT - soft to firm (CPTs 5, 6 & 9 only)	5.07 to 6.44 (2)	-2.17 to -3.54
3.1	SAND / SILTY SAND – typically medium dense, loose in parts	6.75 to 15.57	-3.85 to -12.67
3.2	SAND - medium dense to dense, very dense in parts	10.10 to 11.84	-7.20 to -8.94
4	CLAY - stiff to hard, some interbedded sand layers	19.00 to 30.69	-16.10 to -27.79
5	CPT refusal in Weathered Rock (inferred)	29.68 to 31.54 - limit of investigation	

Notes to Table 1:

1. Layers vary in base depth across the site (i.e. not level) hence a range is given.
2. Unit 2 (soft to firm clay) is commonly encountered in alluvial areas of Newcastle but is not continuous over this site.

Long term groundwater monitoring was not possible following the installation of groundwater wells given the site was being utilised for the reconstruction of the adjacent wharf embankments. Groundwater for this assessment was based on the following information:

- Groundwater measurements during field work for the geotechnical investigation as presented in Ref 1;
- Groundwater levels which were recorded in three groundwater wells on the adjacent site to the east (Ref 4) over the period 20 December 2016 to 23 January 2017 (34 days); and
- Groundwater monitoring completed by Golder Associates in 1993 across the broader Honeysuckle area (Ref 5).

This data is summarised below.

Geotechnical Investigation (Ref 1)

The groundwater levels were recorded manually on 4 May 2018 and 10 May 2018 and have been summarised in Table 2 above. Long term groundwater monitoring was not possible following the installation of groundwater wells given the site was being utilised for the reconstruction of the adjacent wharf embankments.

Table 2: Groundwater Measurements from Ref 1

Parameter (Units)	DP4-BH		DP14-BH		DP20-BH	
	04/05/2018	10/05/2018	4/05/2018	10/05/2018	4/05/2018	10/05/2018
Reduced Level of Well Collar (AHD)	2.06		1.84		2.07	
Depth to Groundwater below Well Collar (m)	2.08	1.94	2.00	1.97	1.99	1.74
Depth to Groundwater below Ground Level (m)	2.18	2.04	2.07	2.04	2.03	1.78
Reduced Level of Groundwater (AHD)	-0.02	0.12	-0.16	-0.13	0.08	0.328

Geotechnical Investigation on adjacent site (Ref 4)

Groundwater monitoring was undertaken as part of the investigation for the adjacent site (Ref 4) over the period 20 December 2016 to 23 January 2017 (34 days). Figure B1 from Ref 4 shows the reduced water levels to AHD plotted against time from the previous investigation along with the average water levels observed in the current investigation. The plots also show the corresponding tide levels and rainfall (Nobby's BOM Station), as well as manual gauging checks from the adjacent site investigation. The proposed bulk excavation of the proposed development is also shown for comparison.

The results from the adjacent site indicate the following:

- Water levels during monitoring period for the adjacent site and current investigation were about 3 m to 4 m above the proposed bulk excavation level. Dewatering will therefore be required during construction;
- There were two moderate rainfall events of about 30 mm during the monitoring period for the adjacent site. There was no noticeable response in water level as a result of the rainfall. This is most likely due to the majority of the site being paved;
- A subdued tidal response in the order of 0.2 m amplitude was apparent, having a time-lag of about three to four hours relative to the tide; and
- It is noted that during construction, while the ground is open to rainfall and runoff, there would likely be a more direct groundwater response to rainfall.

It should be noted that groundwater levels are affected by factors such as climatic conditions, soil permeability and tidal movements and will therefore vary with time.

Golders Report (Ref 5)

A geotechnical investigation completed by Golders across the broader Honeysuckle site in 1994 indicated the following:

- Close correlation exists between the tidal information and those boreholes drill adjacent to the wharf areas although a lag time between peak tide and maximum water level in the ground appears to be between 20 and 90 minutes (with the greater lag occurring in bores further from the Hunter River).

4. Conceptual Groundwater Model

The Unit 1.1, Unit 1.2, Unit 3.1 and Unit 3.2 layers are considered to represent an unconfined aquifer and therefore the water levels in the layers are expected to fluctuate following rainfall and changes in river levels. Based on piezometer level gauging and data logging which was reported in Refs 1 and 4, a design groundwater level of RL0.3 was adopted for the temporary dewatering works.

The Unit 4 clay layer is considered to represent the base of the unconfined aquifer. The Unit 2 clay is not continuous across the site and has therefore been ignored in the groundwater modelling.

The base of the excavations at RL-3.1 will generally be within the Unit 3.1 alluvial soils.

Excavation support is expected to be required for the construction. This could include the use of sheet pile walls or secant pile walls to support the excavation, subject to engineering design.

Dewatering will be required for basement construction in order to draw down the water level to at least RL-3.6 (about 0.5 m below underside of the basement floor level), and locally lower at lift wells and large pile caps (if used). For the purposes of the analysis, a groundwater level within the excavation of RL-3.6 has been adopted, i.e. 0.5 m below bulk excavation levels.

The suggested hydraulic conductivities for site soils were presented in Ref 1 and have been reproduced in Table 3 below.

Table 3: Hydraulic Conductivity Parameters for Design of Dewatering

Unit	Description	Permeability k (m/s)
1.1	Filling – pavement materials, concrete	NA - above water table
1.2	Filling – sand, silty sand, gravel, some rubble	3×10^{-4}
2	Silty Clay / Clayey Sand - soft to firm (not continuous)	NA - Not continuous
3.1	Sand / Silty Sand - loose to medium dense	6×10^{-4}
3.2	Sand - medium dense to dense	4×10^{-4}
4	CLAY - stiff to very stiff	1×10^{-8}

It is noted that the permeabilities of Units 1.2, 2.1 and 2.2 are considered the critical parameters for assessing seepage flows. Accordingly a sensitivity analysis has been undertaken where the hydraulic permeability of these layers was varied.

5. Groundwater Inflow Analysis

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 above.

As discussed above, excavation support is expected to be required and this could include either sheet pile walls or secant pile walls.

It is understood that the following construction sequence is proposed for the site:

i. Site clearing, and preparation works;
ii. Erection of environmental protection measures (e.g. sediment fences);
iii. Installation of a permanent cut-off wall around the perimeter of the excavation;
iv. Installation and commissioning of dewatering system. Commence dewatering;
v. Progressive dewatering of the excavation to the depth of excavation by either spear points. It is understood that subject to treatment and satisfactory testing of the abstracted groundwater, it would be disposed to stormwater;
vi. Construction of footings and floor slabs;
vii. Construction of building above;
viii. Cease groundwater extraction during the construction period, at a time determined by structural / geotechnical engineer.

It is understood that Steps (i) to (vii) above are scheduled to be carried out over a period of approximately 24 to 26 weeks.

There are two main arrangements possible for dewatering: internal and external spear points, as follows:

- Case A - Internal Dewatering**:** This method requires the perimeter wall to be installed into the Unit 4 clay layer. Based on the CPTs from Ref 1, the top of this layer varies in reduced level across the site from RL-15 to RL-13. Spear points or large sumps / pumps could be located inside the pile wall to manage groundwater inflow. Due to the presence of dense and locally very dense sand (Unit 3.2), heavy driving could be expected if sheet piles are adopted resulting in noise and vibration and therefore consideration should be given to secant walls if Case A is adopted;
- Case B - External Dewatering: If the perimeter wall is terminated above the clay (i.e. in Unit 3.1 or Unit 3.2 sand) the water table would have to be drawn down external to the basement excavation using spear points. Some difficulties could be expected with the installation of the sheet piles or spear-points as indicated by premature refusal of pits and CPT equipment in local areas due to inclusions in the Unit 1.2 material. Furthermore, the Unit 2 clay may affect the efficiencies of the spear points and this will need to be considered as part of the detailed design of the dewatering system.

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

- The installed depth of the piled wall has not been determined and therefore the following was assumed for analysis:
  - o Case A - 17 m deep perimeter wall with a minimum of 1 m penetration into the Unit 4 clay; and
  - o Case B - 9 m deep perimeter wall installed into the Unit 3.2 sand (The final depth should be determined based on structural requirements to support the excavation);
- All units are continuous below the site;
- The vertical to horizontal permeability ratio K_v/K_h was modelled at a ratio of 0.5 for all layers;
- Unit 2 clay material was ignored in the analysis as this layer is not continuous across the site;
- Water table within the excavation will be drawn down to 0.5 m below the base of the bulk excavation at RL-3.6;
- No allowance for leakage through the piled walls;
- No external recharge / infiltration.

The model was run in steady state and the resulting head distribution is presented in Figure 3.

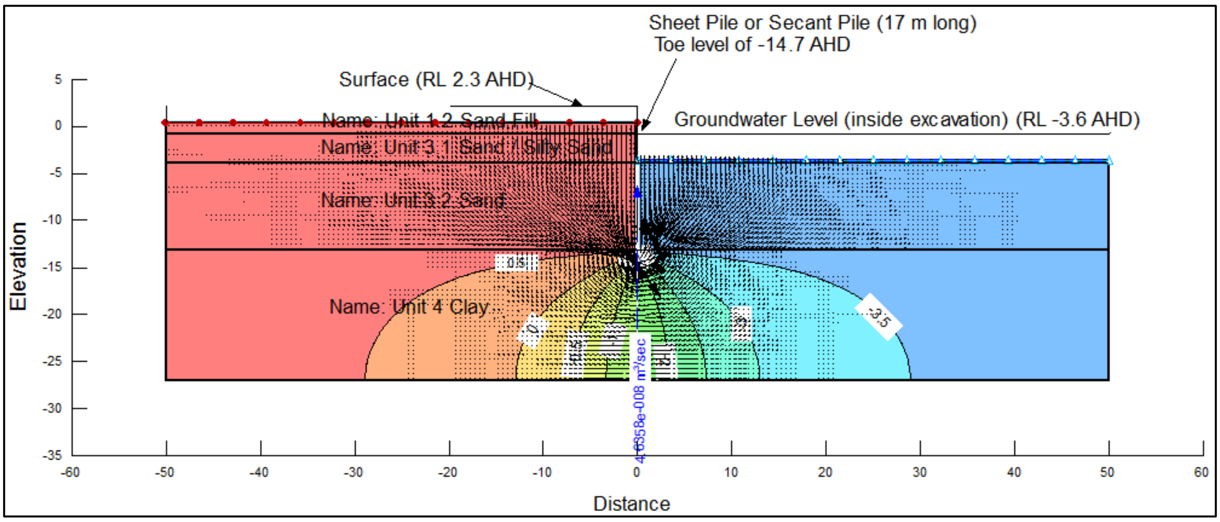

Figure 3: Steady State Head Distribution (Case A - Piled walls installed into Unit 4 clay)

The model for Case A indicated typical flow rates into the excavation in the order of 0.00005 l/s per metre of perimeter (i.e. 0.004 m^3/day/m). Based on this flow, for a basement excavation with a perimeter of about 300 m, the estimated groundwater flow into the excavation is in the order of 1.5 kL per day.

The model was re-run in steady state where the piled wall does not penetrate the clay (Case B) and the wall is founded within the Unit 3.2 Sand as shown in Figure 4.

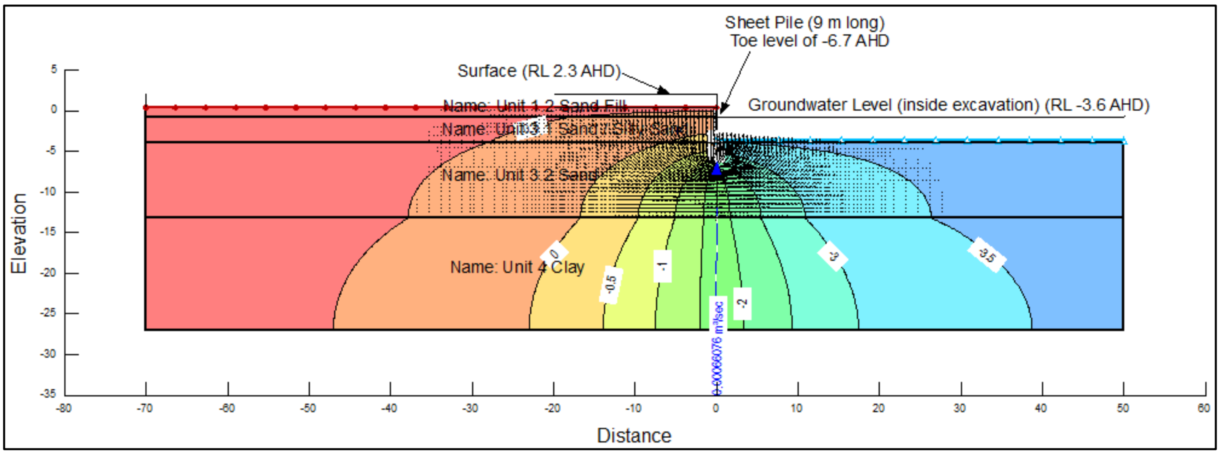

Figure 4: Steady State Head Distribution (Case B - Piled walls installed into Unit 3.2 sand)

The model indicated typical flow rates into the excavation in the order of 0.5 l/s to 0.9 l/s per metre of perimeter (i.e. 43 to 77 m^3/day/m). Based on this flow, for a basement excavation with a perimeter of about 300 m, the estimated groundwater flow into the excavation is in the order of 12900 to 23100 kL per day. There remains a risk of “base-boiling” with Option B which could be managed by increasing the depth of the perimeter piles and/or installation of internal spear-point wells.

The above analysis does not include leakage through the piled walls, which depends on contractor expertise and tightness of joints, hence some excess capacity in removing water would be advisable. Furthermore, the modelling rates are based on steady state analysis, and it is likely that higher dewatering rates will be required upon commencement of pumping in the order of two to three times the steady state rate presented above until steady conditions are achieved.

The modelling indicates that unless the perimeter walls are installed into the Unit 4 clay, potential daily inflows to the basement during construction could be substantial and may not readily permit on-site management such as reinjection. Consideration could be given to constructing the basement in smaller stages to reduce groundwater flows to manageable flows to allow for on-site reinjection and possible treatment of the groundwater.

6. Groundwater Changes during Construction

Provided over-pumping is not undertaken, the modelling suggests that widespread lowering of the unconfined aquifer is unlikely, particularly if Case A is adopted. In summary, the analysis indicates the following:

- Case A - a change in groundwater head of up to 1 m is expected at distances greater than 5 m from the excavation and a change of head of less than 0.5 m is expected at 30 m from the site; and
- Case B - a change in groundwater head of up to 1 m is expected at distances of less than 10 m from the excavation and a change of head of less than 0.5 m is expected at 50 m from the site.

A change in head of 1 m is equivalent to an increase in effective stress of up to about 10 kPa which is expected to result in a total settlement of up to 10 mm which reduces with distance from the excavation. Smaller settlements, however, could be expected as some of the area may have experienced dewatering or changes in groundwater levels in the past due to natural groundwater or previous dewatering activities for the installation of services such as sewer or water.

7. Potential Impacts

An assessment of the potential effects of dewatering has been summarised in Table 4.

Table 4: Assessment of Potential Impact of Dewatering

Item	Comment
Variation in groundwater head	Modelling by DP indicated a change in phreatic head of about 1 m during dewatering works at a distance of up to 10 m from the perimeter of the excavation. A long term change in head is not expected due to the proximity of the adjacent Hunter River.
Proximity of Groundwater Dependent Ecosystems (GDEs)	The existing development on the site is a former wharf and rail facility and is surrounded by roads, footpaths, commercial buildings and grass nature strips with the Hunter River located within about 30 m of the site boundaries. Furthermore excavations undertaken for the adjacent 21 Honeysuckle Drive project has indicated that the near surface soils consist of reclaimed materials. It is further understood from KDC Planning that an application has been presented to NSW Office of Environment & Heritage to request an exemption to provide a Biodiversity Assessment Report (BAR) in accordance with the Framework for Biodiversity Assessment (FBA). The status of GDEs will be confirmed upon receiving the outcome of the application.
Water Supply Losses by neighbouring groundwater users	An on-line records search of registered groundwater wells (http://allwaterdata.water.nsw.gov.au/water.stm) indicated that there were no registered wells located in the vicinity of the site.
Potential Subsidence of neighbouring structures	Analysis presented in Section 5 above indicates: *"A change in head of 1 m is equivalent to an increase in effective stress of up to about 10 kPa which is expected to result in a total settlement of up to 10 mm which reduces with distance from the excavation. Smaller settlements, however, could be expected as some of the area may have experienced dewatering or changes in groundwater levels in the past due to natural groundwater or previous dewatering activities for the installation of services such as sewer or water."*
Mounding of water up- gradient of structure	Mounding of groundwater is expected to be minimal given the proximity of the Hunter River and the relatively high permeability sand that surrounds the basement which would provide drainage around the side perimeter of the building.
Management of Groundwater Quality	The results of the groundwater analysis presented in Ref 2 and reproduced in Table A1 attached indicate that groundwater quality did not satisfy the ANZECC criteria for discharge to Marine water (95%). It is understood that a groundwater treatment system will be adopted to treat groundwater prior to discharge into the stormwater.
Acid Sulfate Soils	The results of laboratory testing presented in Ref 2 indicates that the basement excavation and associated dewatering is likely to expose acid sulfate soils. Management of soil and groundwater with respect to acid sulfate soils should be undertaken with due consideration to the Acid Sulfate Soil Management Plan which has been prepared for the project (Ref 3).

A groundwater management and monitoring plan will be prepared once details on basement support options are confirmed.

8. Conclusion

The results of the modelling indicate that the following groundwater rates for each case:

- Case A: 1.5 KL per day; or
- Case B: 12900 to 23100 kL per day.

Based on the anticipated time of construction (24 to 26 weeks) and predicted flow rates presented above, the total groundwater take during construction will be in the order of:

- Case A: 0.25 ML to 0.28 ML; or
- Case B: 2.2 ML to 4.2 ML.

Following construction, the basement will be tanked and groundwater extraction will cease i.e. there should be no long term groundwater take following construction.

The results of the analysis suggest widespread lowering of the unconfined aquifer is unlikely. The results suggest that a change in groundwater head of up to about 1 m is expected at a distance of 5 m to 10 m from the perimeter wall. A change of 1 m in head is expected to result is a settlement of up to 10 mm.

A temporary groundwater extraction licence will need to be sought from Water NSW for the extraction of groundwater over the construction period. A groundwater management plan is expected to be required to support the application to Water NSW for their approval.

9. Reference

1. Douglas Partners Pty Ltd "Report on Geotechnical Investigation, Huntington, 35 Honeysuckle Drive, Newcastle", Report 91303.00.R.001.Rev1, June 2018.
2. Douglas Partners Pty Ltd "Report on Waste Classification and Groundwater Quality, Huntington, 35 Honeysuckle Drive, Newcastle", Report 91303.00.R.003, June 2018.
3. Douglas Partners Pty Ltd "Acid Sulfate Soil Management Plan, Huntington, 35 Honeysuckle Drive, Newcastle", Report 91303.00.R.005.Rev0, June 2018.
4. Douglas Partners Pty Ltd "Report on Geotechnical Investigation, 50 Honeysuckle Drive, Newcastle", Report 91034.00.R.002.Rev1, April 2017.
5. Golder Associates "Report on Honeysuckle Project, Newcastle, Precinct C & Part D, Volume 1 Planning – Level Geotechnical Investigation" Project 93620094 dated March 1994.
6. Department of Primary Industries – Office of Water "NSW Aquifer Interference Policy: NSW Government policy for the licensing and assessment of aquifer interference activities", September 2012.

10. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at 35 Honeysuckle Drive, Newcastle in accordance with DP's proposal email dated 11 January 2018 and acceptance received from Chris Farrington dated 4 April 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Lee 4 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 DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the subsurface conditions presented in References 1 to 4. Subsurface 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.

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

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical, environmental and groundwater components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Reviewed by

Scott McFarlane
Principal

Stephen Jones
Principal

Attachments: About this Report
Figure B1 (Ref 4)
Table A1 - Laboratory Results of Groundwater Testing (Ref 2)
Drawing 5 – Geotechnical Cross-section A (Ref 1)

About this Report

Douglas Partners

Introduction
These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

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

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

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

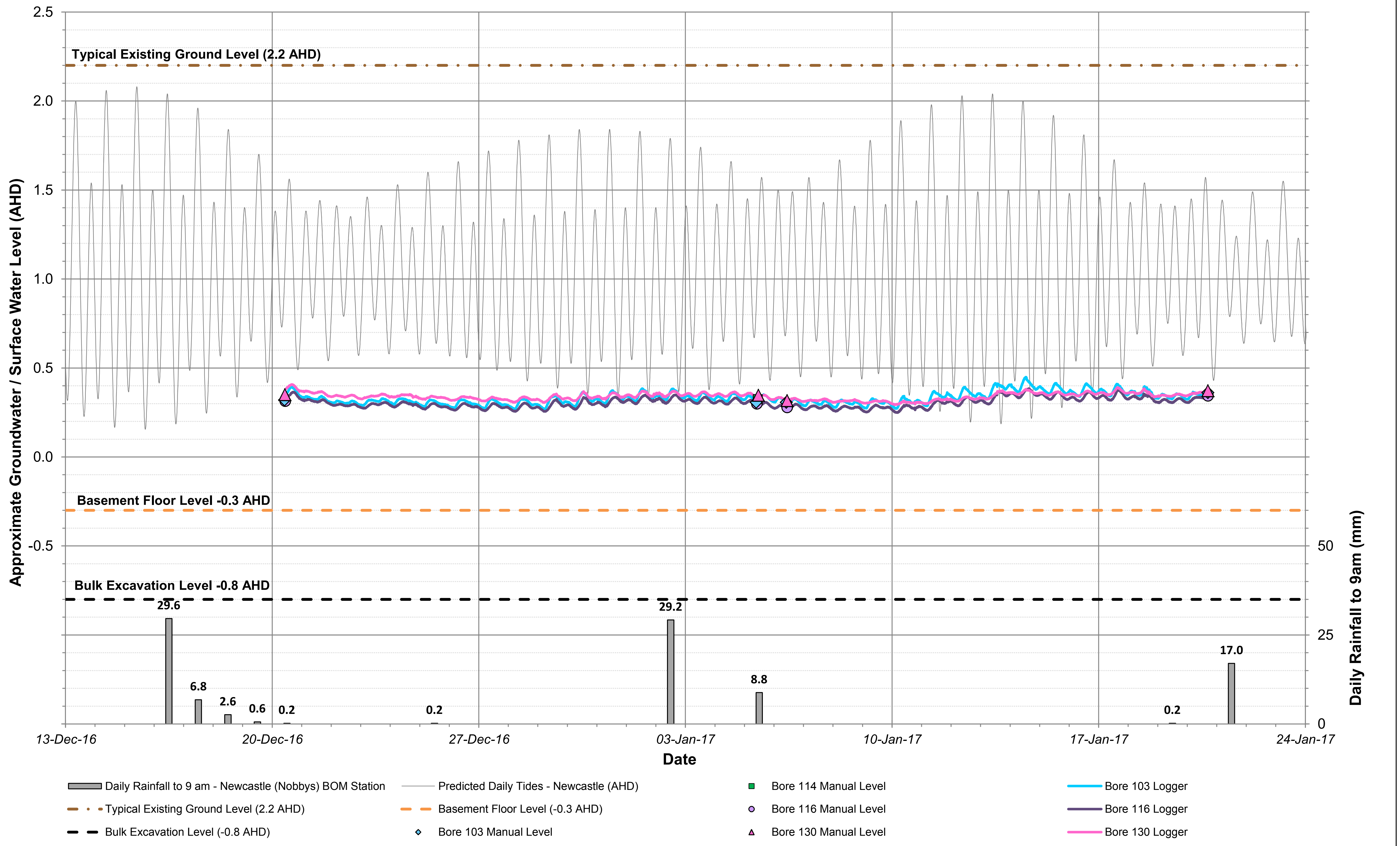
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

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



Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Doma Holdings (NSW) Pty Ltd	TITLE: **Groundwater Pressure Head vs Rainfall**	PROJECT NO: 91034.00
	OFFICE: Newcastle / DRAWN: DEW	**Proposed Residential Tower Development**	FIGURE NO: B1
	SCALE: N/A / DATE: 08.02.2017	**21 Honeysuckle Drive, Newcastle**	REVISION: Rev1

Douglas Partners
Geotechnics / Environment / Groundwater

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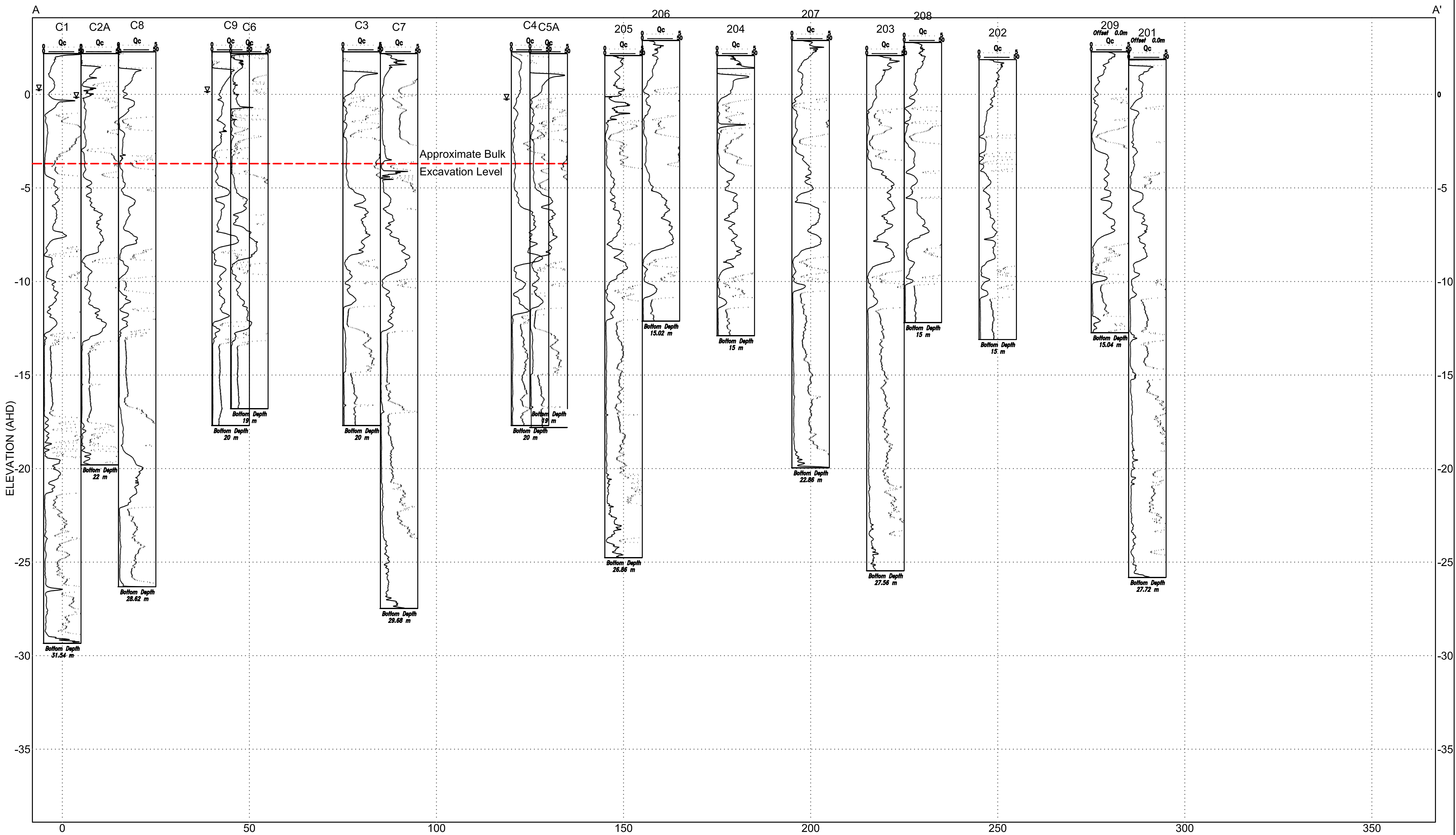
Table A1: Laboratory Results of Groundwater Testing (Ref 2)

	Units	PQL	ANZECC 2000 FW 95%	ANZECC 2000 MW 95%	NEPM 2013 Table 1C GILs, Fresh Waters	NEPM 2013 Table 1C GILs, Marine Waters	NEPM 2013 Table 1C GILs, Drinking Water	**Sample ID** / **Date Sampled**	D1 5/10/2018	DP14 5/10/2018	DP20 5/10/2018	DP4 5/10/2018
Inorganics												
pH (Lab)	pH_Units	0.1	6.5-7.5|8|6.5-8|6.5-8	7-8.5					7.2	7.7	7.7	6
Electrical Conductivity	uS/cm	1							2100	410	2000	510
Turbidity (Lab)	NTU	0.1	6 - 50	0.5 - 10					110	440	97	15
Chloride	mg/L	1							1600	22	1500	54
Nitrogen (Total)	mg/L	0.1	0.25|0.35	0.3					1.6	0.8	1.5	0.9
Sulphate	mg/L	1					500		250	32	250	59
Metals												
Arsenic (Filtered)	mg/L	0.001	0.013	0.0023			0.01		<0.001	0.003	<0.001	<0.001
Beryllium (Filtered)	mg/L	0.0005	0.00013				0.06		<0.0005	<0.0005	<0.0005	<0.0005
Boron (Filtered)	mg/L	0.02	0.37		**0.37**		4		**0.38**	0.1	**0.38**	0.25
Cadmium (Filtered)	mg/L	0.0001	0.0002	0.0007	**0.0002**	0.0007	0.002		<0.0001	<0.0001	<0.0001	<0.0001
Chromium (III+VI) (Filtered)	mg/L	0.001	0.001	0.0044					<0.001	<0.001	0.001	0.001
Copper (Filtered)	mg/L	0.001	0.0014	0.0013	**0.0014**	0.0013	2		0.001	**0.045**	**0.041**	**0.02**
Iron (Filtered)	mg/L	0.01							1.4	0.018	1.4	0.15
Lead (Filtered)	mg/L	0.001	0.0034	0.0044	**0.0034**	0.0044	0.01		<0.001	0.003	0.003	0.002
Manganese (Filtered)	mg/L	0.005	1.9	0.08	**1.9**		0.5		0.14	0.065	0.14	0.038
Mercury (Filtered)	mg/L	0.00005	0.00006	0.0001	**0.00006**	0.0001	0.001		<0.00005	<0.00005	<0.00005	<0.00005
Nickel (Filtered)	mg/L	0.001	0.011	0.007	**0.011**	0.007	0.02		**0.019**	0.01	**0.02**	**0.012**
Phosphorus	mg/L	0.05	0.01|0.02|0.025	0.03					0.2	0.2	0.2	0.2
Selenium (Filtered)	mg/L	0.001	0.005	0.003	**0.005**		0.01		<0.001	<0.001	<0.001	<0.001
Zinc (Filtered)	mg/L	0.001	0.008	0.015	**0.008**	0.015			0.006	**0.059**	**0.066**	**0.079**
TPH												
C10-C16	mg/L	0.05							<0.05	<0.05	<0.05	<0.05
C16-C34	mg/L	0.1							<0.1	<0.1	<0.1	<0.1
C34-C40	mg/L	0.1							<0.1	<0.1	<0.1	<0.1
F2-NAPHTHALENE	mg/L	0.05							<0.05	<0.05	<0.05	<0.05
C6 - C9	mg/L	0.01							<0.01	<0.01	<0.01	<0.01
C10 - C14	mg/L	0.05							<0.05	<0.05	<0.05	<0.05
C15 - C28	mg/L	0.1							<0.1	<0.1	<0.1	<0.1
C29-C36	mg/L	0.1							<0.1	<0.1	<0.1	<0.1
C6-C10 less BTEX (F1)	mg/L	0.01							<0.01	0.011	<0.01	<0.01
C6-C10	mg/L	0.01							<0.01	0.016	<0.01	<0.01
BTEX												
Benzene	mg/L	0.001	0.95	0.5	**0.95**	0.5	0.001		<0.001	<0.001	<0.001	<0.001
Ethylbenzene	mg/L	0.001	0.08	0.005			0.3		<0.001	<0.001	<0.001	<0.001
Toluene	mg/L	0.001	0.18	0.18			0.8		<0.001	0.006	<0.001	<0.001
Xylene (m & p)	mg/L	0.002							<0.002	<0.002	<0.002	<0.002
Xylene (o)	mg/L	0.001	0.35	0.35	**0.35**				<0.001	<0.001	<0.001	<0.001
PAH/Phenols												
Total Positive PAHs	mg/L								0.002	0.00044	0.00036	0.0005
Acenaphthene	mg/L	0.0001							<0.0001	<0.0001	<0.0001	<0.0001
Acenaphthylene	mg/L	0.0001							<0.0001	<0.0001	<0.0001	<0.0001
Anthracene	mg/L	0.0001	0.00001	0.00001					<0.0001	<0.0001	<0.0001	<0.0001
Benz(a)anthracene	mg/L	0.0001							0.0001	<0.0001	<0.0001	<0.0001
Benzo(a) pyrene	mg/L	0.0001	0.0001	0.0001			0.00001		0.0001	<0.0001	<0.0001	<0.0001
Benzo[b+j]fluoranthene	mg/L	0.0002							0.0003	<0.0002	<0.0002	<0.0002
Benzo(g,h,i)perylene	mg/L	0.0001							0.0002	<0.0001	<0.0001	<0.0001
Chrysene	mg/L	0.0001							0.0002	<0.0001	<0.0001	<0.0001
Dibenz(a,h)anthracene	mg/L	0.0001							<0.0001	<0.0001	<0.0001	<0.0001
Fluoranthene	mg/L	0.0001	0.001	0.001					0.0005	0.0002	0.0002	0.0002
Fluorene	mg/L	0.0001							<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	<0.0001
Naphthalene	mg/L	0.0002	0.016	0.05	**0.016**	0.05			<0.0002	<0.0002	<0.0002	<0.0002
Phenanthrene	mg/L	0.0001	0.0006	0.0006					<0.0001	<0.0001	<0.0001	0.0001
Pyrene	mg/L	0.0001							0.0005	0.0002	0.0002	0.0002



NOTE: Summary logs only. Should be read in conjunction with detailed logs.

TESTS / OTHER

N - Standard penetration test value

- Water level

0 20

Horizontal Scale (metres)

Vertical Exaggeration = 5.0

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Lee 4 Pty Ltd	TITLE: Geotechnical Cross-section A	PROJECT No: 91303.00
	OFFICE: Newcastle — DRAWN BY: PLH	Huntington	DRAWING No: 5
	SCALE: 1:1000 (H) 1:200 (V) @ A3 — DATE: 01.06.2018	35 Honeysuckle Drive, Newcastle	REVISION: 0