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Groundwater Assessment – 22 Melwood Ave.,Forestville, NSW

Report prepared for Forestville RSL Club
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DOCUMENT REGISTER

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1 INTRODUCTION

1.1 Background

This report presents the groundwater assessment for the proposed basement to be constructed at 22 Melwood Ave., Forestville, NSW. The assessment was commissioned by Mr Michael Briscas of Construction Management Services on behalf of Forestville RSL Club and presents the results of the hydrogeological investigation carried out for the proposed basement of the residential dwelling.

This groundwater assessment was prepared to address the requirements in the WaterNSW letter issued on 7th November 2024 and 2nd April 2025 for the proposed development and to support the review of general terms of approval by WaterNSW. The assessment is prepared in accordance with the Minimum requirements for building site groundwater investigation and reporting (DPIE, 2021).

The report outlines the groundwater conditions beneath the Site, the need for dewatering of a basement below ground level, potential impact on the neighbouring properties and groundwater system and any water treatment related to groundwater disposal. This investigation follows a geotechnical investigation at this Site carried out by Geo-environmental Engineering in September 2024.

Based on the information and plans supplied by the client (drawings Quattro Architecture of 05/05/25), it is understood that the proposed development comprises the construction of three storey development with three level basement below the current ground level. The deepest southern basement is proposed at the southern boundary. The lowest of the southern basement levels is proposed to have a final floor level of 117.7 mAHD. Second level basement will cover both southern and northern areas and its final floor level is designed at 120.7 mAHD. First level basement will have an area of 4,260 m^2 with the final level at 124 mAHD. Based on existing surface elevations, it is expected that excavation of between approximately 9 to 9.7 metres depth will be required with deeper excavations also expected to be required locally to accommodate the proposed lift shafts. For the second level basement the excavation of between approximately 4.5 to 5 metres depth will be required.

Groundwater level was observed at 2.3 and 3.2 m below ground level; therefore, the proposed basement will require dewatering. The proposed basement design is drained.

The purpose of this investigation is to prepare a groundwater assessment that will evaluate the inflows into the basement during and post construction, assess and provide an indication of duration of water take for dewatering and method of measuring the water take.

1.2 Scope of work

The following scope of works is required based on the Minimum requirements for building site groundwater investigation and reporting (DPIE, 2021) in accordance with the and WaterNSW letter Reference No IDAS1158140 (DA2024/1303) in preparation of the assessment:

- Provide reason for dewatering and show the footprint of the area
- Understand the groundwater level and its fluctuation over a minimum of 3-month period
- Undertake hydraulic testing to determine aquifer properties and estimate groundwater inflow into the basement and the period of discharge during basement construction and on an ongoing basis
- Discuss dewatering techniques and duration of water take
- Assess volume of water to be extracted and drawdown resulting from the proposed development and impact on the neighbouring properties and groundwater system during and post construction period
- Describe the monitoring program to manage any impacts during construction and methods of measuring the water take

2 EXISTING ENVIRONMENT

2.1 Site description

The subject Site is located at 22 Melwood Ave., Forestville as shown in **Figure 1**. Excavation areas which are discussed in this report are almost rectangular in shape, is located between Melwood Ave to the east, residential development to the north and west, Forestville Dog Park, Community Hall and Scouts Hall. To the south are the Forestville War Memorial Playing Fields. The site is located on the hilltop and slopes at 1-2 degrees to the south-east. Surface elevation range from 127.8 at the northern end to 126 m AHD to the south-eastern corner.

The total proposed basement area covers around 4300 m^2 (similar footprint of first and second level basement) and a third level basement in the south 2984 m^2. The ground slopes gently to the south-west. For the purpose of this report second level basement (B2) and third level basement (B3) will be addressed. Given that the first level basement has the same footprint as second level basement it will not be discussed in terms of groundwater. Given that second level basement will be partially underlain by the B3 level basement only half of its area (in the north) will be included in assessment.

Figure 1 Site location map (Source SIX.nsw.gov.au)

2.2 Geology and hydrogeology

According to 1:100,000 Sydney Geological Series, Map Sheet 9130 (Herbert, 1983), by the New South Wales, Department of Mineral Resources, the site is located within an area underlain by a Hawkesbury Sandstone (Rh) formed in the Triassic period. The sandstone is medium to coarse-grained with minor shale and laminate lenses. When fresh it has massive and cross bedded units, and weathers with iron staining common in the upper zone.

Based on the site investigation drilling (Geo-environmental Engineering (GEE), 2024), the upper geological profile includes the fill and silty sand derived from in-situ weathering of the bedrock. The fill comprises silty and clayey sand up to 1.6 m thick and is underlain by natural soil comprising sand and silty sand to a depth of 3 m. This layer grades to weathered sandstone at 1.5 to 3 m depth. Hawkesbury sandstone (weathered) underlies the unconsolidated strata.

2.3 Requirements for proposed development

The proposed development requires the southern basement to be excavated to 117.7mAHD (about 9 to 9.7 m below ground level) in the south (B3) and a bigger second level B2 to 120.7mAHD (about 5 m below ground). B1 has the same footprint as B2 therefore it will be assessed as part of B2. During geotechnical testing and drilling in 2024 (GEE, 2024) groundwater was encountered at a depth ranging from 124.1 to 124.9 mAHD. The proposed excavation will therefore intercept groundwater and will need to be dewatered. The basement is proposed to be designed as drained.

<u>Proposed drained basement construction</u>

The drained basement is proposed to be completed with excavated exposed sandstone, pile walls around the perimeter (soldier pile, contiguous, secant pile) and/or shotcrete with strip drains along the outside of the wall (GEE, 2025). The completion of the basement will be subject to structural and geotechnical engineer advice.

The strip drains will allow any water that reaches the basement walls to flow vertically down where it will be collected in the drain and discharged to the Council stormwater system. The base of the basement will be a concrete structure.

3.0 FIELD INVESTIGATION AND RESULTS

Geotechnical investigation in 2024 (GEE, 2024) included installation of 2 monitoring bores in accordance with the standards (ADIA, 2013). Bores were installed in sandstone and water levels recorded during investigation works. JK Geotechnics undertook geotechnical investigation in 2018 and as part of that program installed a monitoring bore BH1 which was also monitored as part of this groundwater assessment (**Figure 2**).

Further field investigations were carried out in the period from September to December 2024 as part of this report. This included the following:

- Installation of the dataloggers to measure daily groundwater level fluctuation in all bores since September 2024 (undertaken by GEE);
- Hydraulic testing of all three bores (3 tests per bore) to assess permeability; and
- Collection of two groundwater samples from BH1 and BH102.

All monitoring bores are constructed in accordance with the standards (ADIA, 2020). The location of bores is provided in **Figure 2**. The summary of monitoring bore construction is given in **Table 1** and logs are given in **Appendix B.**

Table 1 Summary of monitoring bore installation

Bore ID	***Total depth (m)***	***Surface elevation (mAHD)***	***Screened section (m below ground)***	***Screened lithology***
BH1	9	126.5	3-9	Sandstone
BH101	8	127.6	5-8	Sandstone
BH102	5.6	127.5	2.6-5.6	Sandstone

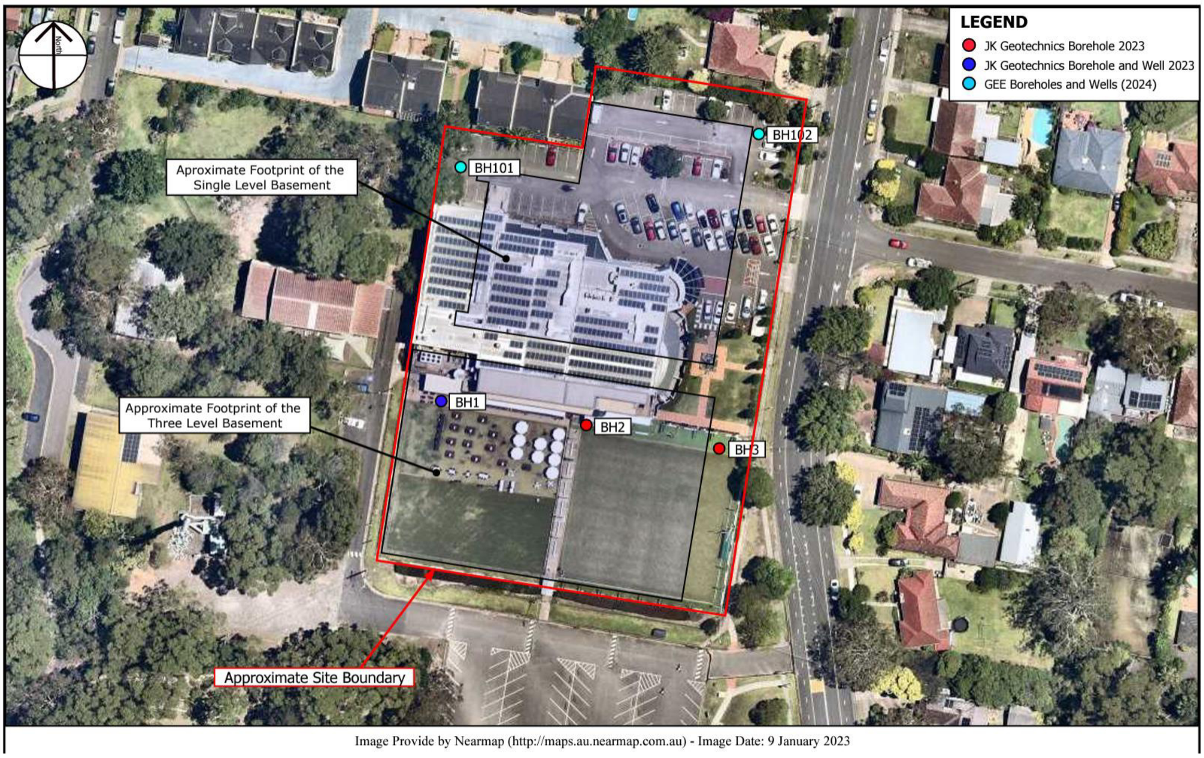

Figure 2 Monitoring bore location map

3.1 Groundwater monitoring

Groundwater monitoring was undertaken in monitoring bores for a period of three months starting on 3rd September 2024. The monitoring included daily groundwater level fluctuation, manual readings on 3 occasions, hydraulic testing and groundwater quality sampling. Groundwater samples were collected from two site bores and hydraulic testing undertaken on all bores (3 tests per bore).

3.2 Groundwater fluctuation

The dataloggers have continuously monitored the water level in piezometers for a period of 3 months and has captured several bigger rainfall events > 25 mm. **Figure 3** shows the hydrographs for bores with measured water levels as depth to water and plotted along with the rainfall data (closest BOM station SN66120). The relationship between rainfall and groundwater can be observed. **Figure 4** shows hydrographs for all bores presented in mAHD to allow comparison with the proposed basement depth.

Figure 3 and **Figure 4** show that groundwater level in BH1 and BH102 fluctuated over the monitoring period by around 4.5 m and 3 m respectively. Both hydrographs typically respond to rainfall recharge (0.2 m rise) which is observed following significant rainfall periods (30 mm in late November). BH101 has shown similar overall fluctuation over the same period with an ovealll decline of around 4.8 m but is influenced by rainfall to a lesser degree.

Rainfall in the months preceding monitoring was below long term average, and this is reflected in overall groundwater level decline over the monitoring period. This decline is observed in all three bores.

Lack of response to rainfall in BH101 is likely the semi-confinement of the sandstone at this location and depth. However, the overall trend is similar to that in BH1 and BH102.

Based on the results and similar behaviour and response to rainfall in bores installed across sandstone, it is considered that one hydrostratigraphic unit exists across the site which includes the weathered sandstone.

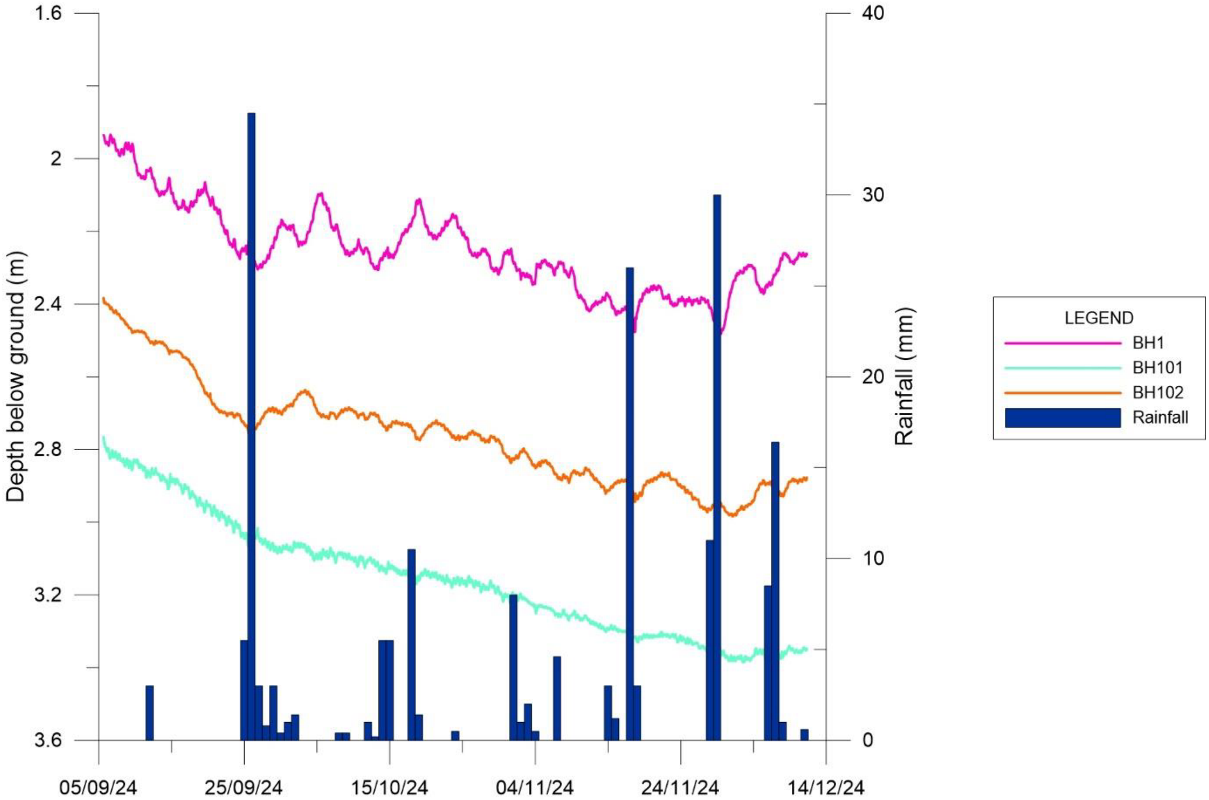

Figure 3 Hydrographs (depth to water/water level) for Site monitoring bores for a period from 3rd September 2024 to 11th December 2024 plotted with rainfall

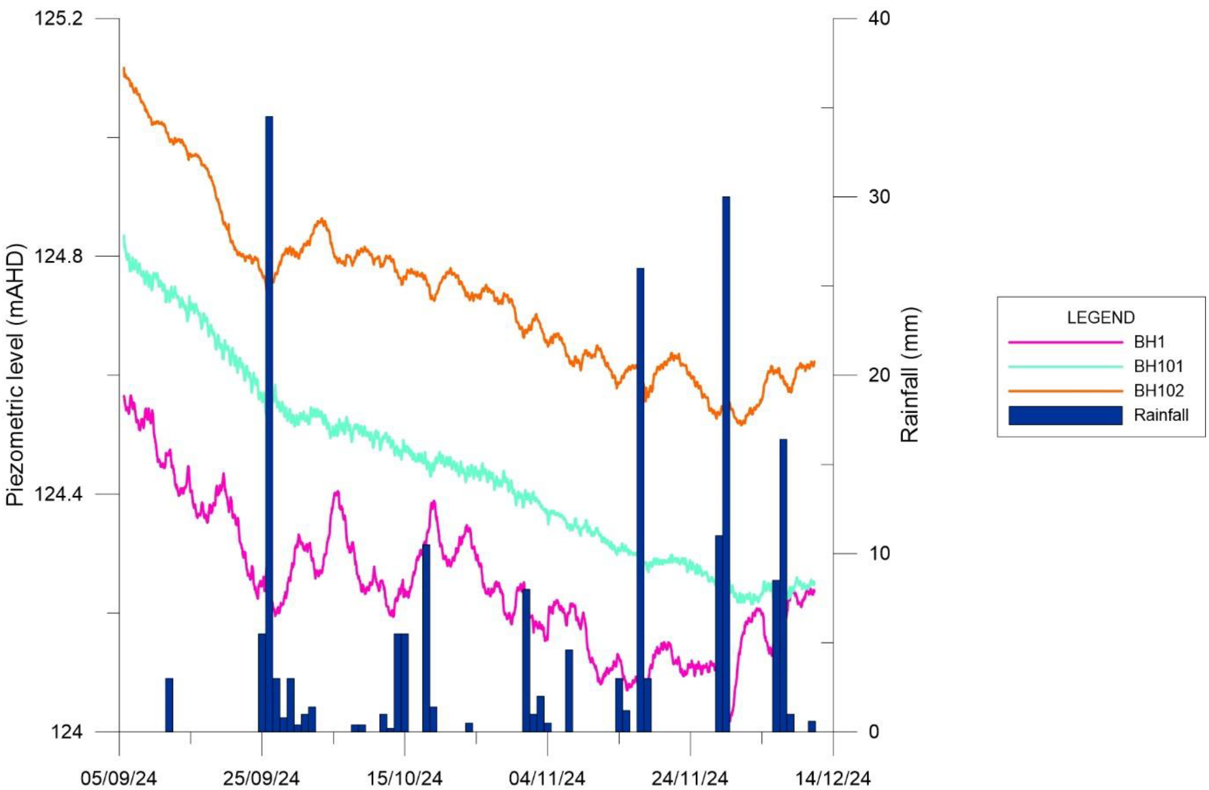

Figure 4 Hydrographs (mAHD) for Site monitoring bores for a period from 3rd September 2024 to 11th December 2024 plotted with rainfall

Table 2 Groundwater level fluctuation (mAHD)

Bore ID	*Minimum level*	*Maximum level*	*Average water level*	*Standard deviation*
BH1	117.9	124.5	124.1	0.89
BH101	120.1	124.8	124.3	0.61
BH102	122.3	125.1	124.7	0.33

3.3 Groundwater flow direction

Based on the groundwater level readings in December 2024 the interpreted groundwater flow direction is to the southwest (**Figure 5**). The groundwater flow in sandstone mimics the topography (**Figure 5**) with ultimate discharge into the Ocean.

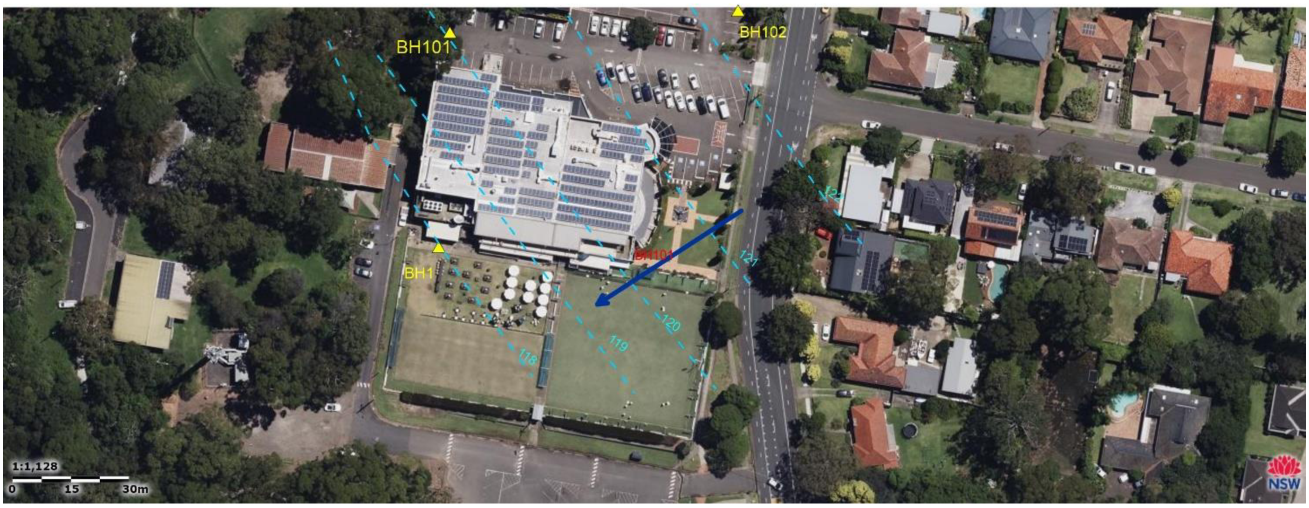

Figure 5 Interpreted groundwater flow direction - dashed lines represent interpreted piezometric level (mAHD) for December 2024

3.4 Aquifer hydraulic testing

In-situ hydraulic conductivity data were obtained from hydraulic testing in August and December 2024. Rising head tests were undertaken where water was removed from the well and the recovery monitored. Falling head tests were also undertaken by addition a known volume and monitoring the decline is piezometeric head. Three tests were undertaken on each bore to ensure higher certainty in the results and in accordance with the Minimum requirements for building site groundwater investigation and reporting (DPIE, 2021).

One set of tests was undertaken by GEE (2024) and analysed using Hvorslev (Hvorslev, 1951) solution. The other two sets of hydraulic tests were analysed using Bower and Rice (1989) method. The hydraulic conductivity results are presented in **Table 3 and Appendix D**. The results obtained from hydraulic testing are within the hydraulic conductivity range for weathered sandstone (Domenico and Schwartz, 1990) with variability due to difference in fracturing and weathering. The hydraulic conductivity across the site ranges from 3.1×10^{-2} to 3.9×10^{-4} m/d.

Table 3 Summary of hydraulic conductivity results for monitoring bores

Tested bore	*Hydraulic conductivity test results (m/day)*
BH1	3.1×10^{-2} to 3.9×10^{-4}
BH101	1.1×10^{-2} to 3.8×10^{-3}
BH102	2.8×10^{-2} to 4×10^{-2}

3.5 Groundwater conceptual model

Figure 6 shows the schematic hydrogeology cross-section (southwest to northeast) through the Site with basement elevation and water table shown. The average thickness of saturated zone (above the proposed basement) across the southern part of the Site is around 6-7 m and in the northern part of the basement it is around 1 m.

The recharge to the groundwater system occurs by rainfall as can be observed in hydrographs, with quick groundwater response. It is not expected that groundwater fluctuations will exceed the maximum measured on Site as 4-5 m fluctuation had already been observed. Discharge occurs via lateral flow to the southwest.

The groundwater gradient across the Site is gentle at 1 m drop over approximately 15 m distance. Based on the geology conditions across the Site and measured groundwater levels, one hydrostratigraphic unit exists beneath the Site.

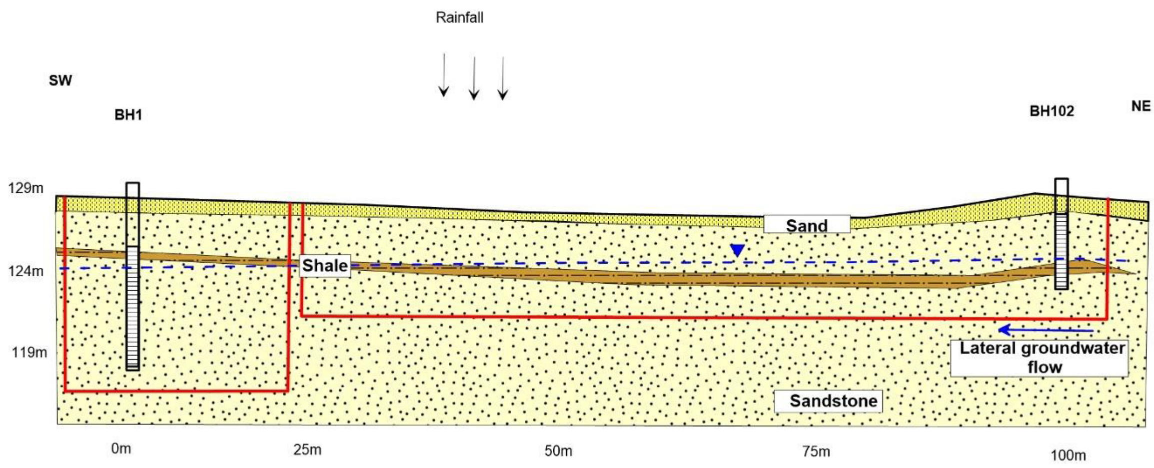

Figure 6 Conceptual model (schematic southwest-northeast hydrogeology cross section) with outline of the proposed basement (red) and water table elevation (blue line) (not to scale)

3.6 Groundwater quality

Two groundwater quality samples were collected in December 2024 from bores BH102 and BH1 using the Hydrasleeve (low disturbance sampling technique). Samples were field filtered using 45-micron filter for heavy metals. Samples were collected in appropriate sample containers, with sample preservation where required. The samples were transported under chain-of-custody protocols in an ice-filled storage container and were analysed at NATA-certified ALS laboratory, Sydney.

Samples were analysed for the species listed in **Table 4**. All analyses were conducted within the required holding times for analytes. Chain-of-custody records and laboratory analytical reports are provided in **Appendix C**.

Table 4 Hydrogeochemical analytes

Sample Type	*Analytes*
Physical parameters	pH, EC, temp, turbidity, TSS
Metals	Al, As, Cd, Cr, Cu, Pb, Ni, Zn, Se, Fe and Hg
Major ions	Ca, Mg, Na, K, Cl, SO_4, Alkalinity, Fluoride
Nutrients	TP, TN, nitrate, nitrite, ammonia
Hydrocarbons	TRH, PAH, BTEX

The ANZG (2018) guidelines for protection of aquatic ecosystems (marine water) have been adopted as the main Site assessment criteria and the groundwater sample were compared against those, given that the any potential discharge to the stormwater system and interaction with the seawater is ultimate discharge point. The 95 % level of protection of marine ecosystems is considered the most appropriate for this ecosystem.

The measured physicochemical parameters (**Table 5**) indicate that groundwater is fresh and slightly acidic.

Table 5 Summary of physicochemical measured parameters

Analytical Group	*Analytes*	*ANZG 2018 Guidelines*	*BH102*	*BH1*
Physical parameters	EC (µS/cm)	125-2200	384	371
	pH (units)	6.5-8*	**4.72**	**4.29**
	Redox (mV)	NA	-29.5	27.4
	Dissolved oxygen (%)	85-100	**19**	**10.2**
	Oil and grease		Not observed	Not observed

Notes: * Lowland River pH values

The summary of analytical results and comparison with ANZG (2018) for 95 % protection of marine species (exceedances are marked bold) are given in **Table 6** and analytical laboratory results are presented in **Appendix C**.

Table 6 Summary of water quality results and comparison with ANZG (2018) guidelines

Analytical Group	*Analytes(mg/L)*	*ANZG 2018 Guidelines (mg/L)*	*BH102*	*BH1*
Metals	Arsenic	ID	<0.001	0.001
	Cadmium	0.0055	<0.0001	<0.0001
	Chromium	0.001	<0.001	0.002
	Copper	0.0013	**0.009**	**0.014**
	Lead	0.0044	0.003	0.003
	Nickel	0.07	0.009	0.013
	Zinc	0.015	**0.060**	**0.132**
*Turbidity **		50	**221**	**156**
Hydrocarbons	Ethylbenzene	0.08	<0.002	<0.002
	Toluene	0.18	<0.002	<0.002
	m-xylene	0.075	<0.002	<0.002
	o-xylene	0.075	<0.002	<0.002
Polycyclic aromatic hydrocarbons	Benzo(a)pyrene	0.0002	<0.0005	<0.0005
	Fluoranthene	0.0014	<0.001	<0.001
	Naphtalene	0.07	<0.001	<0.001
	Phenanthrene	0.002	<0.001	<0.001
Inorganics	Ammonia	0.91	0.04	1.99
	Total phosphorous	0.05	**0.12**	**0.06**
	Total nitrogen	0.5	**1.9**	**3.6**
Oil and grease	Oil and grease		Not observed	Not observed

*units are NTU

These results indicate that:

- The measured concentrations of heavy metals were very low generally below the ANZG (2018) criteria except for copper and zinc
- pH is slightly acidic and groundwater is fresh.
- Turbidity was above the guidelines in both monitoring bores.
- Nutrients –total phosphorous and total nitrogen were above the guidelines in both samples however ammonia was below
- Hydrocarbons, TRH and BTEX and inorganic compounds are all below detection limit.

4.0 MANAGEMENT OF INFLOW AND DISCHARGE

4.1 Predicted groundwater inflow and extraction during construction

The plans and information provided by the client indicate the lowest level in the constructed basement will be:

- Third level basement - Southern area B3 - to be excavated to 117.7 mAHD (about 9 to 10 m below ground level) with an area of around 2,984 m^2 ;
- Second level basement - Northern and southern area (B2) with a deepest level to be excavated to 120.7 mAHD (about 5-7 m below ground) with an area around 4,388 m^2. About 50% of the B2 area has the same footprint as B3 , therefore only northern part will be considered in the groundwater assessment. ;and
- First level basement (B1) – northern and southern area with excavation level of 124 mAHD – the footprint is the same as B2, therefore this will not be considered for the groundwater inflow

This elevation does not include the allowance to accommodate the concrete slab. Based on current conditions, the groundwater level will therefore be approximately 7 m (at high water mark) above the proposed excavation level in the south and 4.5 m above the base of the excavated area in the north. To maintain the Site trafficability in the excavated basement, the water table will have to be lowered to the proposed basement level.

Analytical groundwater assessment was undertaken to estimate the inflow into the excavation. Projected dewatering rates were calculated assuming maximum7 m saturation from the base of the excavation for B3 and 4.5 at B2, hydraulic conductivity of 0.03-0.00039 m/day in the south and 0.03 m/day in the north (based on field obtained results). Dupuit –Thiem equation (Fetter, 1994) for unconfined aquifer was used to calculate the groundwater inflow into the excavation as follows:

$$Q = \frac{\pi K(H^2 \ - \ h_w^2)}{\ln \frac{R_o}{r_w}}$$

Where R_o is equivalent radius of influence calculated using Kruseman and De Ridder (1994) approximation

$$Ro = \sqrt{2.25}k\ ho\ \frac{t}{Sy}$$

Where k is hydraulic conductivity, ho is standing water table, t is time and Sy is specific yield.

It was assumed that the excavation would take 70 days to complete in the south B3 and 60 in the north of B2. Projected short term groundwater inflow is thus calculated:

- In the south B3 at maximum of 36 m^3/day (0.58 L/s) and average of 34 m^3/day (0.4 L/s); and
- in the north B2 at 8 m^3/day (0.09L/s) and pumping at this rate should be sufficient to maintain the water level below the excavation during construction.

The value provides the estimated inflow for static conditions and does not include prolonged high rainfall periods. However, high water levels have already been considered following the review of water levels and it is not expected that temporary excavation will occur over the extremely wet period. Total predicted inflow during construction is predicted at 2.9 ML/year for average conditions, and it is assumed that the excavation will not occur in the period of extreme rainfall. Also, the estimate is based on the instant excavation and the actual excavation will occur in stages therefore slowing down the inflow rate.

4.2 Predicted groundwater inflow post construction

Groundwater modelling was undertaken to understand the long term impact from drained basement and satisfy the WaterNSW requirements under the Water Management Act 2000.

The following models are prepared:

- Conceptual long term groundwater model (**Figure 7**); and
- Analytical long term (steady state) groundwater model (this section).

The data and information used to prepare the groundwater model are provided in the main report and include the following:

- Three months of water level monitoring in three bores across the Site
- Hydraulic testing of Site bores to understand the hydraulic conductivity
- Geochemical data analysis

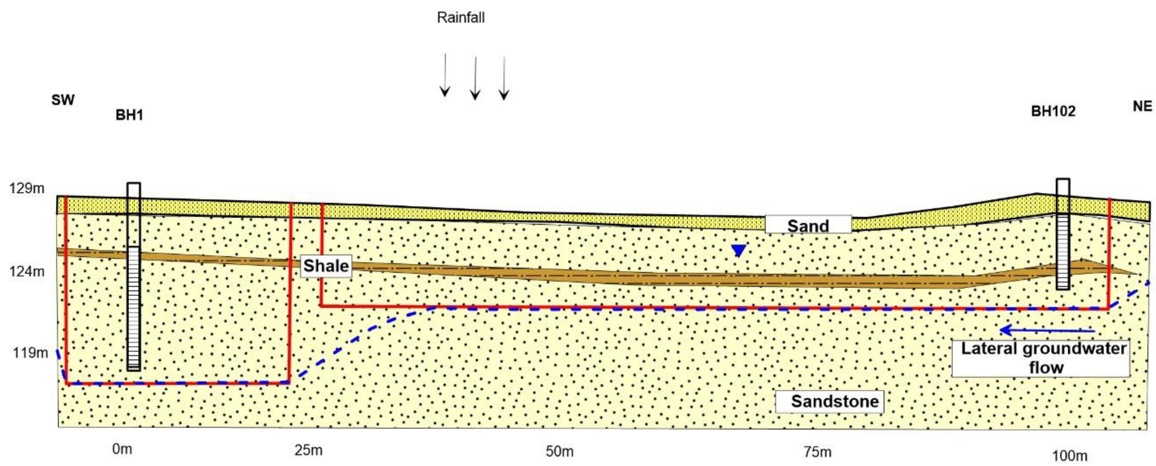

Figure 7 Conceptual model for drained basement with outline of the proposed operational basement (red) and water table elevation (blue line) (not to scale)

Conceptual model shows the recharge and discharge to the system, with groundwater being directed towards the basement within the vicinity of the sump located at the lowest point in the basement and pumping from this point. This is the major difference from the current conceptual model.

Potential inflow into the basement following the construction has been assessed by analytical model. The model is based on the Site collected data as described above and in the Section 3.

The analytical solution used is Dupuit solution as presented in Mansur and Kaufman (1962) and Bear (1979), similar to the adapted Marinelli and Niccoli (2000) solution without recharge. The solution for head profile is derived with Dupuit-Forchheimer approximation. The assumptions made using analytical modelling are:

- Infinite horizontal extent of the aquifer
- Homogenous and isotropic hydraulic conductivity distribution
- Simple boundary conditions
- Steady state groundwater flow
- Pre-construction condition assume approximately horizontal water table
- Unconfined condition

Inflow to the bottom of the basement is not considered because the analytical solution is used only to calculate hydraulic head at the water table, which is independent of groundwater flow through the basement base in the solution. In addition, there is no indication from the hydrographs that there is an upward flow from the sandstone. In this solution the basement is assumed to be a large diameter well with circumference similar to the average perimeter of the basement.

The equation (Kruseman and De Ridder, 1990) used in shown below and **Figure 8** shows the schematic conceptual model.

$$Q = \pi K \frac{(H_2^2 - H_1^2)}{\ln(r_2/r_1)}$$

Where

Q- inflow from large diameter area

k- hydraulic conductivity

h0 height of water table above base of the aquifer, 4 m and 7 m assumed based on the observed fluctuation at B2 and B3 hw water depressed at the base of the basement

rw radius of the well equivalent to the radius of the basement

ro radius of maximum extent of cone of drawdown (SQRT(2.25 x k x Ho x t/Sy)

t time since pumping started

Sy specific yield

The resulting inflows are predicted long term:

- For the southern area B3 around 5 m^3/d (total of 1.8 ML/year average)
- For the northern area B2 at 2 m^3/d (total of 0.73 ML/year average)

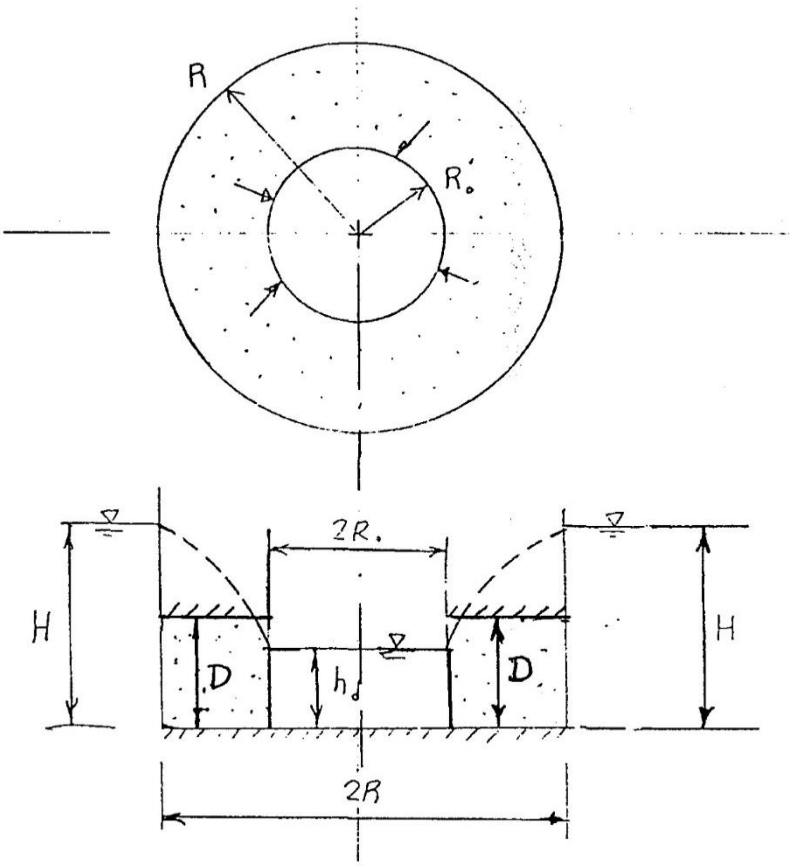

Figure 8 ***2 Schematic Dupuit-Forchheimer approximation***

4.3 Drawdown extent and impact on groundwater users, ecosystems and structures during construction

Using Theis analytical solution (Theis, 1935) drawdown was calculated for known discharge.

- Southern B3 basement - Given the average discharge of 34 m^3/day, transmissivity of 0.6 m^2/day, and specific yield of 0.05 for sandstone (Heath, 1983), it is predicted that after 70 days of continuous pumping, the drawdown will be a maximum of 0.9 m below current water levels at the edge of the excavated basement (**Figure 9**) and at 100 m it will be approaching zero. After 70 days drawdown at 75 m distance is predicted to be 0.3 m.
- Northern B2 basement – based on the discharge of 8 m^3/day (Section 4.1), transmissivity of 0.56 m^2/day it is predicted that after 60 days of continuous pumping the drawdown of 60 m distance from the centre of the excavation will be 0.14 m and will approach zero at 100 m distance **(Figure 10**).

This calculation assumes that groundwater is not allowed to recover at any point in time while the basement is kept open. The estimate assumes that any surface water will be diverted off Site and will not directly contribute to groundwater.

Most conservative option is provided here where it is assumed that basement will be dewatered in an instant i.e. material is removed at the start of the excavation. However, in reality the excavation is assumed to occur within 60 or 70 days where reduced inflow rate will occur into the basement.

The closest residential property is located approximately 50 m distance (Community Hall) from the centre of the southern B3 basement. At that distance the maximum predicted drawdown will be around 1.5 m after 70 days of pumping, which is within the natural groundwater level fluctuation in shallow unconsolidated unit (as observed during 3 months of monitoring 4.5 to 6 m). Therefore, adverse impacts on existing nearby buildings because of dewatering the basement excavation, are expected to be minor.

The assessment was undertaken individually and on a conservative side, however due to the drawdown effect from B3 area there will be less drawdown in B2 area.

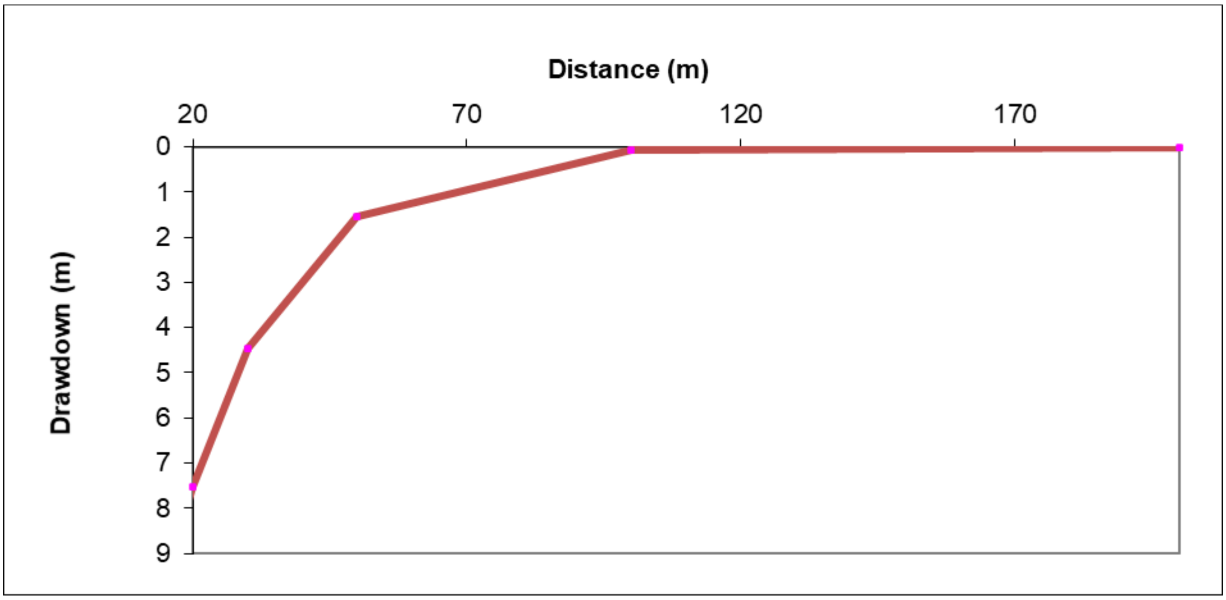

Figure 9 Predicted change in drawdown with distance from the centre of excavation at B3 southern basement (using Theis, 1935) during construction

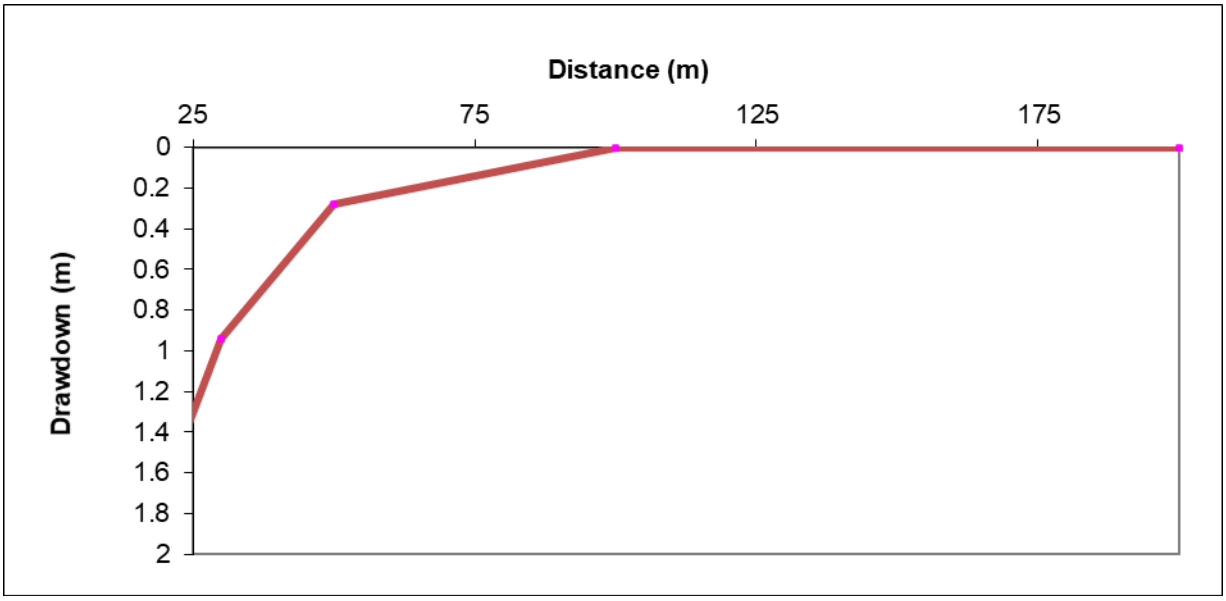

Figure 10 Predicted change in drawdown with distance from the centre of excavation at northern side of B2 basement (using Theis, 1935) during construction

Review of Groundwater dependent ecosystem atlas (BoM, 2024) indicates that moderate potential for terrestrial groundwater dependent ecosystems (GDEs) exists over 1000 m southwest and northwest of the Site (**Figure 11**). Based on the predicted drawdown which approaches zero at <100 m distance from the Site, no impact is predicted from proposed basement construction.

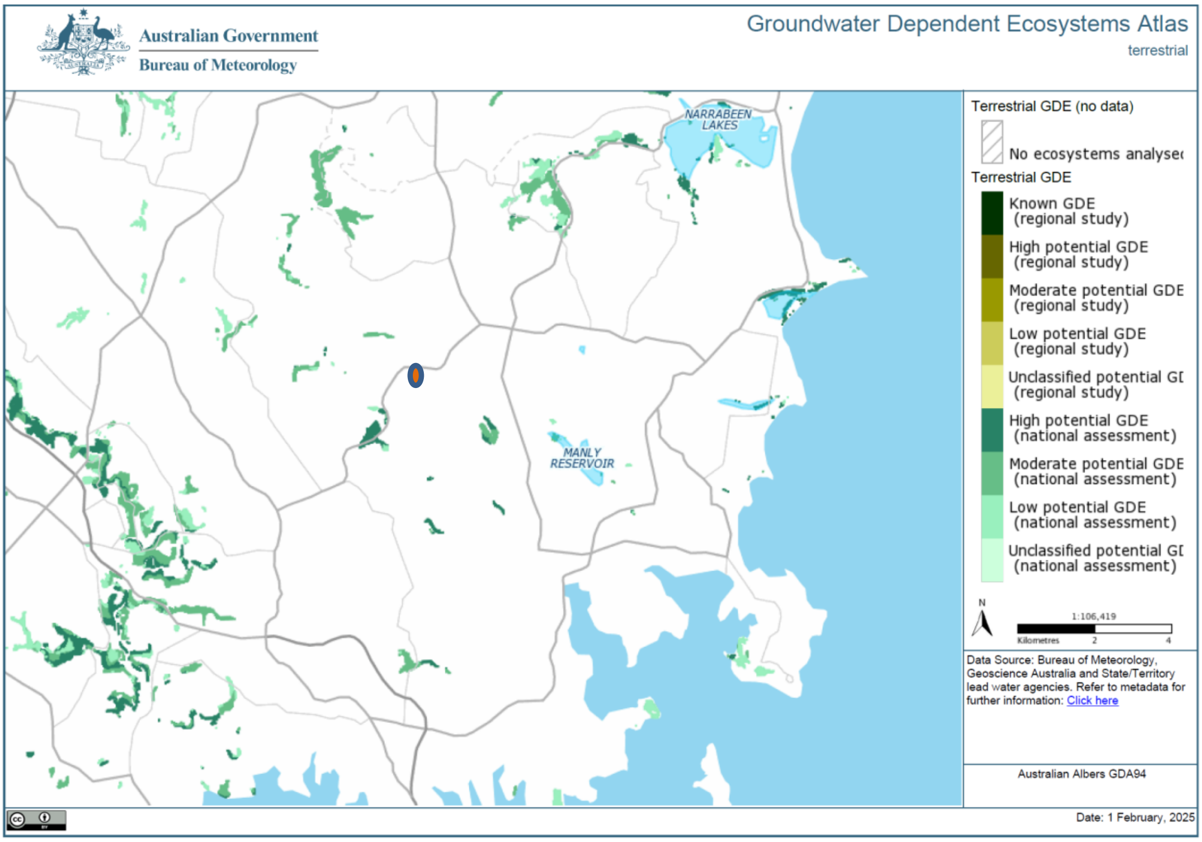

Figure 11 GDE proximity to the Site (marked in red)

Figure 12 shows the proximity of groundwater bores to the site. There are no bores within 100 m radius from the centre of the A1 or A2 excavation where the predicted drawdown approaches zero. Therefore, no impact on groundwater users is predicted.

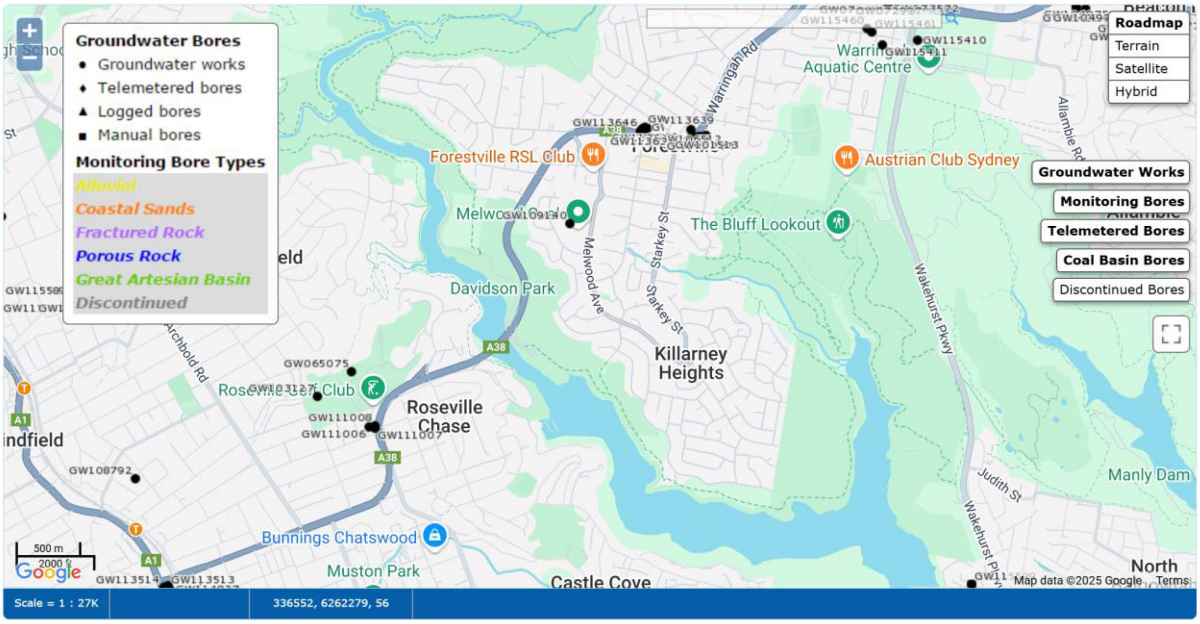

Figure 12 Proximity of groundwater bores to the site (Forestville RSL Club)

4.4 Drawdown extent and impact post construction

Using Theis analytical solution (Theis, 1935) drawdown was calculated for known discharge:

- Southern B3 area - Given long term average discharge of 5 m^3/day, transmissivity of 0.6 m^2/day, and specific yield of 0.05 for (weathered) sandstone (Heath, 1983), it is predicted that after two years of continuous pumping, the drawdown at (**Figure 13**) 50 m distance from the sump will be 1.4 m. At the distance 100 m from the sump in the basement the drawdown is predicted to be around 0.6 m below current levels.
- Northern B2 area- with the average pumping of 2 m^3/day, transmissivity of 0.56 m^2/day, and specific yield of 0.05 for (weathered) sandstone (Heath, 1983), it is predicted that after two years of continuous pumping, the drawdown at (**Figure 14**) 50 m distance from the sump will be 0.58 m. At the distance 150 m from the sump in the basement the drawdown is predicted to be around 0.1 m below current levels.

This level of drawdown within A1 and A2 is within the observed fluctuation as observed during monitoring. This calculation assumes that groundwater is not allowed to recover at any point in time for 360 days.

The predicted estimate is based on the assumptions that 7 m of head is permanently above the basement elevation in the south A1 and 1 m in the north A2, which is within ie maximum of the observed fluctuation based on 3 months of monitoring. The higher end of range is conservative and allows for wetter weather. It is considered that current maximum fluctuation of around 6 m fluctuation can be exceeded across the Site based on the observed data.

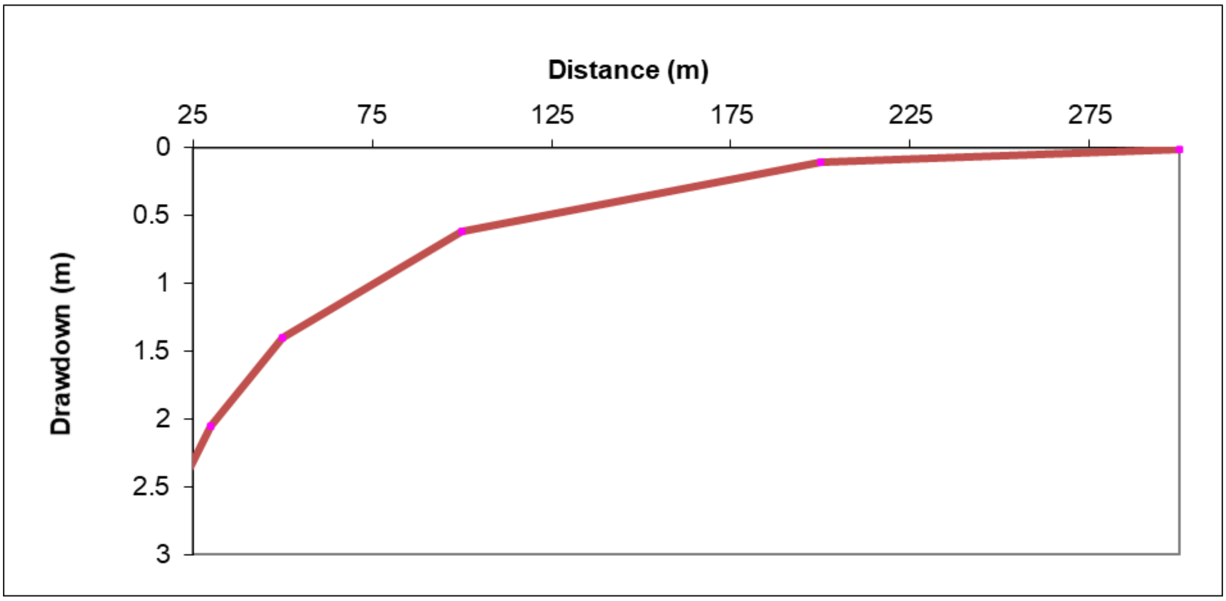

Figure 13 Predicted change long term drawdown with distance from the centre of excavation in the southern B3 basement (using Theis, 1935) post construction

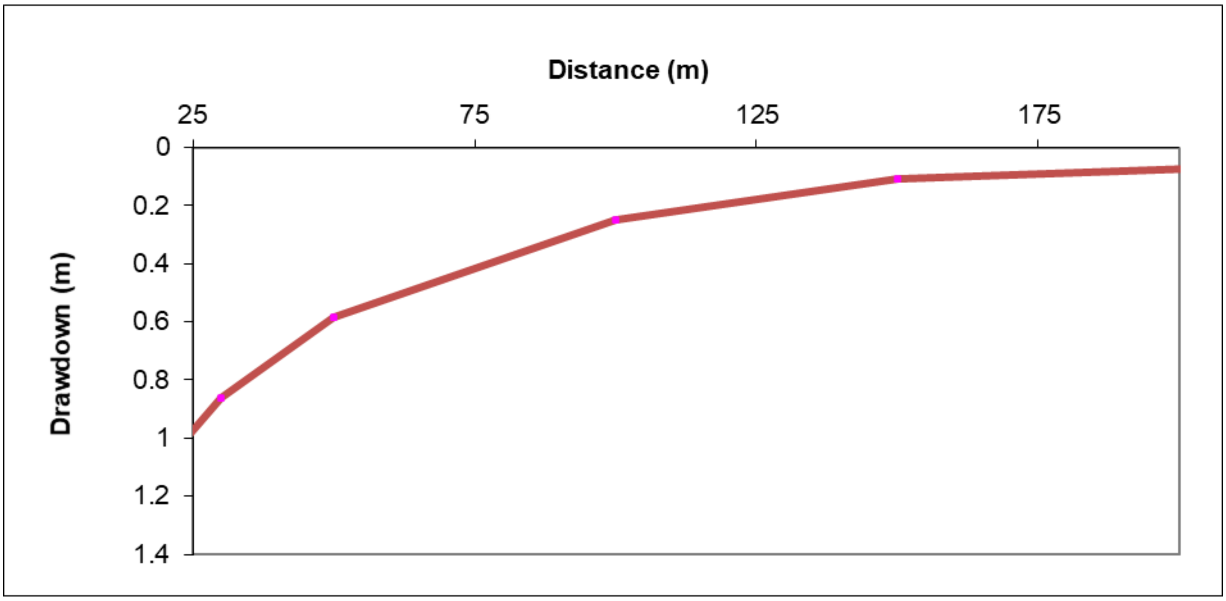

Figure 14 Predicted change long term drawdown with distance from the centre of excavation in the northern part of B2 basement (using Theis, 1935) post construction

Predicted drawdown indicates that there will be no impact to any GDEs or groundwater users during long term operational pumping.

4.5 Dewatering methodology during construction

Given that total predicted groundwater inflow during construction could be managed (average of 34 m^3/day for a period of 70 days) at B3, and separate stage excavation at B2 with average 8 m^3/day for 60 days it is recommended that in-pit sumps and pumps are used to collect the groundwater inflows at the lowest point within the excavation. It is envisaged that four pumps will be required and more efficient than two higher capacity pump. Groundwater will be pumped from a sump to a holding tank or lined pond to be installed by licensed personnel.

The water will be stored in the sump and pumped out of the sump on a regular basis using the pumps such as the submersible dewatering pumps (200 mm diameter pump and four are likely to be required) or firefighter pumps with likely four pumping locations within the proposed excavation. At the surface the water will be stored in the sediment pond/tank or discharged via silt barriers if required to settle the sediment, and then discharged via pipes to the closest stormwater discharge point. It is proposed that water be discharged directly to the curb pit inlet and not to gutter. The details of the proposed system have yet to be designed by the dewatering contractor. The pump capacity and operating hours or flow rate need to be recorded on a daily basis.

4.6 Ongoing long term groundwater inflow management

Given the proposed drained basement design, groundwater is proposed to be collected at the lowest point in the basement by collecting it within the sump. The water is proposed to be pumped on an ongoing basis from the sump as required and managed by the electric on and off switch to prevent flooding of the basement.

Approval will need to be sought from the Council for long term discharge to stormwater system. The occupational certificate for the building will include management practice for discharge and water quality information that will be required on an ongoing basis.

4.7 Groundwater disposal during construction

The groundwater analytical results collected during this investigation indicate that groundwater is fresh, with low pH and has low levels of elevated metals with the exception of Cu and Zn, slightly elevated total phosphorus and nitrogen and no hydrocarbons above the guidelines. Turbidity is above the ANZG (2018) guidelines and Blue Book (Managing Urban Stormwater, Soils and Construction, Volume 1, 4th Edition, 2004, Landcom). Turbidity exceedance is possibly due to sampling from the bottom of the bore.

Based on the groundwater quality and total predicted average inflow of 34 m^3/day in B3 and 8 m^3/day in B2 during construction, it is recommended that groundwater be discharged into the stormwater system. Regular monitoring will need to be undertaken to ensure that none of the parameters are exceeded (pH, EC and TSS/turbidity, oil and grease). If this does occur, water would need to be stored in lined sediment pond or settlement tank so that sediment can be settled before discharge. Alternatively, sediment traps or silt barriers can be used. Turbidity levels and pH need to be measured before disposal into the stormwater system.

Water treatment and removal of copper could be undertaken in small treatment plants using methods such as DMI-65water filtration media, modified clay sorbent, or reactive filter. Biological treatment can be used for removal of total nitrogen and phosphorous from groundwater. Given low levels of Cu and Zn, discharge water could also be diluted prior to discharge.

The proposal is for discharge of water into the stormwater system. Water quality criteria for disposal to the Stormwater system need to satisfy the ANZG (2018) guidelines for the protection of 95% marine species and any Council's guidelines if the water is discharged to the stormwater system and approval received. In addition, the following criteria will apply as per **Table 7.**

Table 7 Criteria for discharge of water into the stormwater system

Parameter	*Criteria*	*Method*
Oil and grease	Not visible	Visual
pH	6.5- 8.5	Meter
Total suspended solids	<50 mg/L	Meter/grab sample

4.8 Groundwater disposal post construction

Post construction the occupational certificate will require the operation plan to be developed to manage the water discharge and quality.

4.9 Assumptions

The following assumptions were made in the calculation of the inflow and drawdown:

- The properties of hydrostratigraphic unit within which the basement will be completed (sand, fill and mainly weathered sandstone) do not change across the Site and are based on the testing results from three bores and 9 hydraulic tests;
- The radius of basement equivalent for the purpose of this inflow estimate are 31 m for B3 and 26.5 m for B2;
- Specific yield has been estimated at 0.05 based on material encountered in boreholes and recorded drill logs information;
- Any rainfall directly onto the basement footprint will be diverted and no allowance was made for wet weather conditions;
- Groundwater levels across the Site do not change during dewatering period and are assumed to be highest as recorded during monitoring.

5.0 GROUNDWATER INFLOW MANAGEMENT AND IMPACTS

Temporary groundwater pumping for dewatering the Site is predicted to have a minor effect on groundwater levels in the area, with minor predicted impact to the closest nearby residential properties. Groundwater levels and outflow volume would, however, need to be monitored outside the excavation (using piezometers), and the pumping rate adjusted to maintain groundwater levels at sufficient depth (not more than 0.5 m) below bulk excavation level.

Long term proposed pumping from the sump is predicted to have limited impact on the drawdown (1.4 m and 0.6 m at 50 m distance for areas B3 and B2, respectively) and total inflow is predicted at an average 1.8 ML/year for B3 and for B2 around 0.7 ML/year.

5.1 Groundwater monitoring and water take measurement during construction

A groundwater level, water quality and dewatering rate monitoring program will need to be implemented during construction.

The following program is proposed:

- Groundwater levels need to be monitored continuously from each of the basement areas on a daily basis 2 weeks prior to, during the construction and one month following the completion of the basement in monitoring bores installed outside of the excavation. Dataloggers need to be installed and maintained during construction as per General terms of conditions issued by WaterNSW.

- Daily pumping records and/or pump capacity and operational hours need to be maintained until the end of dewatering and volume of water removed needs to be reported to the WaterNSW. The measurements need to be undertaken by flowmeter, details of pump operational hours kept along with the pump capacity to allow the calculation and the volume of water disposed of. The lowest level of dewatering is 117.7 mAHD (with 0.2 m allowance for the slab).

- Water quality sampling needs to be undertaken at the start of discharge and on a weekly basis during dewatering. Water samples need to be tested for pH, EC, turbidity and oil and grease as a minimum.

- The monitoring results must be reviewed weekly during construction by an experienced hydrogeologist to ensure that the predicted volumes, quality and levels are not exceeded. Monitoring of discharge water quality to be undertaken weekly during dewatering. The analytical suite should include as a minimum, turbidity/Total Suspended Solids (TSS), EC, temperature, pH, oil and grease as per **Table 7** and DPIE (2021) requirements.

- Final dewatering report needs to be completed and sent to WaterNSW following the completion of dewatering as per General terms and conditions issued by WaterNSW and prior to Operation Certificate being issued.

5.2 Groundwater take measurement post construction

Post construction groundwater take measurement will be defined in the operational plan for the building. A flow meter will need to be installed on the discharge line and annual record of the readings would be reported to WaterNSW on an annual basis.

Water quality measurements would also be taken during the year, typically including EC, turbidity and oil and grease by collection of grab sample form the sump. These results will also be reported on an annual basis to WaterNSW as required by the operation plan for the building.

6.0 SUMMARY AND CONCLUSIONS

This groundwater assessment has been compiled to assess the groundwater inflow rates into the basements during construction, assess the impact of groundwater drawdown and look at the options for discharge of groundwater.

The following is the summary of findings:

- The Site is underlain by thin fill and residual layer comprising silt and sand and underlain by weathered sandstone

- Measurement of groundwater level beneath Site was undertaken in Site bores installed in the sandstone with groundwater table ranging from 117.9 to 125 mAHD. Dewatering will be required as the two deepest basements are at 117.7 and 120.7 mAHD respectively. It is understood that basements will be excavated in stages;

- Groundwater inflow into the proposed basements was estimated based on the hydraulic tests of three site monitoring bores (three tests per bore), groundwater level fluctuation as monitored over three months and planned size and depth of the basements. The short-term groundwater inflows are estimated at average of 34 m^3/day for southern B3 basement and 8 m^3/day for northern B2 basement ; for the duration of 70 days and 60 days for B3 and B2 respectively. The total predicted inflow is predicted at 2.9 ML during excavation;

- The basement is proposed to be designed as drained and long term inflow is estimated by analytical modelling to be around 5 m^3/d for B3 and 2 m^3/d for B2 basement. The total is predicted to not exceed 2.5 ML/year.

- It is recommended that inflow be managed by sumps with water pumped to a sediment settling pond/tank prior to discharge during construction;

- Post construction the water take is proposed to be managed by discharge to Council's stormwater system (approval is required). The water take will be measured by the flowmeter to be installed on the flow line form the sump within the basement.

- Given the predicted inflow of less than 3 ML/year no water access (aquifer interference) licence is required from WaterNSW for long term ongoing water discharge. However, during construction WAL maybe required. Dewatering management plan would need to be prepared and water works supply licence needs to be obtained prior to dewatering for construction period and a separate water supply works approval for post construction period;

- Natural water level fluctuations are below the predicted drawdown during construction on the GDEs, registered groundwater users and nearby buildings. Long term drawdown during building operation (drained basement) is predicted to remain below the natural water level fluctuations.

- Groundwater quality testing indicates that water is fresh and slightly acidic. The heavy metals concentration is below detection limits., with the exception of copper and zinc which are slightly above the ANZG (2018) guidelines. Turbidity, total nitrogen and phosphorous were above the guidelines, and organic compounds were not detected;

- The most suitable water disposal option during construction is considered to be discharge to stormwater (subject to Council's approval). Regular monitoring of discharge water would need to be undertaken on a weekly basis during construction. If pH, EC , TSS/turbidity and oil and grease are exceeded then settlement in sediment ponds dosing to adjust pH to natural may be required before discharge to stormwater. Post construction monitoring would need to be undertaken based on the building management plan (likely on a quarterly basis);

- Monitoring of groundwater level outside of the basements (on a daily basis using dataloggers), daily pumped water volume records (pump capacity/operational hours or flowmeter records), discharge water quality (weekly during discharge) are required during construction to ensure that drawdown does not exceed the predicted, and that discharge complies with Council approval.

- On the completion of construction, the flowrates and monitoring results for groundwater levels and quality will need to be submitted to WaterNSW with completion report.

- Post construction flow meter would need to be installed on the flow line and readings reported on an annual basis to the WaterNSW.

- Any exceedance of drawdown and water quality during construction should be investigated and Council notified. Post construction water take will be reported to WaterNSW and any exceedance notified.

7.0 REFERENCES

ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

Fetter, C.W. (1994) Applied Hydrogeology. 3rd Edition, Macmillan College Publishing Company, New York.

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Herbert, C. 1983. Sydney 1:100 000 Geological Sheet 9130, 1st edition. Geological Survey of New South Wales, Sydney.

National Environment Protection (Assessment of site contamination) Measure. 2013. Schedule B, Guideline on Investigation levels for soil and groundwater.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

LIMITATIONS

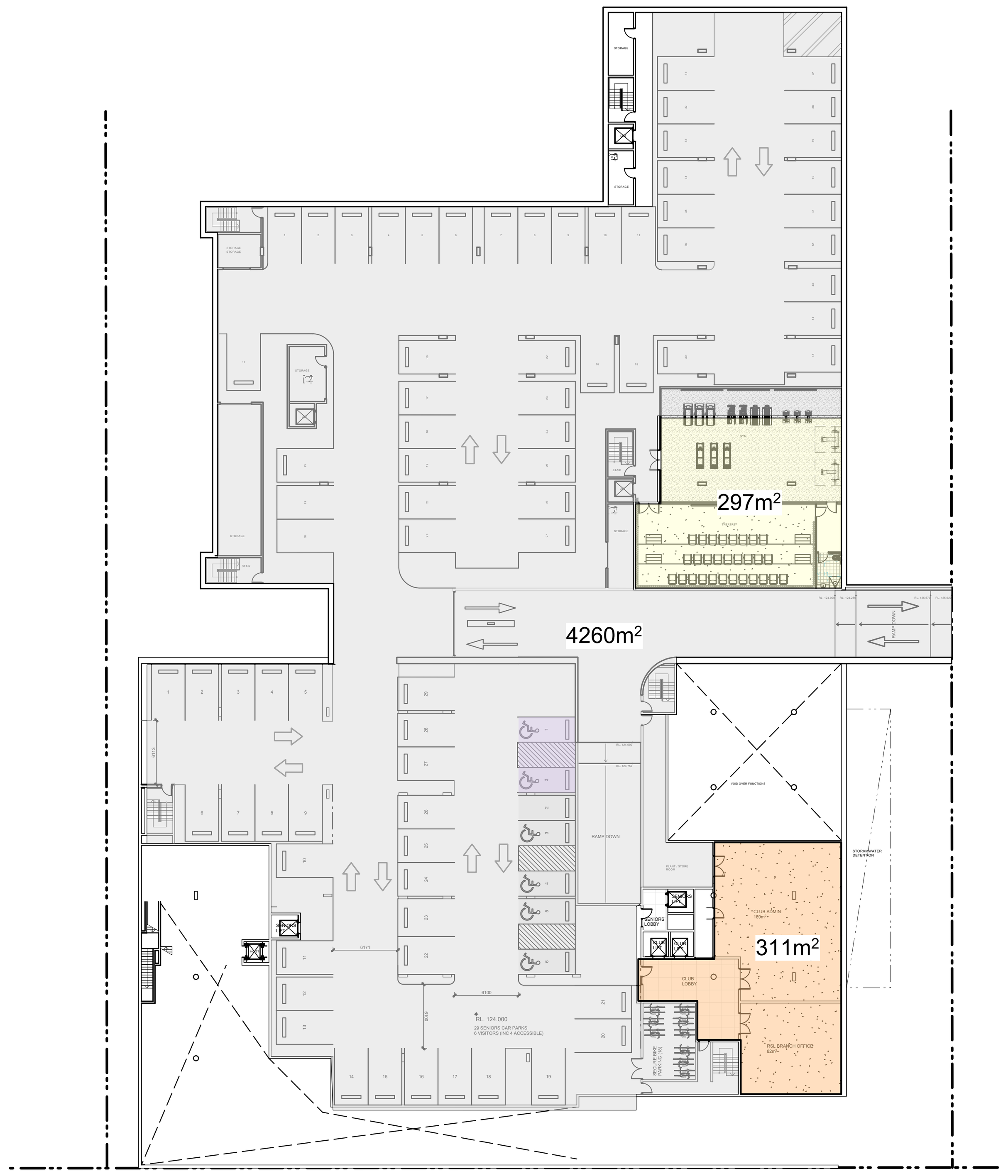
This report has been prepared for Mr Michael Briscas of Construction Management Services on behalf of Forestville RSL Club and for the specific purpose to which it refers. No responsibility is accepted to any third party and neither the whole of the report or any part or reference thereto may be published in any document, statement or circular nor in any communication with third parties without our prior written approval of the form and context in which it will appear.

Dr Katarina David has used a degree of skill and care ordinarily exercised by reputable members of our profession practicing in the same or similar locality. The conclusions presented in this report are relevant to the conditions of the Site and the state of legislation currently enacted as at the date of this report. I do not make any representation or warranty that the conclusions in this report were applicable in the future as there may be changes in the condition of the Site, applicable legislation or other factors that would affect the conclusions contained in this report.

In making this assessment from a limited number of boreholes there is possibility that variations may occur between test locations. Site information is specific only at those points from which samples have been taken. The data derived from Site investigation programme are extrapolated across the Site to form an inferred geological and hydrogeological model about subsurface conditions at the proposed Site. Therefore, the actual conditions at the Site might differ from those inferred to exist, since no groundwater exploration program no matter how comprehensive can reveal all subsurface details. This program provides the professional estimate of the scope of investigation and general information of the subsurface conditions.

APPENDIX A

Excavation (footprint) plan



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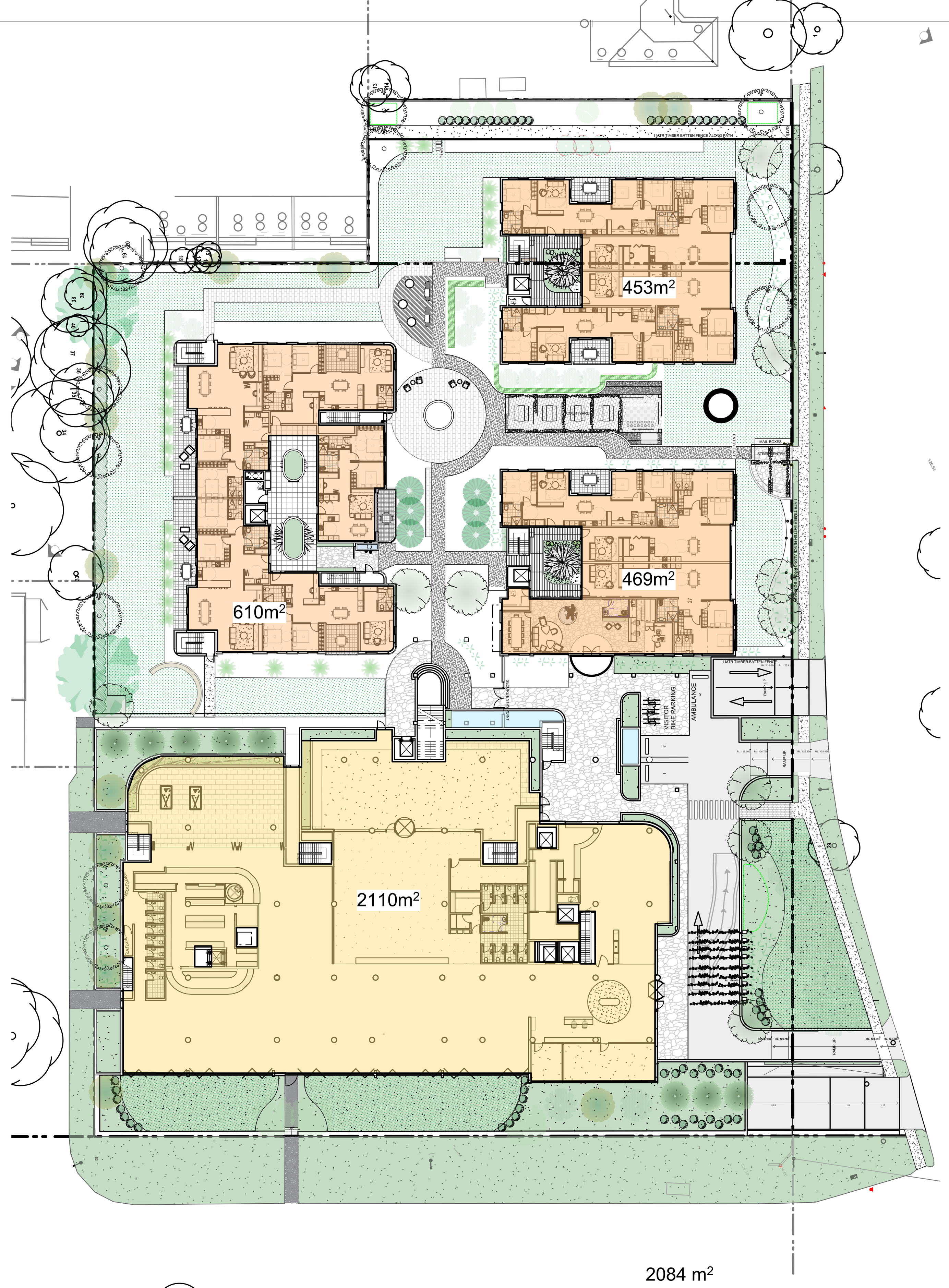
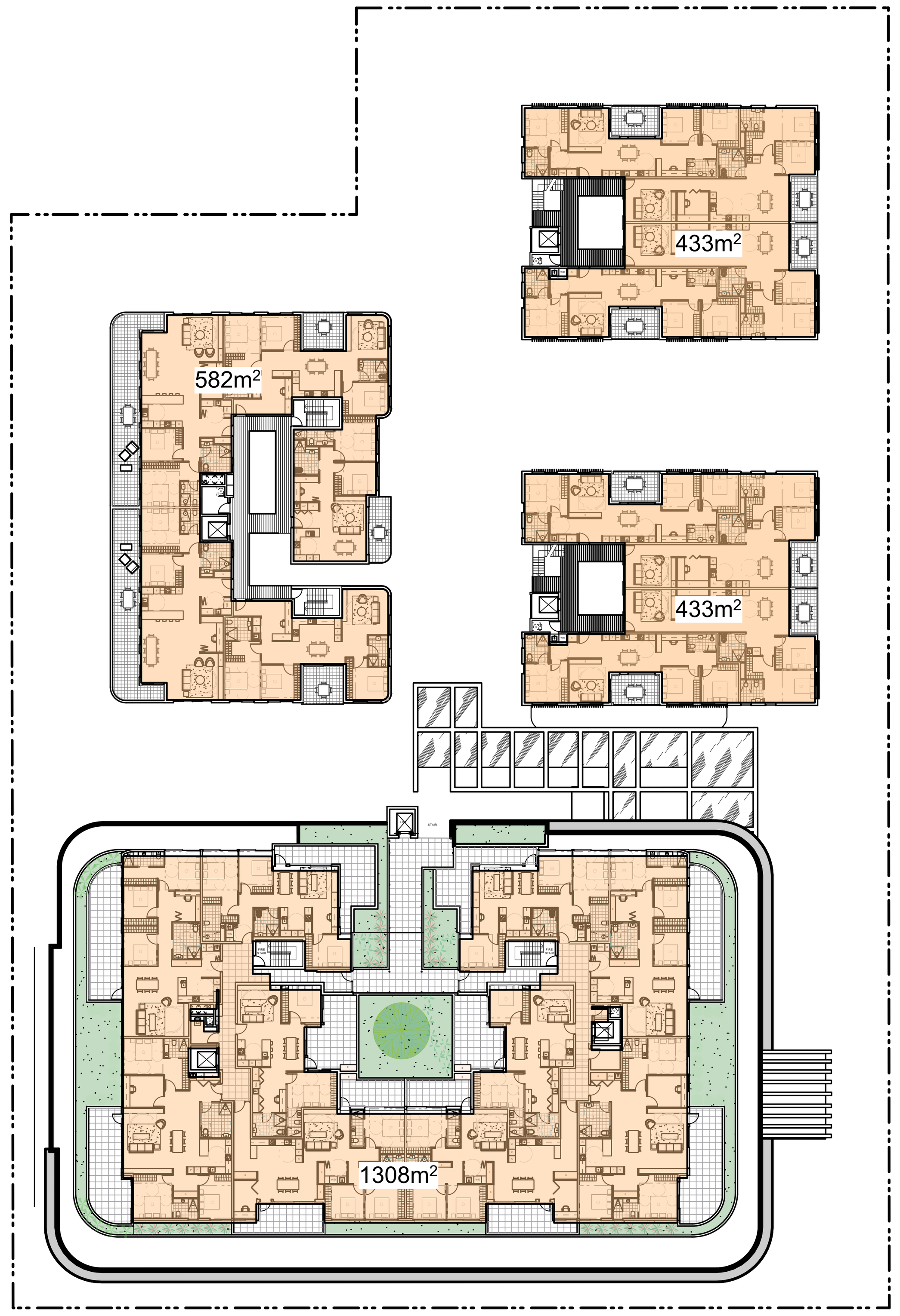


03 AREA CALCULATIONS - GROUND FLOOR
scale 1:500



04 AREA CALCULATIONS - LEVEL 1
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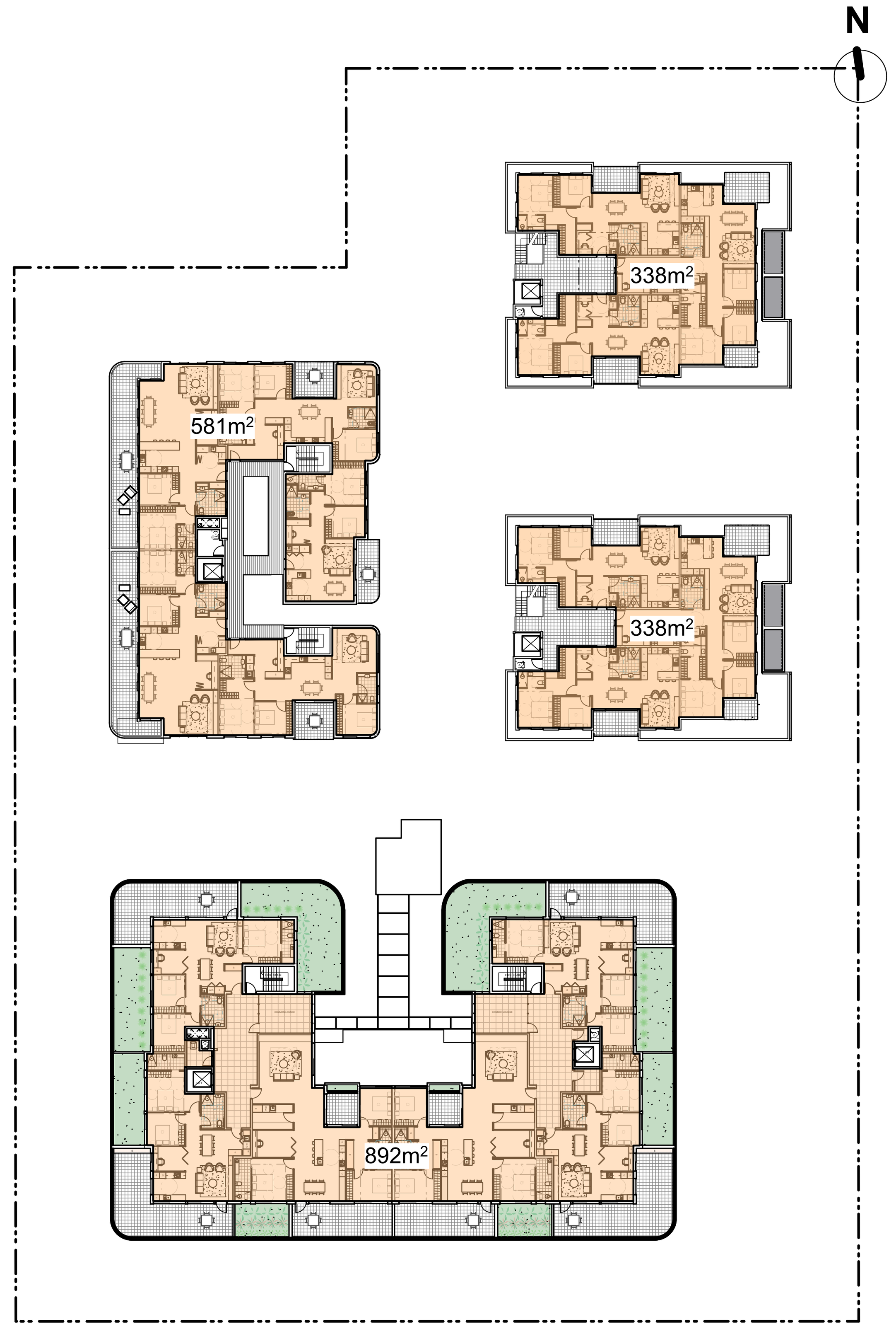

05 AREA CALCULATIONS - LEVEL 2
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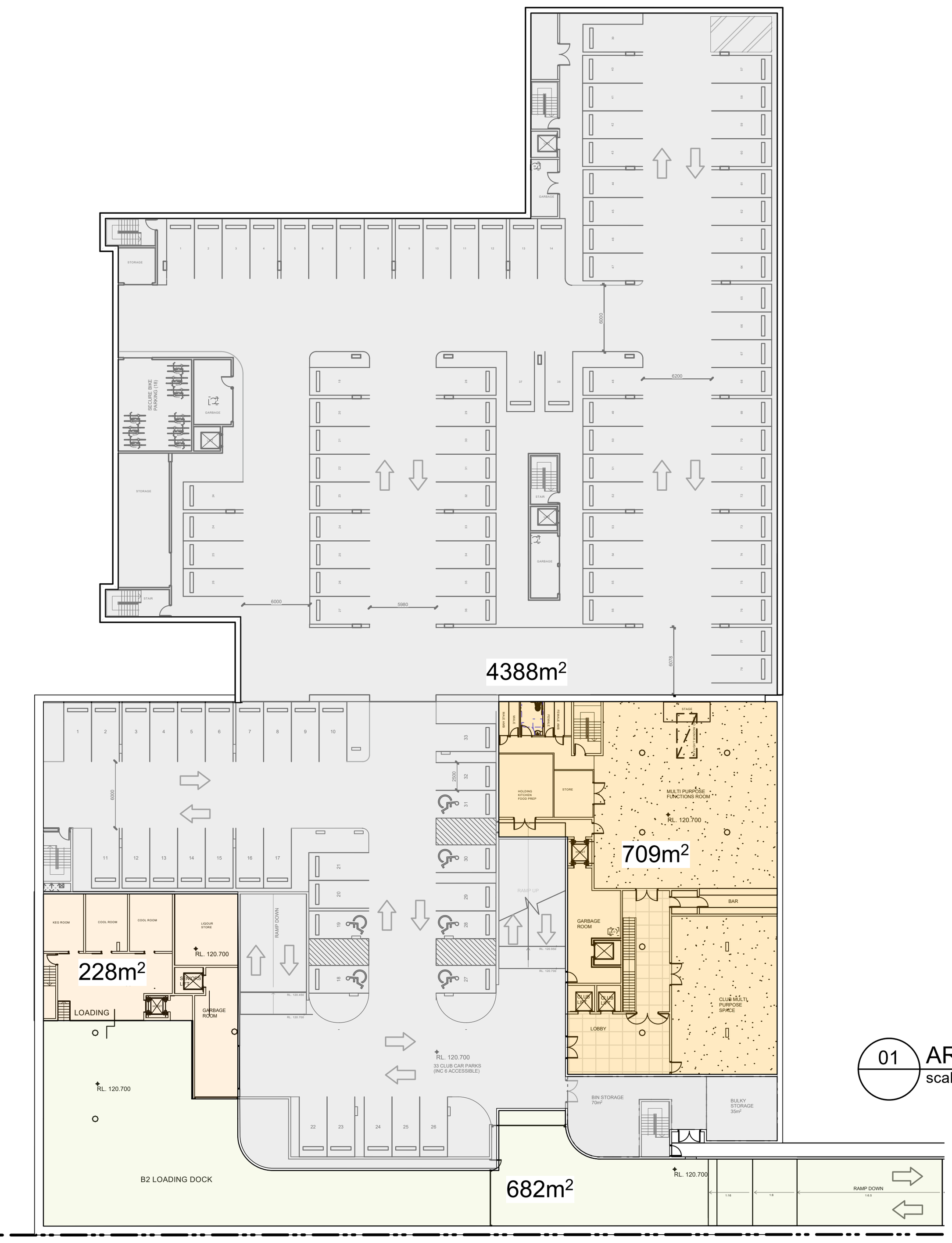

01 AREA CALCULATIONS - BASEMENT 2
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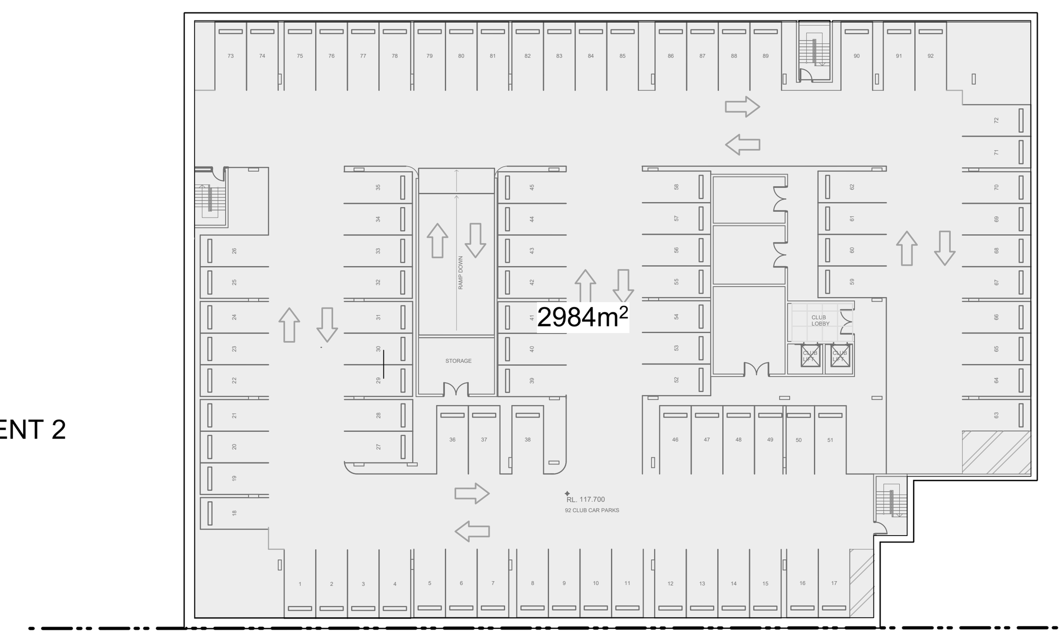

06 AREA CALCULATIONS - BASEMENT 3
scale 1:500

Forestville RSL - Building AREAS	GFA	
	m2	FSR
SITE AREA	**9014**	
SENIOR TOTAL GFA	**6669**	**0.753:1**
CLUB AREA GFA	**3358**	**0.31:1**
TOTAL	**10027**	**1:07**
Club Building		
	GFA	
B 2	937	
B1	311	
G	2110	
	3358	
Retirement Living - Club	GFA	
1	1308	
2	892	
	2200	
Retirement Living - Building 1 - GFA	GFA	
B1	232	
G	453	
1	433	
2	338	
	1456	
Retirement Living - Building 2	GFA	
G	469	
1	433	
2	338	
	1240	
Retirement Living - Building 3	GFA	
G	610	
1	582	
2	581	
	1773	

DA

Quattro ARCHITECTURE

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Peter Hosking (Director) Registered Architect - 6854

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ACN 150 198 842 W: www.qarch.com.au

Rev. No.	Date	Revision	By
A	16/11/2022	CLIENT MEETING	PJH
B	01/12/2023	CONCEPT UPDATE	PJH
C	12/04/2024	B5 ADDED	PJH
D	30/08/2024	DA	PH
E	14/02/2025	DA UPDATE	PH
F	11/04/2025	ISSUE TO CONSULTANTS	PJH
G	5/05/2025	DA RESUBMISSION	pjh

CLIENT
FORESTVILLE RSL

PROJECT
CLUB REDEVELOPMENT
22 MELWOOD AVE
LOT 2589 & LOT 31
DP752038 & DP 366454

FROM OUR FAMILY TO YOURS · SINCE 1959

DRAWING
SITE ANALYSIS - AREA CALCS

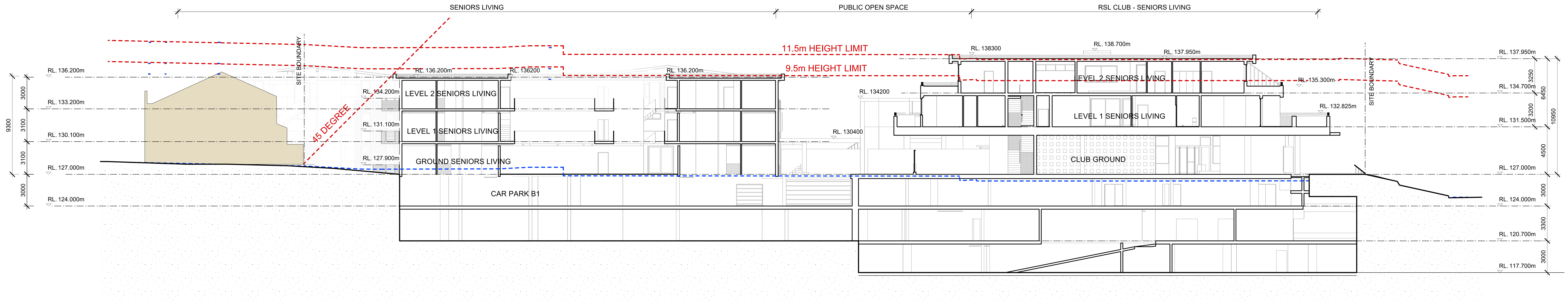
Scale at A1 1:500
Scale at A3 1:1000
0m 5 10 25 40

Figured dimensions shall take precedence over scale. Contractors must verify all dimensions on job before commencing any work or making shop drawings.

MASTERPLAN SET

DRAWN	DATE	CHKD
AL	20/04/2023	PH
PROJECT #	SHEET #	REVISION #
22-0716	**DA_A_054**	**G**

N



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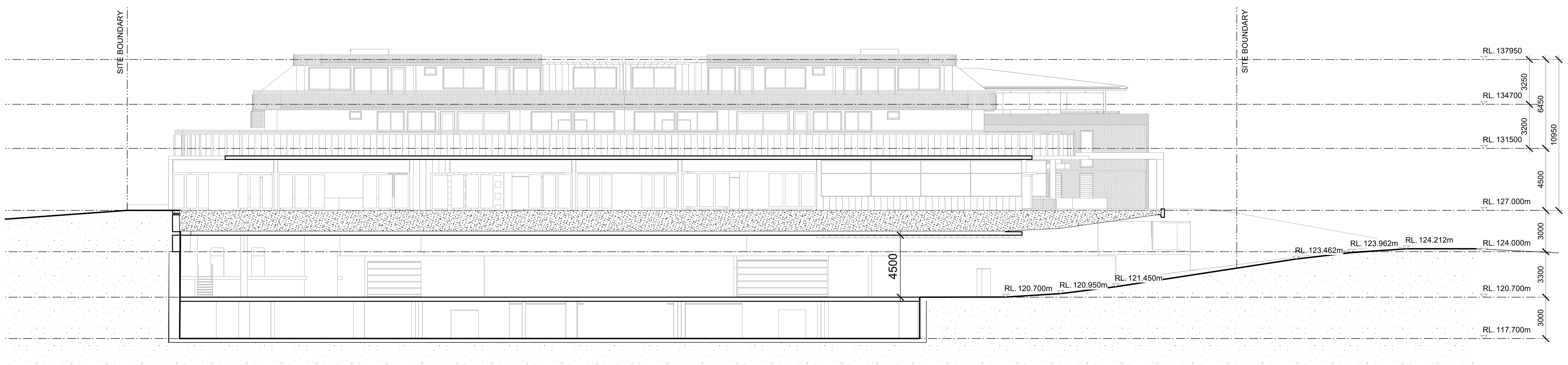

02 SITE SECTION
scale 1:200

DA

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G	5/05/2025	DA RESUBMISSION	pjh

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DRAWING
SECTIONS

Scale at A1 1:200
Scale at A3 1:400

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MASTERPLAN SET

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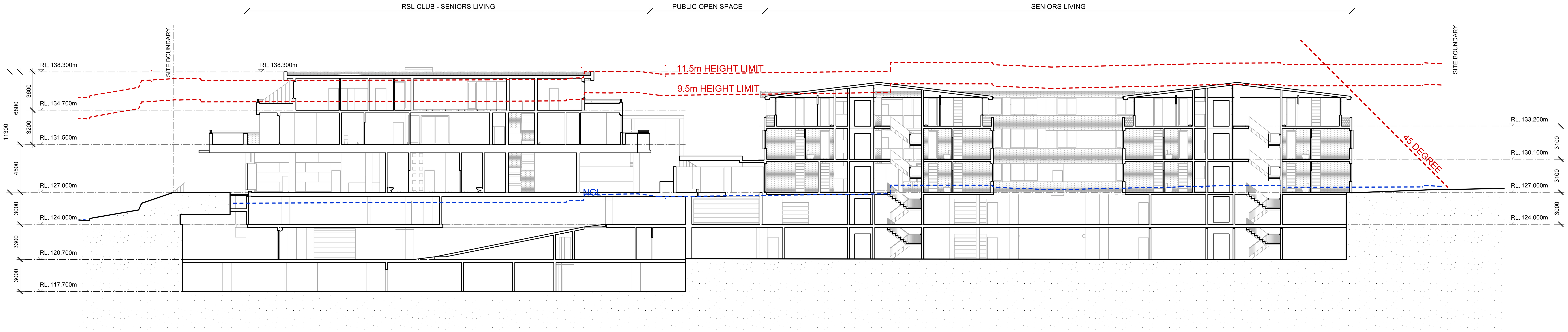
AL	20/04/2023	PH
PROJECT #	SHEET #	REVISION #
22-0716	DA_A_250	G

N



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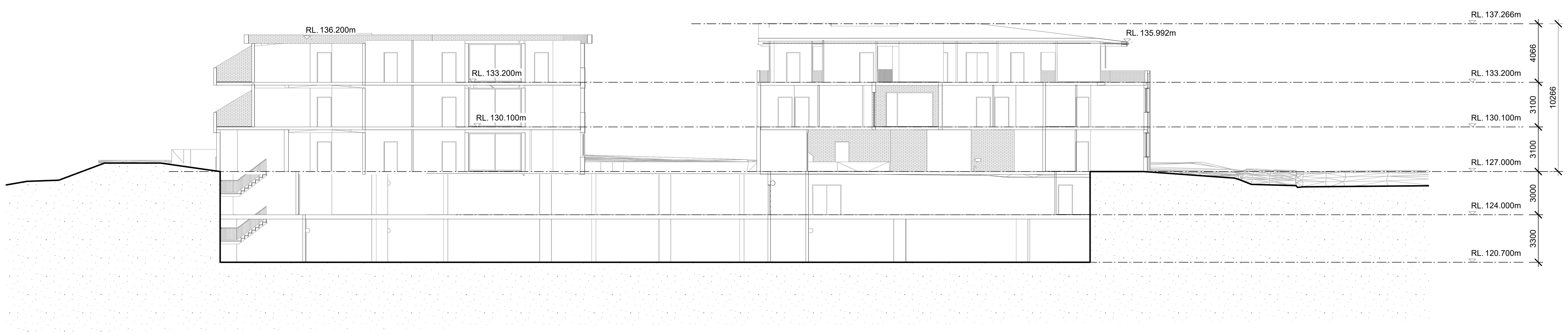

02 SITE SECTION
scale 1:200

DA

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G	5/05/2025	DA RESUBMISSION	pjh

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DRAWING
SECTIONS

Scale at A1 1:200
Scale at A3 1:400
0m 2.5 5 10 15 16

Figured dimensions shall take precedence over scale. Contractors must verify all dimensions on job before commencing any work or making shop drawings.

MASTERPLAN SET

DRAWN	DATE	CHKD
AL	20/04/2023	PH
PROJECT #	**SHEET #**	**REVISION #**
22-0716	DA_A_251	G

APPENDIX B

Monitoring bore logs

Borehole Log Report

Geo Environmental Engineering
2 / 5-7 Malta Street
Fairfield East NSW 2165
T +61 2 9420 3361

Hole ID.	**BH101**
Hole Depth:	**10.23 m**
Sheet:	**1 of**

Project Name:	**PSI / Geotechnical Investigation**	Project Number:	**E24016FOR**
Location / Site:	**20 - 22 Melwood Avenue, Forestville NSW**	Client:	**Forestville RSL Club Ltd**

Drilling Company:	**Geo Environmental Engineering**	Date Started:	**25/07/2024**	Ground Level:	**RL127.6m** (approx)
Drill Method:	**SFA / NMLC**	Date Completed:	**25/07/2024**	Easting:	----------
Equipment:	**Hanjin D&B 8D**			Northing:	----------

Method	Water Level	Depth (m)	RL (m)	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests ID No.	SPT	Observations / Comments	Well Details	Well Construction
SFA		0.00	127.5		Fill	**ASPHALT (80mm)**.						0.00	
SFA				SC	Fill	**FILL / DISTURBED**- Clayey Sand, orange/red/brown, with Silt.	medium dense to dense	m	ZZ250724-01 0.2 -0.3m			0.05, 0.15	
SFA		1	127.0, 126.5, 126.0	SP	Residual Soil	**SAND (extremely weathered sandstone)**- red/orange/grey, fine to medium grained, trace clay, with bands of highly weathered sandstone.			BH101-0.5 0.5 -0.6m	5 30 Ref. blows 30+		1.00	Bentonite
		2–6	125.5 – 122.0			*BH101 continued as cored hole from 1.72m*							

Moisture		Additional Comments
D	Dry	
Dp	Damp	
SM	Slightly Moist	
M	Moist	
VM	Very Moist	
W	Wet	
Sd	Saturated	

Logged By: **Zachary Ziesel** Date: **25/07/2024** Checked By: **Stephen McCormack** Date: **19/08/2024**

Borehole Log Report

Geo Environmental Engineering
82 Bridge Street
Lane Cove NSW 2066
T +61 2 9420 3361

Hole ID.	**BH101**
Hole Depth:	**10.23 m**
Sheet:	**3 of 4**

Project Name:	**PSI / Geotechnical Investigation**	Project Number:	**E24016FOR**
Location / Site:	**22 Melwood Avenue, Forestville NSW**	Client:	**Forestville RSL**

Drilling Company:	**Geo Environmental Engineering**	Date Started:	**25/07/2024**	Ground Level:	**RL127.6m** approx
Drill Method:	**SFA / NMLC**	Date Completed:	**25/07/2024**	Easting:	----------
Equipment:	**Hanjin D&B 8D**			Northing:	----------

Method	Depth (m)	RL (m)	Material Type	Material Description	Weathering	Is(50) MPa (D=diametral, A=axial)	RQD %
	0.0–1.9	127.5–126.0					
NMLC	1.9–5.0	125.5–123.0	Bedrock	**SANDSTONE** - red/orange/grey, fine to coarse grained.	HW-MW (to ~4.1), FR	A=0.29 D=0.2; A=0.12 D=0.05; A=0.34 D=0.21	92; 90
NMLC	5.0–5.3	122.5	Bedrock	**SHALE** - dark grey.	FR	A=0.1 D=0.03	90
NMLC	5.3–6.0	122.0	Bedrock	**SANDSTONE** - grey, fine to coarse grained.	FR		100

Estimated Strength (MPa): EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH

Defect Spacing (mm): 20, 60, 200, 600, 2000

Core Photo:

Defect Description (type, inclination, thickness, shape, roughness, coating):

- DB
- SM, CLAY
- SM, CLAY
- SM, CLAY
- DB
- JT, 35, RG, FE
- BD, 1, RG, FE
- SM, CLAY
- BD, 3, RG, FE
- SM, CLAY
- SM, CLAY
- BD, 4, RG, FE
- BD, 2, RG, FE
- SM, CLAY
- HB
- DB
- BD, 1, SMTH
- BD/SM (2-5mm spacing, clay infill)
- BD, 2, RG
- SM, CLAY

Casing & Core Lifts: 2.7; 5.83

Additional Comments

Logged By:	**Zachary Ziesel**	Date:	**25/07/2024**	Checked By:	**Stephen McCormack**	Date:	**19/08/2024**

Borehole Log Report

Geo Environmental Engineering
82 Bridge Street
Lane Cove NSW 2066
T +61 2 9420 3361

Hole ID.	**BH101**
Hole Depth:	**10.23 m**
Sheet:	**4 of 4**

Project Name:	**PSI / Geotechnical Investigation**	Project Number:	**E24016FOR**
Location / Site:	**22 Melwood Avenue, Forestville NSW**	Client:	**Forestville RSL**

Drilling Company:	**Geo Environmental Engineering**	Date Started:	**25/07/2024**	Ground Level:	**RL127.6m** approx
Drill Method:	**SFA / NMLC**	Date Completed:	**25/07/2024**	Easting:	----------
Equipment:	**Hanjin D&B 8D**			Northing:	----------

Method	Water Level	Depth (m)	RL (m)	Graphic Log	Material Type	Material Description	Weathering	Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH	Is(50) MPa D=diametral A=axial	U.C.S. (Mpa)	RQD %	Core Photo	Defect Spacing (mm) 20 60 200 600 2000	Defect Description type, inclination, thickness, shape, roughness, coating — Specific / General	Well Details	Depth (m)	Casing & Core Lifts
NMLC		6.5 – 10.23	121.5 – 117.5		Bedrock	**SANDSTONE** - grey, fine to coarse grained.	FR	H	A=1.05 D=0.67; A=1.19 D=1.37; A=1.11 D=1.26; A=1.22 D=0.91; A=1.08 D=0.87		100; 100			BD, 10, RG (approx. 7.7 m); BD, 10, RG (approx. 8.45 m)		6.5 – 10.0	8.8; 10.23
		10.5 – 12.0	117.0 – 116.0			**Hole Terminated at 10.23 m** target depth reached										10.5 – 12.0	

Additional Comments

Logged By:	**Zachary Ziesel**	Date:	**25/07/2024**	Checked By:	**Stephen McCormack**	Date:	**19/08/2024**

Borehole Log Report

Geo Environmental Engineering
2 / 5-7 Malta Street
Fairfield East NSW 2165
T +61 2 9420 3361

Hole ID.	**BH102**
Hole Depth:	**5.70 m**
Sheet:	**1 of**

Project Name:	**PSI / Geotechnical Investigation**	Project Number:	**E24016FOR**
Location / Site:	**20 - 22 Melwood Avenue, Forestville NSW**	Client:	**Forestville RSL Club Ltd**

Drilling Company:	**Geo Environmental Engineering**	Date Started:	**25/07/2024**	Ground Level:	**RL127.5m** (approx)
Drill Method:	**SFA / NMLC**	Date Completed:	**25/07/2024**	Easting:	**----------**
Equipment:	**Hanjin D&B 8D**			Northing:	**----------**

Method	Water Level	Depth (m)	RL (m)	Graphic Log	USCS Symbol	Material Type	Material Description	Consistency / Density	Moisture	Samples / Tests ID No.	SPT	Observations / Comments	Well Details	Well Construction
Solid Flight Auger		0.00				Fill	**ASPHALT (80mm).**						0.00 0.05 0.15	
					SP	Fill	**FILL**- Gravelly Sand, dark grey/grey, fine to coarse grained, fine to coarse sand and gravel, with silt.	loose	m	ZZ250724-02/100 0.1 -0.2m				
			127.0		SP		**SAND**- red/grey, fine to medium grained, trace clay/silt. bands of extremely weathered to highly weathered sandstone with depth. predominately grey from 1.0m.	medium dense to dense	m	ZZ250724-03 0.4 -0.5m; BH102-0.5 0.5 -0.6m; ZZ250724-04 1.0 -1.1m	6, 5, 15 N=20		1.00	Bentonite
		1	126.5											
			126.0				**SANDSTONE**- grey/red, fine to coarse grained, extremely to highly weathered.							
		2	125.5											
			125.0			Natural	*BH102 continued as cored hole from 2.58m*							
		3	124.5											
			124.0											
		4	123.5											
			123.0											
		5	122.5											
			122.0											
		6	121.5											

Moisture	
D	Dry
Dp	Damp
SM	Slightly Moist
M	Moist
VM	Very Moist
W	Wet
Sd	Saturated

Additional Comments

Logged By:	**Zachary Ziesel**	Date:	**25/07/2024**	Checked By:	**Stephen McCormack**	Date:	**19/08/2024**

Borehole Log Report

Geo Environmental Engineering
82 Bridge Street
Lane Cove NSW 2066
T +61 2 9420 3361

Hole ID.	BH102
Hole Depth:	5.70 m
Sheet:	3 of 3

Project Name:	PSI / Geotechnical Investigation	Project Number:	E24016FOR
Location / Site:	22 Melwood Avenue, Forestville NSW	Client:	Forestville RSL

Drilling Company:	Geo Environmental Engineering	Date Started:	25/07/2024	Ground Level:	RL127.5m approx
Drill Method:	SFA / NMLC	Date Completed:	25/07/2024	Easting:	----------
Equipment:	Hanjin D&B 8D			Northing:	----------

Method	Depth (m)	RL (m)	Graphic Log	Material Description	Weathering	Estimated Strength (MPa)	Is(50) MPa (D=diametral, A=axial)	RQD %	Defect Description (Specific)
	0.5	127.0							
	1.0	126.5							
	1.5	126.0							
	2.0	125.5							
	2.5	125.0							
NMLC	2.5–4.4		Sandstone	**SANDSTONE** - grey some red, orange, fine to coarse grained.	HW-MW		A=0.08 D=0.04; A=0.13 D=0.03; A=0.17	83	BD, 10, RG; SM, CLAY; BD, 10, RG, FE; JT, 20, RG, FE; SM, CLAY; SM, CLAY; BD, 3, RG, FE; SM, CLAY; BD, 15, RG, FE; BD, 1, RG; SM, CLAY
NMLC	4.4–5.15		Shale	**SHALE** - dark grey, grey, with interbedded sandstone.	FR		A=0.54 D=0.14		BD, 1,SMTH; BD, 1,SMTH; BD, 1,SMTH; BD, 1,SMTH; DB; BD, 3, SMTH; BD, 1, SMTH
NMLC	5.15–5.7		Sandstone	**SANDSTONE** - grey, fine to coarse grained.	FR		A=0.71 D=0.57; A=2.3 D=0.92		SM, CLAY; SM, CLAY; BD, 3, RG; BD, 3, RG; BD, 10. RG
	6.0	121.5		**Hole Terminated at 5.70 m** target depth reached					

Depth scale: 3.0 (124.5), 3.5 (124.0), 4.0 (123.5), 4.5 (123.0), 5.0 (122.5), 5.5 (122.0), 6.0 (121.5). Casing & Core Lifts: 5.7

Column headings: Method, Water Level, Depth (m), RL (m), Graphic Log, Material Type, Material Description, Weathering, Estimated Strength (MPa) EL 0.03 VL 0.1 L 0.3 M 1 H 3 VH 10 EH, Is(50) MPa D=diametral A=axial, U.C.S. (Mpa), Rock Mass Defects: RQD %, Core Photo, Defect Spacing (mm) 20 60 200 600 2000, Defect Description type, inclination, thickness, shape, roughness, coating — Specific, General; Well Details, Depth (m), Casing & Core Lifts

Additional Comments

Logged By:	Zachary Ziesel	Date:	25/07/2024	Checked By:	Stephen McCormack	Date:	19/08/2024

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
1
1 / 2

Client: FORESTVILLE RSL CLUB LTD
Project: PROPOSED PRIVATE MEDICAL CENTRE
Location: 22 MELWOOD AVENUE, FORESTVILLE, NSW

Job No.: 31993BM **Method:** SPIRAL AUGER **R.L. Surface:** ~126.5 m
Date: 16/11/18 **Datum:** AHD
Plant Type: JK205 **Logged/Checked By:** J.B.J/M.P.

Groundwater Record	Field Tests	RL (m AHD)	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
		126–120	0–6		CONCRETE: 100mm.t				5mm.t DIAMETER REINFORCMENT 50mm TOP COVER
	N > 0 2,0/ 150mm REFUSAL			-	FILL: Silty sand, fine to medium grained, dark brown.	M			APPEARS POORLY COMPACTED
				-	Extremely Weathered sandstone: silty SAND, fine to medium grained, purple grey, trace of ironstone gravel and clay.	XW	VD		HAWKESBURY SANDSTONE
					SANDSTONE: fine to medium grained, light grey with dark grey bands.	DW	VL		VERY LOW 'TC' BIT RESISTANCE
							VL - L		VERY LOW TO LOW RESISTANCE
							L		LOW RESISTANCE
					REFER TO CORED BOREHOLE LOG				Groundwater monitoring well installed to 9.0m. Class 18 machine slotted PVC standpipe 9.0m to 3.0m. Casing 3.0m to 0.15m. 2mm sand filter pack 9.0m to 1.4m. Bentonite seal 1.4m to 0.1m. Completed with a concreted gatic cover

SAMPLES: ES, U50, DB, DS

Graphic Log

CORED BOREHOLE LOG

Borehole No. 1

Client: FORESTVILLE RSL CLUB LTD
Project: PROPOSED PRIVATE MEDICAL CENTRE
Location: 22 MELWOOD AVENUE, FORESTVILLE, NSW

Job No.: 31993BM	**Core Size:** NMLC	**R.L. Surface:** ~126.5 m
Date: 16/11/18	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK205	**Bearing:** N/A	**Logged/Checked By:** J.B.J/M.P.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	DEFECT DETAILS – SPACING (mm) (600, 200, 60, 20)	DEFECT DETAILS – DESCRIPTION (Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness) Specific / General	Formation
		124			START CORING AT 2.88m						
100% RETURN		123	3		SANDSTONE: fine to medium grained, light grey with dark grey banding, orange and purple staining, bedding at 5-15°.	HW	L - M	0.40		(2.95m) XWS, 0°, 50 mm.t (3.08m) J, 15°, St, R, Fe Sn (3.36m) Be, 0°, P, Fe Sn	Hawkesbury Sandstone
					NO CORE 0.10m						
		122	4		SANDSTONE: fine to medium grained, light grey with orange and purple staining, and a very high strength iron indurated band.	HW	L - M	0.30 0.20		(3.78m) Be, 10°, P, R, Fe Sn (3.82m) J, 30°, P, R, Fe Sn, 1cm IN FILL (4.44m) CS, 100 mm.t (4.51m) XWS, 150 mm.t	
						MW	VH	3.0			
		121, 120, 119, 118	5, 6, 7, 8		as above, but light grey with dark grey bands, bedding at 5-15°.	FR	M	1.9 6.8 0.30 0.50 0.90		(4.90m) J, 0°, Ir, R, Fe Sn (5.56m) Be, 2°, C, R, XWS 1mm.t	
							M - H	1.2 1.0 0.90 1.0 1.2		(6.78m) CS, 1 mm.t (7.09m) CS, 1 mm.t (7.95m) Be, 0°, Ir, R, Cb, 1 mm.t (8.88m) Be, 0°, P, R, Qz Vn	

END OF BOREHOLE AT 9.00 m

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JK 9.01.2 LIB.GLB Log JK CORED BOREHOLE - MASTER 31993BM FORESTVILLE.GPJ <<DrawingFile>> 30/11/2018 15:55 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.01.2 2018-04-02 Prj: JK 9.01.0 2018-03-20

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No.
2
1 / 2

Client: FORESTVILLE RSL CLUB LTD
Project: PROPOSED PRIVATE MEDICAL CENTRE
Location: 22 MELWOOD AVENUE, FORESTVILLE, NSW

Job No.: 31993BM **Method:** SPIRAL AUGER **R.L. Surface:** ~126.2 m
Date: 12/11/18 **Datum:** AHD
Plant Type: JK205 **Logged/Checked By:** J.B.J/M.P.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION				0			CONCRETE: 140mm.t.				REINFORCEMENT 10mm.t. TOP COVER 100mm.t
	ES		126			-	FILL: Silty sand, fine to medium grained, dark brown.	M			
	DS	N = 5 2,2,3					FILL: Silty sand, fine to medium grained, light brown.				APPEARS POORLY COMPACTED
	ES		125	1							
	ES, DS	N=SPT 18/ 150mm REFUSAL				-	Extremely Weathered sandstone: Silty SAND, fine to medium grained, light grey mottled pink, trace of clay bands.	XW	VD		HAWKESBURY SANDSTONE
1HR AFTER CORING	DS		124	2							
	DS		123	3			SANDSTONE: fine to medium grained, light orange grey.	DW	L		LOW 'TC' BIT RESISTANCE
			122	4			REFER TO CORED BOREHOLE LOG				
			121	5							
			120	6							

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
2
2 / 2

Client: FORESTVILLE RSL CLUB LTD
Project: PROPOSED PRIVATE MEDICAL CENTRE
Location: 22 MELWOOD AVENUE, FORESTVILLE, NSW

Job No.: 31993BM | **Core Size:** NMLC | **R.L. Surface:** ~126.2 m
Date: 12/11/18 | **Inclination:** VERTICAL | **Datum:** AHD
Plant Type: JK205 | **Bearing:** N/A | **Logged/Checked By:** J.B.J/M.P.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	SPACING (mm) (600, 200, 60, 20)	DEFECT DETAILS DESCRIPTION: Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness (Specific / General)	Formation
		123			START CORING AT 3.55m						
100% RETURN					NO CORE 0.24m						Hawkesbury Sandstone
		122	4		SANDSTONE: fine to medium grained, light grey with dark grey banding, bedding at 0°, trace of iron indurated bands.	HW	VL - L	0.050 0.060 0.30 0.20		(3.79m) XWS, 0°, 5 mm.t (3.88m) CS, 0°, 10 mm.t (4.22m) XWS, 0°, 90 mm.t (4.44m) CS, 0°, 10 mm.t (4.56m) Be, 0°, C, R, Fe Sn, 1 mm.t (4.92m) J, 5°, C, R, Cn	
		121	5			SW	M	0.70			
		120	6		SANDSTONE: fine to medium grained, light grey with dark grey, bedding at 5-30°, trace of fine to coarse grained bands.			0.90		(5.67m) CS, 0°, 10 mm.t (6.27m) CS, 0°, 10 mm.t	
		119	7				H	1.8 1.2	600 200 60 20	(6.76m) J, 10°, P, S, Cn (7.10m) Be, 0°, P, Cb Cn, 1 mm.t	
		118	8			FR		0.80 1.2 1.1		(8.09m) Be, 1°, St, R, Cn	
		117	9		END OF BOREHOLE AT 8.92 m				600 200 60 20		

JK 9.01.2 LIB.GLB Log JK CORED BOREHOLE - MASTER 31993BM FORESTVILLE.GPJ <<DrawingFile>> 30/11/2018 15:56 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.01.2 2018-04-02 Prj: JK 9.01.0 2018-03-20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
3
1 / 2

BOREHOLE LOG

Client: FORESTVILLE RSL CLUB LTD
Project: PROPOSED PRIVATE MEDICAL CENTRE
Location: 22 MELWOOD AVENUE, FORESTVILLE, NSW

Job No.: 31993BM **Method:** SPIRAL AUGER **R.L. Surface:** ~126.2 m
Date: 12/11/18 **Datum:** AHD
Plant Type: JK205 **Logged/Checked By:** J.B.J/M.P.

Groundwater Record	Field Tests	RL (m AHD)	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
					CONCRETE: 140mm.t				REINFORCEMENT: 10mm.t TOP COVER 100mm.t
		126		-	FILL: Silty sand, fine to medium grained, dark brown, trace clay and brick fragments.	M			APPEARS POORLY COMPACTED
	N = 12 2,2,10				FILL: Silty sand, fine to medium grained, light brown.				
		125	1	-	Extremely Weathered sandstone: Silty SAND, fine to medium grained, light grey.	XW	VD		HAWKESBURY SANDSTONE
		124	2		SANDSTONE: fine to medium grained, light grey with extremely weathered bands.	DW	VL		VERY LOW 'TC' BIT RESISTANCE
		123	3		SANDSTONE: fine to medium grained. light grey with dark grey bands, trace o fextremely weathered bands.		VL - L		VERY LOW RESISTANCE WITH LOW BANDS
		122, 121, 120	4, 5, 6		REFER TO CORED BOREHOLE LOG				

JK 9.01.2 LIB.GLB Log JK AUGERHOLE - MASTER 31993BM FORESTVILLE.GPJ <<DrawingFile>> 30/11/2018 15:56 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.01.2 2018-04-02 Prj: JK 9.01.0 2018-03-20

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
3

CORED BOREHOLE LOG

Client: FORESTVILLE RSL CLUB LTD
Project: PROPOSED PRIVATE MEDICAL CENTRE
Location: 22 MELWOOD AVENUE, FORESTVILLE, NSW

Job No.: 31993BM | **Core Size:** NMLC | **R.L. Surface:** ~126.2 m
Date: 12/11/18 | **Inclination:** VERTICAL | **Datum:** AHD
Plant Type: JK205 | **Bearing:** N/A | **Logged/Checked By:** J.B.J/M.P.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT SPACING (mm) (600, 200, 60, 20)	DEFECT DESCRIPTION – Specific (Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness)	General	Formation
		123			START CORING AT 3.72m							
100% RETURN					NO CORE 0.07m					(3.79m) XWS, 0°, 140 mm.t		Hawkesbury Sandstone
		122	4		SANDSTONE: fine to medium grained, light grey mottled pink/orange, bedding at 1-3°.	HW	VL	0.10				
						MW	L - M	0.10		(4.13m) Be, 3°, Ir, R, Clay, 1 mm.t (4.18m) Be, 3°, Ir, R, Cn		
								0.60		(4.45m) CS, 0°, 10 mm.t		
		121	5					0.060		(5.24m) XWS, 0°, 5 mm.t		
								0.40		(5.48m) Be, 5°, P, R, Fe Sn (5.60m) XWS, 0°, 10 mm.t (5.92m) Be, 0°, P, R, Cn		
		120	6		SANDSTONE: fine to medium grained, light grey with dark grey banding, bedding at 5-10°.	FR		0.70				
		119	7				M - H	1.6 0.60 1.1				
		118	8					0.70 0.50		(7.85m) Be, 2°, P, R, Cb Vn (8.07m) Be, 0°, P, R, Cb Cn, 1 mm.t (8.92m) Be, 2°, P, R, Cb Cn, 1 mm.t		
		117	9		END OF BOREHOLE AT 8.98 m							

JK 9.01.2 LIB.GLB Log JK CORED BOREHOLE - MASTER 31993BM FORESTVILLE.GPJ <<DrawingFile>> 30/11/2018 15:56 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.01.2 2018-04-02 Prj: JK 9.01.0 2018-03-20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

APPENDIX C

Analytical lab results and COC

CERTIFICATE OF ANALYSIS

Work Order	: **ES2501118**	Page	: 1 of 7
Client	: **KATARINA DAVID**	Laboratory	: Environmental Division Sydney
Contact	: MS KATARINA DAVID	Contact	: Customer Services ES
Address	: 6 Lawrence Street Blackheath 2785	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: FORES	Date Samples Received	: 16-Jan-2025 17:20
Order number	: ----	Date Analysis Commenced	: 21-Jan-2025
C-O-C number	: ----	Issue Date	: 28-Jan-2025 14:22
Sampler	: ----		
Site	: ----		
Quote number	: ES24KATDAV0001		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP075 (SIM): Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EP075(SIM): Where reported, Total Cresol is the sum of the reported concentrations of 2-Methylphenol and 3- & 4-Methylphenol at or above the LOR.
- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH102	BH1	----	----	----
			Sampling date / time	16-Jan-2025 00:00	16-Jan-2025 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2501118-001	ES2501118-002	--------	--------	--------
				Result	Result	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**403**	**214**	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**221**	**156**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**3**	<1	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**3**	<1	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**13**	**78**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**128**	**36**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**3**	**2**	----	----	----
Magnesium	7439-95-4	1	mg/L	**8**	**6**	----	----	----
Sodium	7440-23-5	1	mg/L	**64**	**45**	----	----	----
Potassium	7440-09-7	1	mg/L	**2**	**10**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.001**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.009**	**0.014**	----	----	----
Lead	7439-92-1	0.001	mg/L	**0.003**	**0.003**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.009**	**0.013**	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.060**	**0.132**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	**0.0003**	**0.0001**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH102	BH1	----	----	----
			Sampling date / time	16-Jan-2025 00:00	16-Jan-2025 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2501118-001	ES2501118-002	--------	--------	--------
				Result	Result	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.04**	**1.99**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**1.22**	**1.05**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.22**	**1.05**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.7**	**2.6**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**1.9**	**3.6**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.12**	**0.06**	----	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**3.94**	**2.64**	----	----	----
ø Total Cations	----	0.01	meq/L	**3.64**	**2.81**	----	----	----
ø Ionic Balance	----	0.01	%	**3.93**	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	----	----	----
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	----	----	----
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	----	----	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	----	----	----
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	----	----	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	----	----	----
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	----	----	----

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	BH102	BH1	----	----	----
			Sampling date / time	16-Jan-2025 00:00	16-Jan-2025 00:00	----	----	----
				ES2501118-001	ES2501118-002	--------	--------	--------
				Result	Result	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	----	----	----
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L	<0.5	<0.5	----	----	----
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	µg/L	<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	<100	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	<100	<100	----	----	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	----	----	----
Toluene	108-88-3	2	µg/L	<2	<2	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH102	BH1	----	----	----
			Sampling date / time	16-Jan-2025 00:00	16-Jan-2025 00:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	ES2501118-001	ES2501118-002	--------	--------	--------
				Result	Result	----	----	----
EP080: BTEXN - Continued								
Ethylbenzene	100-41-4	2	µg/L	<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	----	----	----
^ **Total Xylenes**	----	2	µg/L	<2	<2	----	----	----
^ **Sum of BTEX**	----	1	µg/L	<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L	<5	<5	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1.0	%	**26.5**	**22.4**	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%	**66.2**	**52.3**	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%	**85.1**	**36.9**	----	----	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1.0	%	**63.3**	**51.5**	----	----	----
Anthracene-d10	1719-06-8	1.0	%	**85.3**	**57.5**	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%	**89.0**	**68.7**	----	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**75.4**	**79.7**	----	----	----
Toluene-D8	2037-26-5	2	%	**91.7**	**96.7**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%	**97.3**	**101**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

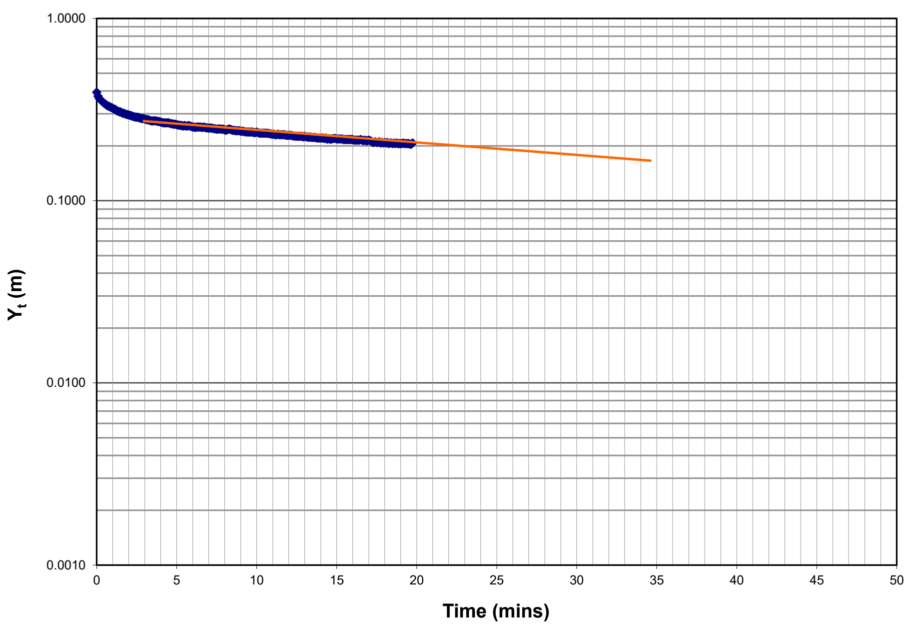
Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72	143
Toluene-D8	2037-26-5	75	131
4-Bromofluorobenzene	460-00-4	73	137

APPENDIX D

Hydraulic testing analysis

Aquifer Test Solutions: Slug Tests Bouwer Rice

Project Name:	**20-22 Melwood Ave, Forestville**	Date:	6-Dec-24
Client:	**Forestville RSL club**		9am
Well No. / Name:	**BH101_3**	**Depth to equilibrium water level** (m bgl)**:**	3.92 m
Type of test:	Falling head Rising head ▪	**Well Completion:**	Fully Penetrating Partially Penetrating ▪



r_c =	casing radius	0.025
r_w =	radial distance between undisturbed aquifer and well centre	0.051
L_e =	length of intake	4
H =	saturated thickness of aquifer	15
L_w =	distance b/n water table and bottom of intake	6.21
R_e =	effective well radius	1.03
t =	time	22
Y_o =	initial drawdown	0.39
Y_t =	vertical distance between the water level in well at time t and equilibrium level	0.19
L_e/r_w =		78.43137255
A =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	4
B =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	0.8
C =	dimensionless co-efficient that is a function of L_e/r_w, and L_w = H	3

If $L_w < H$

$$\ln(R_e/r_w) = \{1.1 \,.\, [\ln(L_w/r_w)]^{-1} + A+B \,.\, \ln[(H-L_w)/r_w] \,.\, (L_e/r_w)^{-1}\}^{-1}$$

= **3.01** m

If $L_w = H$

$$\ln(R_e/r_w) = \{1.1 \,.\, [\ln(L_w/r_w)]^{-1} + C \,.\, (L_e/r_w)^{-1}\}^{-1}$$

= **Lw < H** m

$$K = [r_c^2 \cdot \ln(R_e/r_w)]\, 2L^{-1} \,.\, t^{-1} \,.\, \ln(Y_o/Y_t)$$

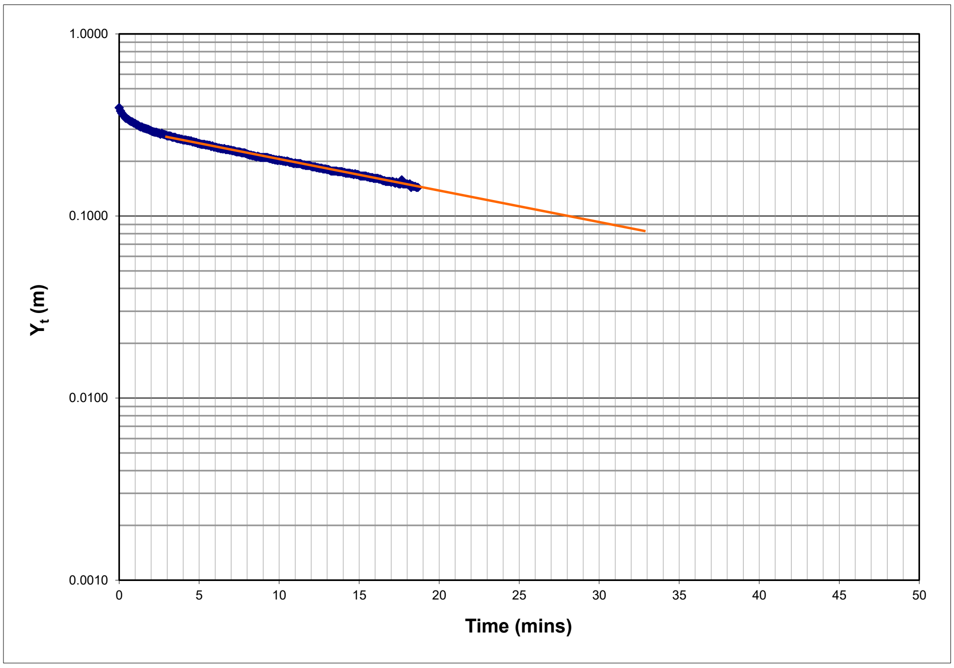
= 7.68E-06 m/min

= **1.11E-02** m/d

Ref. Bouwer H. 1989. *The Bouwer and Rice Slug Test - an Update*. Ground Water. Vol.27, No.3. May - June 1989.
Kruseman G.P. and N.A. de Ridder. 1991. *Analysis and Evaluation of Pumping Test Data*. 2nd Ed. Int. Inst. For Land Reclamation and Improvement. Wageningen. The Netherlands.

Aquifer Test Solutions: **Slug Tests** **Bouwer Rice**

Project Name:	**20-22 Melwood Ave, Forestville**	Date:	6-Dec-24
Client:	**Forestville RSL club**		9am
Well No. / Name:	**BH101_3**	**Depth to equilibrium water level** (m bgl):	4.12 m
Type of test:	Falling head Rising head ▮	**Well Completion:**	Fully Penetrating Partially Penetrating ▮



r_c =	casing radius	0.025
r_w =	radial distance between undisturbed aquifer and well centre	0.051
L_e =	length of intake	4
H =	saturated thickness of aquifer	15
L_w =	distance b/n water table and bottom of intake	6.21
R_e =	effective well radius	1.16
t =	time	27
Y_o =	initial drawdown	0.39
Y_t =	vertical distance between the water level in well at time t and equilibrium level	0.29
L_e/r_w =		78.43137255
A =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	3.5
B =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	0.7
C =	dimensionless co-efficient that is a function of L_e/r_w, and L_w = H	2.5

If L_w < H

$$\ln(R_e/r_w) = \{1.1 \cdot [\ln(L_w/r_w)]^{-1} + A{+}B \cdot \ln[(H-L_w)/r_w] \cdot (L_e/r_w)^{-1}\}^{-1}$$

= **3.13** m

If L_w = H

$$\ln(R_e/r_w) = \{1.1 \cdot [\ln(L_w/r_w)]^{-1} + C \cdot (L_e/r_w)^{-1}\}^{-1}$$

= **Lw < H** m

$$K = [r_c^{2} \cdot \ln(R_e/r_w)]\ 2L^{-1} \cdot t^{-1} \cdot \ln(Y_o/Y_t)$$

= 2.68E-06 m/min

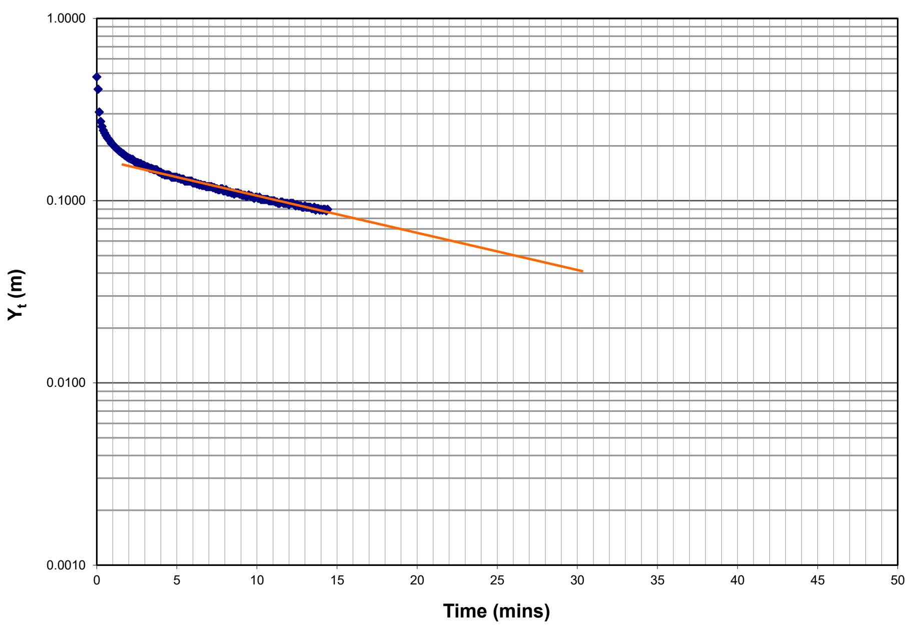
= **3.86E-03** m/d

Ref. Bouwer H. 1989. *The Bouwer and Rice Slug Test - an Update*. Ground Water. Vol.27, No.3. May - June 1989.

Kruseman G.P. and N.A. de Ridder. 1991. *Analysis and Evaluation of Pumping Test Data*. 2nd Ed. Int. Inst. For Land Reclamation and Improvement. Wageningen. The Netherlands.

Aquifer Test Solutions: **Slug Tests** **Bouwer Rice**

Project Name:	**20-22 Melwood Ave, Forestville**	Date:	6-Dec-24
Client:	**Forestville RSL club**		9am
Well No. / Name:	**BH102_3**	**Depth to equilibrium water level** (m bgl)**:**	3.5 m
Type of test:	Falling head Rising head ▪	**Well Completion:**	Fully Penetrating Partially Penetrating ▪



r_c =	casing radius	0.025
r_w =	radial distance between undisturbed aquifer and well centre	0.051
L_e =	length of intake	3
H =	saturated thickness of aquifer	10
L_w =	distance b/n water table and bottom of intake	2.2
R_e =	effective well radius	0.58
t =	time	30
Y_o =	initial drawdown	0.47
Y_t =	vertical distance between the water level in well at time t and equilibrium level	0.046
L_e/r_w =		58.82352941
A =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	3.5
B =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	0.7
C =	dimensionless co-efficient that is a function of L_e/r_w, and L_w = H	2.5

If $L_w < H$

$$\ln(R_e/r_w) = \{1.1 \,.\, [\ln(L_w/r_w)]^{-1} + A{+}B \,.\, \ln[(H-L_w)/r_w] \,.\, (L_e/r_w)^{-1}\}^{-1}$$

= **2.43** m

If $L_w = H$

$$\ln(R_e/r_w) = \{1.1 \,.\, [\ln(L_w/r_w)]^{-1} + C \,.\, (L_e/r_w)^{-1}\}^{-1}$$

= **Lw < H** m

$$K = [r_c^{2} \cdot \ln(R_e/r_w)]\, 2L^{-1} \,.\, t^{-1} \,.\, \ln(Y_o/Y_t)$$

= 1.96E-05 m/min

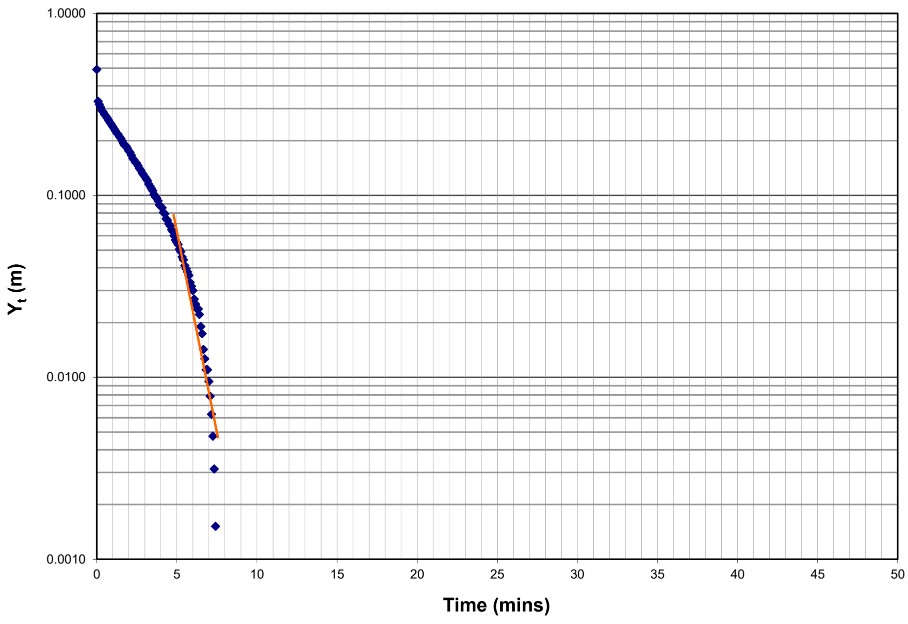
= **2.82E-02** m/d

Ref. Bouwer H. 1989. *The Bouwer and Rice Slug Test - an Update*. Ground Water. Vol.27, No.3. May - June 1989.

Kruseman G.P. and N.A. de Ridder. 1991. *Analysis and Evaluation of Pumping Test Data*. 2nd Ed. Int. Inst. For Land Reclamation and Improvement. Wageningen. The Netherlands.

Aquifer Test Solutions: Slug Tests Bouwer Rice

Project Name:	**20-22 Melwood Ave, Forestville**	Date:	6-Dec-24
Client:	**Forestville RSL club**		9am
Well No. / Name:	**BH1_2**	**Depth to equilibrium water level** (m bgl)**:**	2.89 m
Type of test:	Falling head Rising head ▪	**Well Completion:**	Fully Penetrating Partially Penetrating ▪



r_c =	casing radius	0.025	
r_w =	radial distance between undisturbed aquifer and well centre	0.051	
L_e =	length of intake	6	
H =	saturated thickness of aquifer	18	
L_w =	distance b/n water table and bottom of intake	6.11	
R_e =	effective well radius	1.23	
t =	time	7	
Y_o =	initial drawdown	0.49	
Y_t =	vertical distance between the water level in well at time t and equilibrium level	0.48	
L_e/r_w =		117.6470588	
A =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	4.5	
B =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	1	
C =	dimensionless co-efficient that is a function of L_e/r_w, and L_w = H	4	

If L_w < H

$$\ln(R_e/r_w) = \{1.1 \,.\, [\ln(L_w/r_w)]^{-1} + A+B \,.\, \ln[(H-L_w)/r_w] \,.\, (L_e/r_w)^{-1}\}^{-1}$$

= **3.18** m

If L_w = H

$$\ln(R_e/r_w) = \{1.1 \,.\, [\ln(L_w/r_w)]^{-1} + C \,.\, (L_e/r_w)^{-1}\}^{-1}$$

= **Lw < H** m

$$K = [r_c^{2} \cdot \ln(R_e/r_w)]\, 2L^{-1} \,.\, t^{-1} \,.\, \ln(Y_o/Y_t)$$

= 4.88E-07 m/min

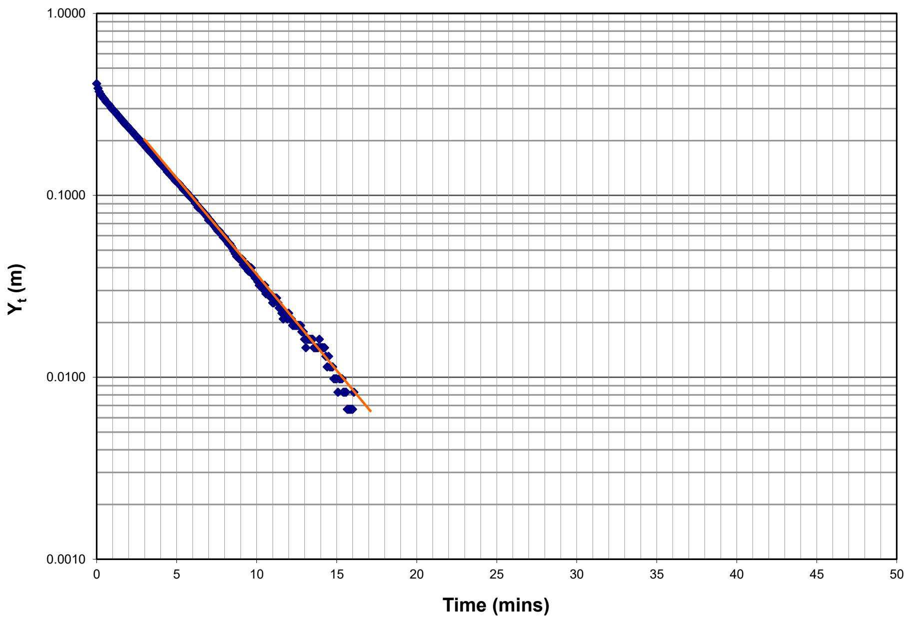
= **7.03E-04** m/d

Ref. Bouwer H. 1989. *The Bouwer and Rice Slug Test - an Update*. Ground Water. Vol.27, No.3. May - June 1989.

Kruseman G.P. and N.A. de Ridder. 1991. *Analysis and Evaluation of Pumping Test Data*. 2nd Ed. Int. Inst. For Land Reclamation and Improvement. Wageningen. The Netherlands.

Aquifer Test Solutions: **Slug Tests** **Bouwer Rice**

Project Name:	**20-22 Melwood Ave, Forestville**	Date:	6-Dec-24
Client:	**Forestville RSL club**		9am
Well No. / Name:	**BH1_2**	**Depth to equilibrium water level** (m bgl)**:**	2.82 m
Type of test:	Falling head Rising head ▪	**Well Completion:**	Fully Penetrating Partially Penetrating ▪



r_c =	casing radius	0.025
r_w =	radial distance between undisturbed aquifer and well centre	0.051
L_e =	length of intake	6
H =	saturated thickness of aquifer	18
L_w =	distance b/n water table and bottom of intake	6.11
R_e =	effective well radius	1.23
t =	time	15
Y_o =	initial drawdown	0.41
Y_t =	vertical distance between the water level in well at time t and equilibrium level	0.4
L_e/r_w =		117.6470588
A =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	4.5
B =	dimensionless co-efficient that is a function of L_e/r_w, and L_w < H	1
C =	dimensionless co-efficient that is a function of L_e/r_w, and L_w = H	4

If L_w < H

$$\ln(R_e/r_w) = \{1.1 \,.\, [\ln(L_w/r_w)]^{-1} + A{+}B \,.\, \ln[(H-L_w)/r_w] \,.\, (L_e/r_w)^{-1}\}^{-1}$$

= **3.18** m

If L_w = H

$$\ln(R_e/r_w) = \{1.1 \,.\, [\ln(L_w/r_w)]^{-1} + C \,.\, (L_e/r_w)^{-1}\}^{-1}$$

= **Lw < H** m

$$K = [r_c^2 \cdot \ln(R_e/r_w)]\, 2L^{-1} \,.\, t^{-1} \,.\, \ln(Y_o/Y_t)$$

= 2.73E-07 m/min

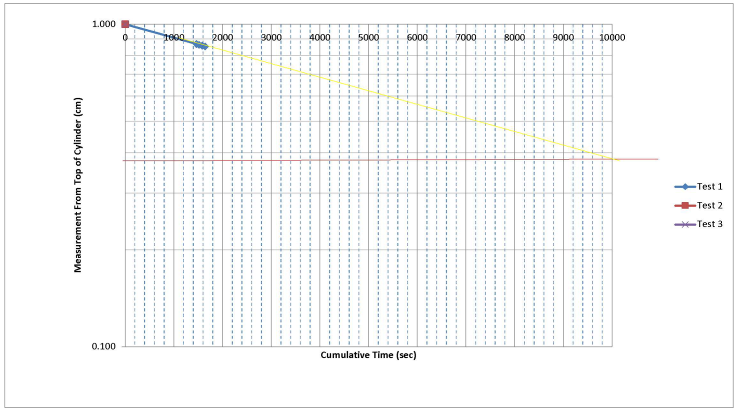
= **3.93E-04** m/d

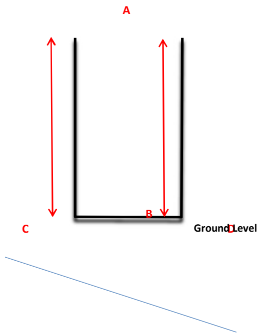
Ref. Bouwer H. 1989. *The Bouwer and Rice Slug Test - an Update* . Ground Water. Vol.27, No.3. May - June 1989.
Kruseman G.P. and N.A. de Ridder. 1991. *Analysis and Evaluation of Pumping Test Data* . 2nd Ed. Int. Inst. For Land Reclamation and Improvement. Wageningen. The Netherlands.

LOCATION A

A - Diameter of Bore (m)	0.1	
B - Diameter of well screen (m)	0.05	
C - Standing Water Level (m)	3.17	m BTOC

Measurement from top of well (ground) TEST 2 BH3	Piezometric Head	H/Ho	Cumulative time		cumulative time (sec)
metres	m	m	Minutes	Seconds	sec
7	3.83	1.000	0	0	0
6.5	3.33	0.869	24	20	1460
6.48	3.31	0.864	25	15	1515
6.46	3.29	0.859	26	16	1576
6.44	3.27	0.854	27	17	1637





951) method used to calculate hydraulic conductivity

$$K\ (m/s) = r_c^2 \times \frac{\ln(L/r_w^*)}{2\,b\,T_o}$$

Where		Test 1		units
r_c =	radius of well casing =	0.0252		metres
b =	saturated thickness =	2.5		metres
T_o = when H/Ho is 0.37	Time lag	10000	Refer to the GRAPH	seconds
L =	Length well screen	3		metres
r_w =	radius of well =	0.05		metres

Calculation	TEST 1
r_c^2 =	0.00063504
$\ln(L/r_w^*)$ =	4.0943
$2\,b\,T_o$ =	50000

Hydraulic Conductivity (k) - m/sec = 5.20E-08
Hydraulic Conductivity (k) - m/day = 0.004

Dupuit Thiem Equation (J. Dupuit 1863)

$$Q = \frac{3.14 \times K \times (h_o^2 - h_w^2)}{\ln(r_o/r_w)}$$ Groundwater inflows (m^3/day)

Where		Test 1	units
K =	Hydraulic Conductivity	0.0	m/d
h_o=	Height of static water level above the base of the aquifer This is the realistic value	5	
r_w =	radius of excavation area = This was incorrectly assigned , I have recalculated	25	metres
h_w=	height of depressed water level in the excavation	3	metres
R_o=	maximum extent of cone drawdown (√2.25 x K x h0 x t/Sy)	35.79	
t =	time in days	365	days
Sy =	Specific Yield from typical reported literature for clay (morris and Johnson 1967) This is installed in sandstone not clay , based on the log , allwance for some clay as well, please check	0.1	metres

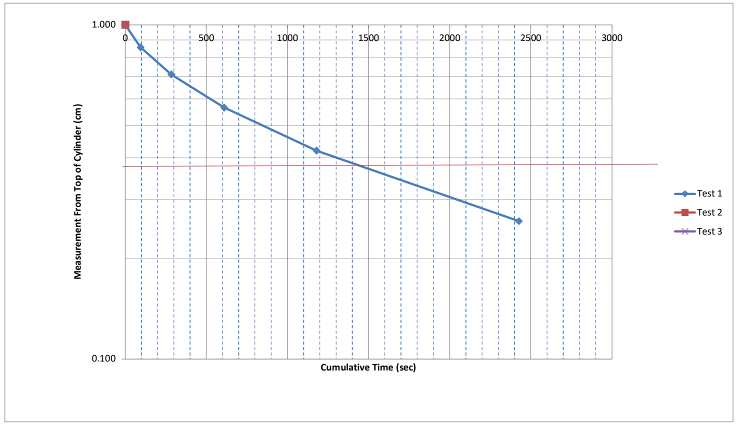
Sandstone 0.1, clay 0.06

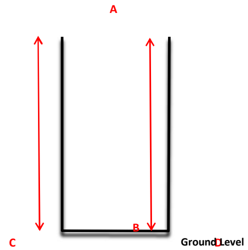
Calculation	TEST 1
3.14 x K =	0.0588
$h_o^2 - h_w^2$ =	16.0000
$\ln(r_o/r_w)$ =	0.358894826

Groundwater inflows (m^3/day)	**3**
Groundwater inflows (L/day)	**2621**
Groundwater inflows (kL/day)	**3**
Groundwater inflows (L/sec)	**0.0**
Groundwater inflows (ML/day)	**0.003**
Groundwater inflows (ML/year)	**0.957**

LOCATION A

A - Diameter of Bore (m)	0.1	
B - Diameter of well screen (m)	0.05	
C - Standing Water Level (m)	2.73	m BTOC





Measurement from top of well (ground)	Piezometric Head	H/Ho	Cumulative time		cumulative time (sec)
metres	m	m	Minutes	Seconds	sec
4.8	2.07	1.000	0	0	0
4.5	1.77	0.855	1	35	95
4.2	1.47	0.710	4	45	285
3.9	1.17	0.565	10	10	610
3.6	0.87	0.420	19	40	1180
3.265	0.535	0.258	40	26	2426

951) method used to calculate hydraulic conductivity

$$K\ (m/s) = r_c^{2} \times \frac{\ln(L/r_w^*)}{2\,b\,T_o}$$

Where		Test 1		units
r_c =	radius of well casing =	0.0252		metres
b =	saturated thickness =	2.5		metres
T_0 = when H/Ho is 0.37	Time lag	1480	Refer to the GRAPH	seconds
L =	Length well screen	3		metres
r_w =	radius of well =	0.05		metres

Calculation	TEST 1
r_c^2 =	0.00063504
$\ln(L/r_w^*)$ =	4.0943
$2\,b\,T_o$ =	7400

Hydraulic Conductivity (k) - m/sec = 3.51E-07
Hydraulic Conductivity (k) - m/day = 0.030

Dupuit Thiem Equation (J. Dupuit 1863)

$$Q = 3.14 \times K \times \frac{(h_o^2 - h_w^2)}{\ln(r_o/r_w)}$$ Groundwater inflows (m^3/day)

Where		Test 1	units
K =	Hydraulic Conductivity	0.0	m/d
h_0=	Height of static water level above the base of the aquifer This is the realistic value	5	
r_w =	radius of excavation area = This was incorrectly assigned , I have recalculated	25	metres
h_w=	height of depressed water level in the excavation	3	metres
R_0=	maximum extent of cone drawdown (√2.25 x K x h0 x t/Sy)	35.31	
t =	time in days	365	days
Sy =	Specific Yield from typical reported literature for clay (morris and Johnson 1967) This is installed in sandstone not clay , based on the log , allwance for some clay as well, please check	0.1	metres

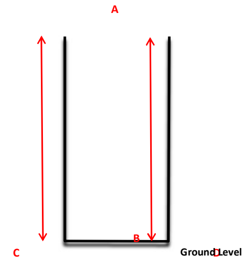
Sandstone 0.1, clay 0.06

Calculation	TEST 1
3.14 x K =	0.0953
$h_o^2 - h_w^2$ =	16.0000
$\ln(r_o/r_w)$ =	0.345195339

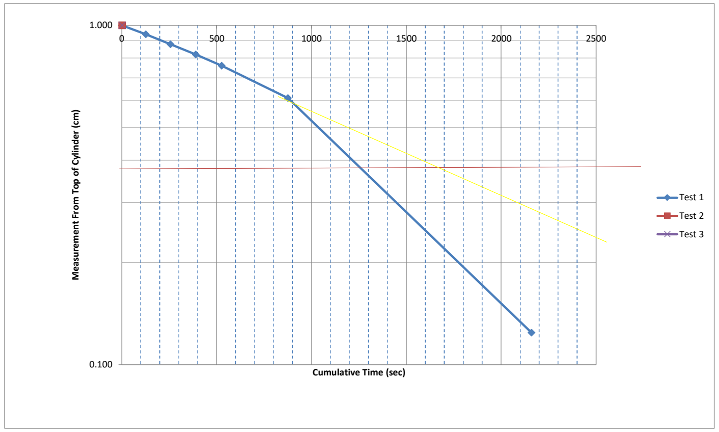
Groundwater inflows (m^3/day)	**4**
Groundwater inflows (L/day)	**4418**
Groundwater inflows (kL/day)	**4**
Groundwater inflows (L/sec)	**0.1**
Groundwater inflows (ML/day)	**0.004**
Groundwater inflows (ML/year)	**1.613**

LOCATION A

A - Diameter of Bore (m)	0.1	
B - Diameter of well screen (m)	0.05	
C - Standing Water Level (m)	1.92	m BTOC



Measurement from top of well (ground)	Piezometric Head	H/Ho	Cumulative time		cumulative time (sec)
metres	m	m	Minutes	Seconds	sec
8.6	6.68	1.000	0	0	0
8.2	6.28	0.940	2	7	127
7.8	5.88	0.880	4	17	257
7.4	5.48	0.820	6	30	390
7	5.08	0.760	8	47	527
6	4.08	0.611	14	35	875
2.75	0.83	0.124	35	59	2159



951) method used to calculate hydraulic conductivity

$$K\ (m/s) = r_c^{\,2} \times \frac{\ln (L/r_w{}^*)}{2\ b\ T_o}$$

Where		Test 1		units
r_c =	radius of well casing =	0.0252		metres
b =	saturated thickness =	2.5		metres
T_0 = when H/Ho is 0.37	Time lag	1700	Refer to the GRAPH	seconds
L =	Length well screen	6		metres
r_w =	radius of well =	0.05		metres

Calculation	TEST 1
$r_c{}^2$ =	0.00063504
ln $(L/r_w{}^*)$ =	4.7875
2 b T_o =	8500
Hydraulic Conductivity (k) - m/sec =	**3.58E-07**
Hydraulic Conductivity (k) - m/day =	**0.031**

Dupuit Thiem Equation (J. Dupuit 1863)

$$Q = 3.14 \times K \times \frac{(h_o^2 - h_w^2)}{\ln(r_o/r_w)}$$

Groundwater inflows (m^3/day)

Where		Test 1	units
K =	Hydraulic Conductivity	0.0	**m/d**
h_0=	Height of static water level above the base of the aquifer	5	
r_w =	This is the realistic value radius of excavation area = This was incorrectly assigned , I have recalculated	25	**metres**
h_w=	height of depressed water level in the excavation	3	**metres**
R_o=	maximum extent of cone drawdown (√2.25 x K x h0 x t/Sy)	45.99	
t =	time in days	365	**days**
Sy =	Specific Yield from typical reported literature for clay (morris and Johnson 1967) This is installed in sandstone not clay , based on the log , allwance for some clay as well, please check	0.06	**metres**

Sandstone 0.1, clay 0.06

Calculation	TEST 1
3.14 x K =	0.0970
$h_o{}^2 - h_w{}^2$ =	16.0000
$\ln(r_o/r_w)$ =	0.609515061
Groundwater inflows (m^3/day)	**3**
Groundwater inflows (L/day)	**2547**
Groundwater inflows (kL/day)	**3**
Groundwater inflows (L/sec)	**0.0**
Groundwater inflows (ML/day)	**0.003**
Groundwater inflows (ML/year)	**0.930**