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Report on
Geotechnical Investigation

Proposed Residential Development
12-20 Berry Road and 11-19 Holdsworth Avenue,
St Leonards

Prepared for
Aqualand St Leonard Development 3 Pty Ltd

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

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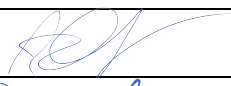
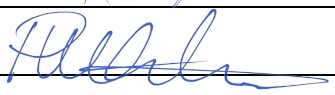
Author		17 June 2022
Reviewer		17 June 2022

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Report on Geotechnical Investigation
Proposed Residential Development
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1. Introduction

This report presents the results of a geotechnical investigation and supplementary geotechnical investigation undertaken for a proposed residential development at 12-20 Berry St and 11-19 Holdsworth Ave, St Leonards. The investigations were commissioned by Aqualand St Leonard Development 3 Pty Ltd and was undertaken in accordance with Douglas Partners' (DP) proposal 210589.00.P.001.Rev2 dated 29 November 2021 and a Services Agreement dated 30 November 2021.

The investigation was carried out to provide information on the subsurface conditions for design and planning purposes. The initial investigation included the drilling of six rock cored boreholes and the installation of three groundwater monitoring wells, while the supplementary investigation included the extension of three of the rock cored boreholes to deeper depths and the installation of a further three groundwater monitoring wells. Details of the field and laboratory testing are given in this report, together with comments on design and construction issues.

Based on the latest concept design drawings by Silvester Fuller, dated 14 June 2022, it is understood that the proposed development will include the demolition of existing structures and the construction of two residential towers of (ten storeys and two partially excavated storeys) over three shared partial basement levels (ground floors) and basement parking.

At the time of initial investigation in 2021 the depth of the basement was unconfirmed as further design was being undertaken and it was understood that three or four basement levels are likely to be considered (as per Drawing DA_A-SK-110-000 rev.4 dated 12 December 2021). After further planning, it was understood that only three basement levels are required and a further supplementary geotechnical investigation was undertaken to extend three of the boreholes to below the lowest proposed basement level. Given the sloping / stepped nature of the site, the bulk excavation level is anticipated to extend to depths of up to approximately 20 m along the northern half of the basement extent and 16 m along the southern half of the basement extent.

2. Site Description

The development site comprises 10 adjacent properties (12-20 Berry St and 11-19 Holdsworth Ave, St Leonards) which are situated between Berry Rd and Holdsworth Ave. The site is approximately rectangular with an area of about 5015 m^2 and situated on a south facing hillside that falls down towards River Rd. The site levels were observed to be following the general shape of the surrounding hillside and falling from RL 75.6 m AHD at the north west corner to RL 65.6 m AHD at the south east corner of the site.

At the time of DP's presence on site, nine residential buildings (including one duplex) of one to three storeys occupied the site. The site is situated within an area of residential use. A summary of the current land uses adjacent to the proposed development site is provided in Table 1.

Table 1: Summary of Adjacent Land Use

Direction Relative to the Site	Land Use Description
North	Generally comprising residential houses of between 1 and 2 storeys (some over a partial basement level) and residential streets.
East	
South	
West	

3. Regional Geology

Reference to the Sydney 1:100 000 Geological Sheet indicated that the site is underlain by Ashfield Shale which is typically a dark grey to black shale and laminite. The site is also near a boundary with Hawkesbury Sandstone (approx. 20 m to the south of the site) which typically comprises medium to coarse grained quartz sandstone with some shale bands or lenses. The results of the investigation on the site confirmed the regional mapping with interbedded siltstone and sandstone intersected at shallow depths with sandstone below.

Within the Sydney area the most comment defects within the Hawkesbury Sandstone are widely spaced horizontal bedding planes, typically 1-3 m, and two orthogonal sets of steeply dipping joints. The joints typically have dips of 75 to 90 degrees from horizontal (i.e. close to vertical) and are orientated with strikes just east of north (about 010 degrees) and just south of east (about 110 degrees). Apart from these main defects sets there are likely to be other less common joints or faults with moderate dips of 20-30 degrees and 40-60 degrees.

4. Field Work Methods

The initial field work for the investigation was undertaken between 2 December 2021 and 17 December 2021 and included:

- On-site electronic scanning for buried services at proposed borehole locations;
- Drilling of six boreholes (BH1 to BH6) using a tight access track mounted drilling rig. The boreholes were drilled into the weathered rock to depths of between 1.2 m and 5.6 m using solid flight augers. The boreholes were then continued to depths of between 14.7 m and 15.0 m using NMLC diamond coring equipment to obtain continuous core samples of the bedrock;
- Standard penetration tests (SPTs) were undertaken at regular intervals within the soil profile;

- Installation of three groundwater monitoring wells (BH1, BH3 and BH6) to allow for the measurement of groundwater levels;
- A rising head permeability test in the wells. The water column in the wall was removed and then the rise in the water level (i.e. recharge) was measured at regular time intervals.

The supplementary field work for the investigation was undertaken between 24 March 2022 and 12 April 2022 and included:

- On-site electronic scanning for buried services at proposed borehole locations;
- Drilling of three boreholes (BH1A, BH3A and BH6A) using a tight access track mounted drilling rig. The boreholes were set out approximately 1 m from the original boreholes (BH1, BH3 and BH6) and drilled out to the original boreholes depths using a PCD bit. The boreholes were then continued to depths of between 20.4 m and 24.0 m using NMLC diamond coring equipment to obtain continuous core samples of the bedrock;
- Installation of three groundwater monitoring wells (BH1A, BH3A and BH6A) to allow for the measurement of groundwater levels;

All boreholes were backfilled with drilling spoil upon completion and concrete capped where necessary. The locations of the boreholes are shown in Drawing 1 in Appendix B. The borehole locations were measured from existing site features and levels were estimated using the supplied survey plan. Eastings and northings provided in the boreholes logs have been obtained from NSW government online mapping.

5. Field Work Results

The detailed borehole logs and rock core photographs are included in Appendix C, together with notes defining classification methods and terms used to describe the soils and rocks.

5.1 Boreholes

Based on the results of the site investigation, the sequence of subsurface materials encountered at the site, in increasing depth order, is summarised in Table 2. Discussion on the selection of the ‘Units’ is provided in Section 7.

Table 2: Summary of the Subsurface Profile

Unit	Material	Depth Range to Top of Unit (m)	RL Range to Top of Unit (m AHD)	Thickness (m)	General Description
1	Filling / Topsoil	0	69.4 to 73.9	0.1 to 0.3	Typically comprising grey-brown silty clay topsoil. At the surface of BH2 and BH4 40 mm of asphaltic concrete was observed to be underlain by gravelly sand fill to 0.1 m. At the surface of BH6 70 mm of brick paver was observed.
2	Residual Soil	0.1 to 0.3	69.3 to 73.6	0.7 to 4.2	Typically comprising medium plasticity, brown clay with traces of silt and sand of stiff to very stiff consistency.
3	VL-L Sandstone	1.0 to 4.3	65.1 to 72.9	1.3 to 4.1	Generally highly to moderately weathered red-brown to brown, very low to low strength sandstone.
4	M & H Sandstone	4.0 to 5.6	63.8 to 69.9	9.1 to 11	Generally slightly weathered to fresh, pale brown, medium and high strength sandstone, slightly weathered to fresh.
5	H Siltstone	19.1	50.3	>1.3	Only observed within BH6A. Generally fresh, grey to dark grey, high strength siltstone

Notes: VL = Very Low Strength, L = Low Strength, M = Medium Strength, H = High Strength

5.2 Groundwater and Permeability Test

Groundwater was not observed during auger drilling of the boreholes. The essential use of water as a drilling fluid during coring of the boreholes precluded any further groundwater observations. The installed monitoring wells were purged dry of drilling fluids using a bailer. A summary of the measured groundwater levels following purging is provided in Table 3.

Table 3: Summary of Groundwater Measurements following Purging

Borehole ID	Surface RL (m AHD)	Groundwater Depth (m)	Groundwater RL (m AHD)	Date	Comments
BH1	73.9	13.5	60.4	21 December 2021	Measured 7 days after well installation
BH1A	73.9	18.8	55.1	19 April 2022	Measured 7 Days after purging of well
BH3	71.5	dry	-	21 December 2021	Measured 7 days after well installation
BH3A	71.5	16.4	55.2	19 April 2022	Measured 7 Days after purging of well
BH6	69.4	13.7	55.7	21 December 2021	Measured 7 days after well installation
BH6A	69.4	13.8	55.6	19 April 2022	Measured 7 Days after purging of well

Rising head permeability tests were carried out within BH1 and BH6, and a falling head permeability test was carried out within BH3 on 21 December 2021, to evaluate the rock mass hydraulic conductivity (or permeability). The test involves removing water or the addition of water (for rising head and fall head permeability tests, respectively) and measuring the changes in water level within the well at regular time intervals. The results of the permeability tests using Hvorslev's (1951) method are summarised in Table 4 below.

Table 4: Hydraulic Conductivity Test Results

Borehole	Hydraulic Conductivity, k (m/s)
BH1	4.9×10^{-8}
BH3	8.7×10^{-8}
BH6	6.6×10^{-9}

Groundwater monitoring was undertaken within all installed monitoring wells. BH1, BH3 and BH6 were monitored between 21 December 2021 and 22 February 2022, while BH1A, BH3A and BH6 were monitored between 26 April 2022 and 16 June 2022. A summary of the observed groundwater levels is provided within Table 5; detailed graphs have been provided within Appendix C.

Table 5: Summary of Groundwater Observations during Monitoring Periods

Borehole ID	Surface RL (m AHD)	Minimum Groundwater RL (m AHD)	Maximum Groundwater RL (m AHD)
BH1	73.9	68.2	69.7
BH1A	73.9	54.8	55.3
BH3	71.5	dry	dry
BH3A	71.5	55.0	55.4
BH6	69.4	60.3	60.7
BH6A	69.4	58.7	59.2

Refer to Section 7 and 9.4 for further comments on groundwater.

6. Laboratory Testing

Laboratory testing was carried out on six soil samples to determine aggressiveness for exposure classification of buried concrete and steel elements.

The results of the laboratory testing are summarised in Table 6. The detailed laboratory test reports are given in Appendix D.

Table 6: Summary of Chemical Laboratory Test Results

Borehole	Material	Depth (m)	Conductivity (µS/cm)	pH	Cl (PPM)	SO_4 (PPM)
BH1	Clay	0.9 – 1.0	100	5.5	<10	170
BH2	Silty Clay	0.4 – 0.5	32	4.7	<10	34
BH3	Clay	0.4 – 0.5	28	6.0	10	<10
BH4	Weathered Sandstone	2.4 – 2.5	25	5.0	<10	23
BH5	Clay	1.0 – 1.45	19	5.4	<10	20
BH6	Weathered Sandstone	4.0 – 4.3	21	5.0	21	58

Notes: Cl = Chloride ion concentration, SO_4 = Sulphate ion concentration, PPM = Parts Per Million

The point load test results on rock cores were tested in-house, with the results shown on the borehole logs in Appendix C.

7. Geotechnical Model

From the investigation, the site is underlain by a thin surficial layer of residual clay over shallow sandstone bedrock. Minimal cutting and filling of the land is evident at the test locations as seen by the minimal fill depths observed, however deeper depths of fill may be present along the shared property boundaries, especially near retaining walls. The likely depth/height of prior cutting and filling is estimated to be less than 2 m.

Groundwater seepage was not observed during the field investigation, however ephemeral seepage flow across the top of the rock and along bedding planes/joints within the rock should be anticipated. The permanent groundwater table is likely to be located well below the proposed excavation level, however it should be noted that groundwater levels are transient and may fluctuate over time, particularly, following periods of heavy rainfall. The groundwater levels measured within the monitoring wells (BH1, BH3 and BH6) are considered to represent trapped water within the borehole void emanating from near surface seepage.

For design purposes, the observed subsurface profile during the investigation has been grouped into four geotechnical units. Four geotechnical cross sections (Section A-A', B-B', C-C' and D-D') showing the interpreted subsurface profile between the borehole locations are shown on Drawing 2 to 5 in Appendix B, respectively.

The interpreted depth and RLs at the top of the various units at each test location is shown in Table 7. Reference should be made to the borehole logs for more detailed information and descriptions of the soil and rock profile. A summary of the geotechnical model is presented in Table 7.

Table 7: Summary of Geotechnical Model

Unit	Material	Depth [m] Reduced Level (m AHD) to Top of Each Unit					
		BH1/ BH1A	BH2	BH3/ BH3A	BH4	BH5	BH6/ BH6A
1	Filling / Topsoil	[0] (73.9)	[0] (71.2)	[0] (71.5)	[0] (69.8)	[0] (71.5)	[0] (69.4)
2	Residual Soil	[0.3] (73.6)	[0.1] (71.1)	[0.2] (71.3)	[0.1] (69.7)	[0.3] (71.2)	[0.1] (69.3)
3	VL-L Sandstone	[1.0] (72.9)	[1.0] (70.2)	[2.0] (69.5)	[2.0] (67.8)	[2.4] (69.1)	[4.3] (65.1)
4	M & H Sandstone	[4.0] (69.9)	[5.1] (66.1)	[4.6] (66.9)	[4.7] (65.1)	[4.2] (67.3)	[5.6] (63.8)
5	H Siltstone	N.E	N.E	N.E	N.E	N.E	[19.1] (50.3)

Notes: : VL = Very Low Strength, L = Low Strength, M = Medium Strength, H = High Strength, N.E = Not encountered

8. Proposed Development

Based on the supplied architectural concept drawings prepared by Silvester Fuller Pty Ltd, it was understood that the proposed development will include the demolition of existing structures on the site followed by the construction of two residential towers of ten storeys over two partial ground floor levels and a shared basement. At the time of the supplementary investigation it is understood that three basement levels are proposed with the lowest (Basement 3) at a finished floor level of 55.4 m AHD.

Given the sloping nature of the site, the excavation for three basement levels is expected to extend to depths of about 18 m along near the northern basement boundary and 14 m along the southern site boundary, assuming a bulk excavation level of RL 54.9 m AHD. The approximate basement extent is shown in Drawing 1 in Appendix B.

9. Comments

9.1 Site Excavation

9.1.1 Dilapidation Surveys

Dilapidation surveys should be carried out on adjacent / existing buildings, pavements and infrastructure that may be affected by the excavation works. The dilapidation surveys should be undertaken before the commencement of any excavation work in order to document any existing defects so that claims for damage due to construction related activities can be accurately assessed.

9.1.2 Excavation Conditions

Based on the borehole logs, the proposed bulk excavation works are anticipated to extend through all Units (soil and rock) outlined in Table 7. The extent of the bulk excavation is also shown in Drawings 1 to 5 in Appendix B. The excavatability of the materials that will likely be encountered during the bulk excavation works are summarised in Table 8. The detailed excavation for footings, services and side walls within low strength or stronger rock will generally require the use of a rotary rock saw or grinder, or hydraulic rock hammers.

The excavation rate that can be achieved, particularly within medium and high strength rock, varies considerably and is dependent upon the degree of jointing in the rock, the rock strength, the type of machinery being used and the skill of the operator. It is suggested that bulk excavation tenderers be required to make their own assessment of the equipment required to carry out the work. Contractors may inspect the rock core samples at the DP office in West Ryde prior to submitting final tenders (rock cores are generally kept for 6 months after drilling unless longer holding times are requested).

Table 8: Summary of Soil and Rock Excavatability

Unit	Material	Material Strength	Excavatability
1	Filling	Sandy Clay / Sand	Excavated using buckets of conventional earthmoving equipment, particularly if fitted with 'rock teeth'. However, the assistance of rock hammering or ripping will probably be required for effective removal of any medium to high strength ironstone bands within the weathered rock profile.
2	Residual Soil	Sand	
3	VL-L	Very Low to Low Strength Sandstone	
4	M & H Sandstone	Medium and High Strength Sandstone	Hard ripping using a large 'bulldozer' (such as a D9 or larger plant), or excavators fitted with either ripping tynes or rock hammers. Rock hammers or saws / grinders are generally required for effective excavation of slightly fractured and unbroken rock. Some of the unbroken, high strength rock may be effectively 'unrippable' with very low productivity.
5	H Siltstone	High Strength Siltstone	

9.1.3 Vibrations

During excavation, it will be necessary to use appropriate methods and equipment to keep ground vibrations at adjacent buildings and structures within acceptable limits. The level of acceptable vibration is dependent on various factors including the type of structure (e.g. reinforced concrete or brick structures etc.), its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the structure and the vibration transmitting medium.

Ground vibration can be strongly perceptible to humans at levels above 2.5 mm/s vector sum peak particle velocity (VSPPV). This is generally much lower than the vibration levels required to cause structural damage to buildings. The Australian Standard AS2670.2-1990 "Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings (1-80 Hz)" indicates an acceptable day time limit of 8 mm/s VSPPV for human comfort.

Based on the experience of DP and with reference to AS2670, it is suggested that a maximum VSPPV of 8 mm/s (applicable at the foundation level of existing buildings) be adopted for this site for both architectural and human comfort considerations.

As the magnitude of vibration transmission is site specific, it is recommended that a vibration trial be undertaken at the commencement of rock excavation. The trial may indicate that smaller or different types of excavation equipment should be used for bulk (or detailed) excavation purposes.

To reduce the effects of (vibrations from) hydraulic rock hammers, the work method should allow for:

- Rock sawing around the perimeter of the excavation and perimeter of the pad footings; and
- Use of rock hammers in short burst to prevent generation of resonant frequencies.

9.1.4 Disposal of Excavated Material

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the *Waste Classification Guidelines* (EPA, 2014). This includes filling and natural materials that may be removed from the site.

9.2 Excavation Support

Vertical excavations within the soil (Unit 1 and 2) and weathered/ jointed rock profile (Unit 3 and some of Unit 4 as outlined in Table 7) will require both temporary and permanent lateral support during and after excavation.

9.2.1 Batter Slopes and Vertical Rock Faces

Suggested temporary and permanent batter slopes for unsupported excavations up to a maximum height of 4 m are shown in Table 9. If surcharge loads are applied near the crest of the slope then further specific geotechnical review and probably flatter batters or stabilisation using rock bolts or soil nails may be required.

Table 9: Recommended Batter Slopes for Exposed Material

Unit	Material	Maximum Temporary Batter Slope (H : V)	Maximum Permanent Batter Slope (H : V)
1	Filling	1.5 : 1	2 : 1**
2	Residual Soil	1 : 1	2 : 1**
3	VL-L Sandstone	0.5 : 1*	1 : 1*
4	M & H Sandstone	Vertical*	Vertical*
5	H Siltstone	Vertical*	Vertical*

Note: VL = Very Low Strength, L = Low Strength, M = Medium Strength, H = High Strength

* Subject to jointing assessment by experienced Geotechnical Engineer/Engineering Geologist

** Permanent batters in soil may need to be reduced to 3H: 1V to facilitate maintenance of grassed slopes, if required

Competent medium strength or stronger sandstone will generally be stable when cut vertically provided there are no adversely oriented joints or other defects present. All vertical faces in rock should be inspected by an experienced geotechnical engineer as the excavation progresses in depth intervals of no deeper than 1.5 m. The purpose of the inspections is to identify the extent of shotcrete face protection required and to check for the presence of any adverse defects daylighting into the excavation face which may require additional stabilisation measures (such as rock bolts, anchors or shotcrete).

Given that the typical main joint sets within Hawkesbury Sandstone in the Sydney region are oriented at a slight angle to the proposed excavation faces, it is expected that there will be some narrow

wedges formed where these near vertical joints intersect the excavation faces and some rock bolts may be required to stabilise these wedges.

9.2.2 Retaining Walls

Where batter slopes cannot be used, shoring walls will be required to support the Unit 1, 2, and 3 materials as outlined in Table 7. Anchored soldier pile walls are often used to provide temporary retaining support to soils and weathered rock. The soldier piles are usually spaced at approximately 2 m to 2.5 m centres, however, more closely spaced piles may be required to reduce wall movements, or prevent collapse of infill materials, particularly where pavements, structures or services are located in close proximity to the excavation.

It may be possible to terminate the shoring piles within unsupported Unit 4 medium strength or stronger sandstone above the bulk excavation level. In this case it will be essential for an experienced geotechnical engineer or engineering geologist to assess the stability of the rock directly beneath each pile toe immediately after it is exposed during bulk excavation. No passive pressure will be available and as such, it will generally be necessary to restrain the toe of the piles with temporary or permanent rock bolts or anchors, as appropriate.

It is suggested that preliminary design of cantilevered shoring systems (or shoring with one row of anchors or propping) be based on a triangular earth pressure distribution using the earth pressure coefficients provided in Table 10. 'Active' earth pressure coefficient (K_a) values may be used where some wall movement is acceptable, and 'at rest' earth pressure (K_o) values should be used where the wall movement needs to be reduced (i.e. adjacent to existing structures or utilities).

Table 10: Recommended Design Parameters for Shoring Systems

Unit	Material	Unit Weight (kN/m^3)	Earth Pressure Coefficient		Effective Cohesion c' (kPa)	Effective Friction Angle (Degrees)
			Active (K_a)	At Rest (K_o)		
1	Filling	20	0.4	0.6	0	25
2	Residual Soil	20	0.3	0.45	2	25
3	VL-L Sandstone	24	0.15	0.25	20	30
4	M & H Sandstone	24	0*	0*	100	35
5	H Siltstone	24	0*	0*	100	30

Note: EL = Extremely Low Strength, VL = Very Low Strength, L = Low Strength, M = Medium Strength, H = High Strength
* Subject to jointing assessment by experienced Geotechnical Engineer/Engineering Geologist

The design for lateral earth pressures where multiple rows of anchors or propping are used (i.e. two rows or more of anchors or props) may be based on a trapezoidal earth pressure distribution. The following earth pressure magnitudes are considered appropriate, where H is the height of soil and very low to low strength rock to be retained, in metres:

- 6H kPa, where some lateral movement is allowed; and
- 8H kPa, where lateral movements need to be limited (e.g. next to buildings and services).

In each case the maximum pressure generally acts over the central 60% of the wall, reducing to zero at the top and base of the wall.

The design of the shoring should allow for all surcharge loads, including building footings, inclined slopes behind the wall, traffic, site sheds, and construction related activities.

Shoring walls should also be designed for full hydrostatic pressures unless drainage of the ground behind impermeable walls can be provided. Drainage could comprise 150 mm wide strip drains pinned to the face at 1 m to 2 m centres behind shotcrete in-fill panels. The base of the strip drains should extend out from the shoring wall to allow any seepage to flow into a perimeter toe drain which is connected to the stormwater drainage system.

9.2.3 Passive Resistance

Passive resistance for piles founded in rock below the base of the bulk excavation (including allowance for services and/or footings) may be based on the ultimate passive restraint values provided in Table 11. This ultimate value represents the pressure mobilised at high displacements and therefore it will be necessary to incorporate a factor of safety of at least 3 to limit wall movement. The top 0.5 m of the socket should be ignored due to possible disturbance and over-excavation.

Table 11: Recommended Passive Resistance Values

Unit	Foundation Stratum	Maximum Allowable Passive Pressure (kPa)	Maximum Ultimate Passive Pressure (kPa)
3	VL-L Sandstone	200*	700*
4	M & H Sandstone	1,300*	4,000*
5	H Siltstone		

Note: VL = Very Low Strength, L = Low Strength, M = Medium Strength, H = High Strength
* subject to geotechnical inspection

9.2.4 Ground Anchors

The design of temporary and permanent ground anchors/rock bolts for the support of excavations and / or shoring systems may be carried out on the basis of the maximum bond stresses given in Table 12.

Table 12: Recommended Bond Stresses for Rock Anchor Design

Unit	Material Description	Maximum Allowable Bond Stress (kPa)	Maximum Ultimate Bond Stress (kPa)
3	VL-L Sandstone	150	250
4	M & H Sandstone	500	1,000
5	H Siltstone		

The parameters given in Table 12 assume that the drilled holes are clean and adequately flushed. The anchors should be bonded behind a line drawn up at 45 degrees from the base of the shoring, and "lift-off" tests should be carried out to confirm the anchor capacities. Trial anchors should be used to confirm bond stress values. It is suggested that ground anchors should be proof loaded to 125% of the design working load and locked-off at no higher than 80% of the working load.

9.3 Excavation Induced Ground Movement and Adjacent Buildings

Horizontal movements due to stress relief will occur during the excavation works. Based on published literature and DP's experience, the lateral deflection associated with excavation in Hawkesbury Sandstone may be in the order of 0.05% to 0.15% of the excavation height in rock, which corresponds to approximately:

- 10 mm to 30 mm for a 20 m depth excavation in the approximate northern half of the basement extent; and
- 8 mm to 24 mm for a 16 m depth excavation in the approximate southern half of the basement extent.

The above predicted deflections would generally be greatest at the centre of the excavated faces and would reduce with distance away from the excavation face/boundary. It is expected that deflections at the surrounding buildings, which typically have a setback of about 2 m or more from the common site boundary, would be less than the values indicated above.

It is generally not possible / practical to provide restraint (i.e. anchoring) for the relatively high in-situ horizontal stresses associated with stress relief movements. Therefore it is recommended that appropriate allowance be made for movements of this order in the design, planning and construction.

Precise survey and/ or inclinometer monitoring of excavation faces and nearby buildings/ structures should be carried out to assess vertical and horizontal movements during the excavation. The survey and/ or inclinometer monitoring should commence prior to excavation to provide a baseline and should continue every 1.5 m drop of the excavation. If deflections show an increase in the rate of movement or exceed the predicted movements, then the structural engineer and geotechnical engineer should be contacted for immediate review.

If a more accurate assessment of predicated ground movements at surrounding buildings as a result of the proposed excavations is required then numerical modelling (using commercially available software such as Plaxis 2D) of the proposed excavation adjacent to the neighbouring buildings may be required.

9.4 Groundwater

It is expected that perched groundwater seepage will occur along the top of the soil and rock interface and through joints and along bedding planes within the rock exposed in the basement floor and walls, particularly after wet weather. This seepage is not expected to be associated with a regional groundwater table.

During construction and in the long term, it is anticipated that seepage into the excavation could be controlled by perimeter and subfloor drainage connected to a sump-and-pump system. On this basis, a drained basement may be considered for this site. Generally, water collected from dewatering operations should be suitable for disposal by pumping to stormwater drains subject to confirmation testing of groundwater quality and approval from the Council.

It is possible that seepage into the basement may give rise to precipitation of red brown iron oxide residue from the oxidisation of soluble iron likely to be present within the groundwater and therefore perimeter and subfloor drains should be designed for easy access to allow for inspection, maintenance and periodic cleaning.

9.5 Foundations

Footings may be designed using the values given in Table 13. For bored piles, if required, shaft adhesion values for uplift (tension) may be taken as being equal to 70% of the shaft adhesion values for compression in Table 13.

Table 13: Recommended Design Parameters for Foundation Design

Unit	Foundation Stratum	Maximum Allowable Pressure (Serviceability)		Maximum Ultimate Pressure (Ultimate)		Young's Modulus, E (MPa)
		End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	End Bearing (kPa)	Shaft Adhesion (Compression) (kPa)	
2	Residual Soil	100	-	300	-	25
3	VL-L Sandstone	1,000	100	3,000	150	100
4	M & H Sandstone	3,500	350	40,000	1,500	1,000
5	H Siltstone					

EL = Extremely Low Strength, VL = Very Low Strength, L = Low Strength, M = Medium Strength, H = High Strength

Higher allowable bearing pressures of about 6,000 kPa could be adopted in the Unit 4 and Unit 5, the medium and high strength (or stronger) sandstone/siltstone, subject to further geotechnical investigation and testing. This would require a minimum of four cored boreholes to be drilled to approximately 3 m to 4 m below the nominated bulk excavation level and spoon testing within one third of all footing excavations. Spoon testing involves drilling a 50 mm diameter hole below the base of the footing, to a depth of 1.5 times the footing width, followed by testing to check for the presence of weak/clay bands. If weak seams are detected then footings may need to be taken deeper to reach suitable foundation material.

Footings (i.e. pads or piles) founded on the edge or within the zone of influence of vertical rock excavations, would be subject to assessment of jointing in the rock. Examples of where such a scenario could occur include:

- Footings founded outside of basement excavation and near the vertical cut face for the basement excavation; and
- Shoring piles (if adopted) terminated above the bulk excavation level in the Unit 4 rock.

Generally the allowable bearing pressure for footings founded near the edge of vertical rock excavations on Unit 4 medium and high strength sandstone (or stronger) should be limited to about 1,500 kPa. If deeper excavation exposes adverse jointing in the rock below the footings, then stabilisation using rock bolts/anchors/shotcrete and/or underpinning may be required. Alternatively, the footings may be taken down below the zone of influence of a vertical cut face, in which case there would be no need to reduce the bearing pressure.

Foundations proportioned on the basis of the allowable bearing pressures in Table 13 would be expected to experience total settlements of less than 1% of the footing width under the applied working load, with differential settlements between adjacent columns expected to be less than half of this value.

Footings designed using ultimate values and Limit State Design will need to consider serviceability which usually governs the design in this case. For pile design, a basic geotechnical strength reduction factor, Φ_{gb}, of about 0.56 (or possibly higher) calculated from Table 4.3.2 (A, B, and C) of AS2159-2009: Piling Design and Installation, is considered feasible. However, the structural engineer will need to make their own assessment with the final (Φ_{gb}) number being dependent on the design and installation method (and associated risk rating) adopted by the structural engineer. A higher Φ_{gb} value could be achieved if pile load testing is carried out.

All footings should be inspected by a geotechnical engineer to confirm that foundation conditions are suitable for the design parameters.

9.6 Pavements and Engineered Filling

It is expected that the subgrade for the new pavements along the entrance driveway will generally comprise residual clay, for which a preliminary CBR value of 3% may be adopted for preliminary pavement design purposes. It is recommended that once the existing surface levels at the location of the proposed driveway have been stripped, an inspection be carried out by an experienced geotechnical engineer to confirm the appropriate CBR value to use for design.

Site preparation will be required prior to construction of proposed pavements/ driveways. Earthworks recommendations provided in this report should be complemented by reference to AS 3798 – 2007 Guidelines on earthworks for commercial and residential developments.

The following methodology is suggested for subgrade preparation of pavements and for raising of site levels using engineered filling:

- Strip the filling down to the surface of the residual soils / rock;
- Where soil / filling is exposed, proof rolling of the subgrade will be required. Proof rolling of the exposed subgrade should be carried out prior to placement of any filling or the construction of slabs. Proof rolling should comprise six passes of a smooth drum roller (say at least 10 tonne). The final pass should be carried out under the observation of a geotechnical engineer to identify any soft or saturated zones. Any such zones should be over-excavated to a maximum depth of 600 mm and replaced with compacted durable granular material.
- If any filling is required to raise surface levels, it should be placed in layers not greater than 200 mm loose thickness and compacted to between 98% to 100% of Standard dry density, with moisture content within ±2% of the optimum moisture content.
- The filling, natural residual soil and rock on the site is suitable for reuse as engineered filling provided it has a maximum particle size of 100 mm. Reuse should also consider the contamination status and is subject to approval by an environmental consultant.

9.7 Seismic Design

In accordance with the Earthquake Loading Standard, AS1170.4, 2007, the site has a site sub-soil class of rock (B_e).

9.8 Soil and Groundwater Aggressivity

In accordance with AS2159-2009, the results of the chemical laboratory testing indicate that the soils are mild to buried concrete and non-aggressive to buried steel.

10. Limitations

Douglas Partners (DP) has prepared this report (or services) for this project at 12-20 Berry St and 11-19 Holdsworth Ave, St Leonards in accordance with DP's proposal 210589.00.P.001.Rev2 dated 29 November 2021 and the work was carried out under a mutual Services Agreement signed and provided to Aqualand St Leonard Development 3 Pty Ltd on 30 November 2021. This report is provided for the exclusive use of Aqualand St Leonard Development 3 Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

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

The scope for work for this investigation did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

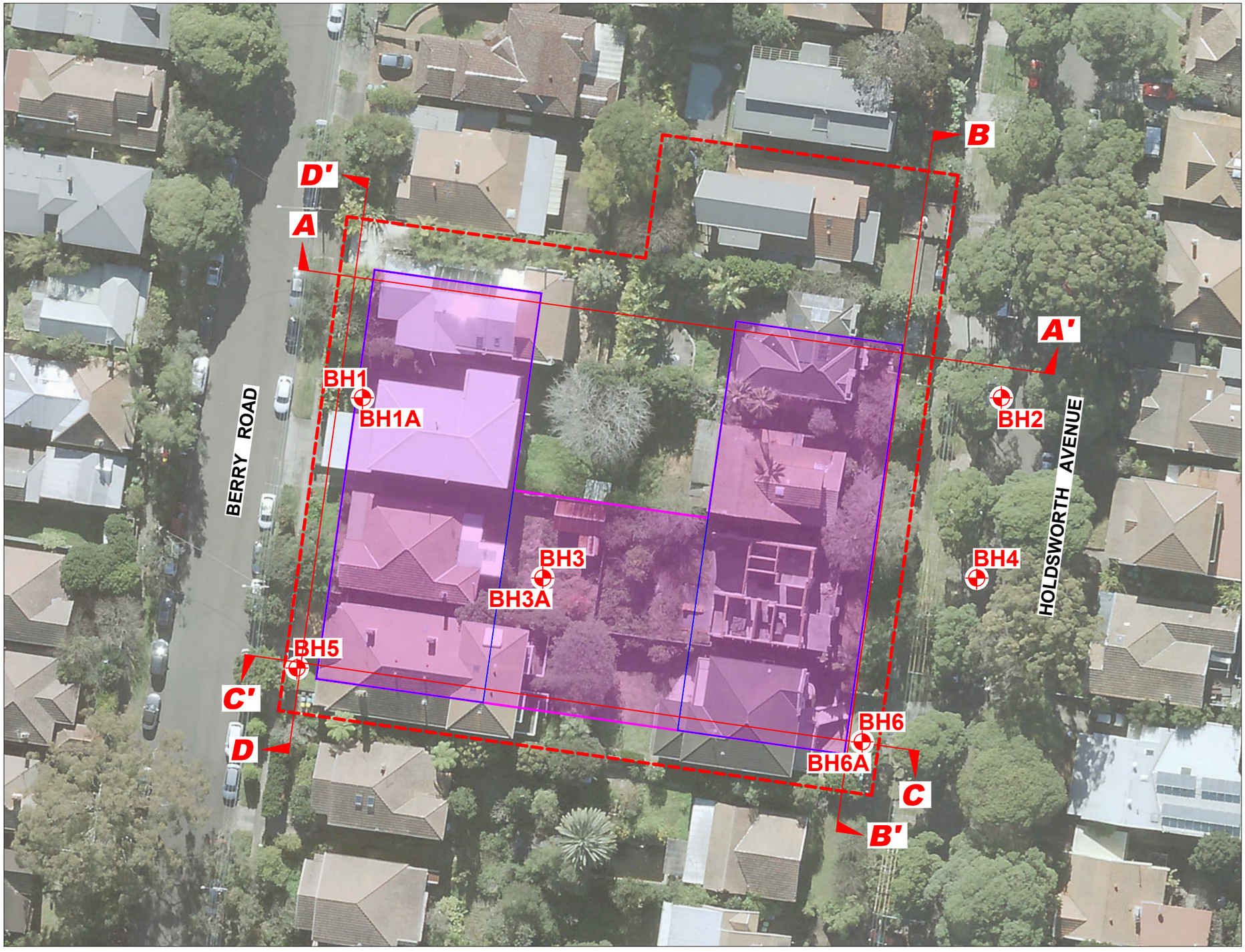
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

Site Inspection

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

Appendix B

Drawings



Locality Plan

NOTE:
1: Base image from MetroMap (Dated 30.07.2021)

0 5 10 15 20 30 40 50m

1:500 @ A3

LEGEND

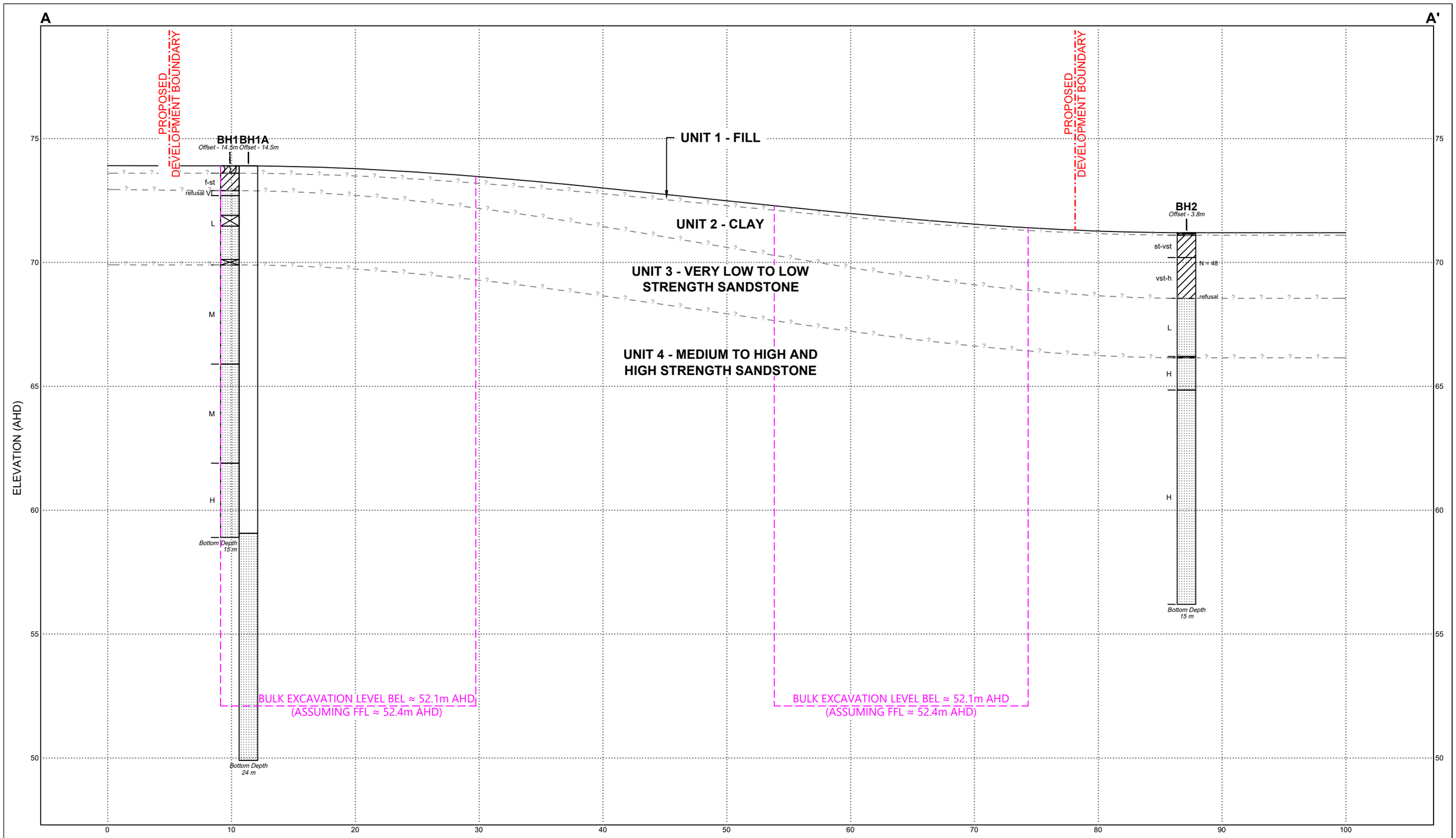
- Approximate Site Boundary
- Approximate Proposed Building Footprint
- Approximate Proposed General Basement Footprint
- Test Bore Location
- Geological Cross Section

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Aqualand Projects Pty Ltd		TITLE: **Test Location Plan** **Proposed Residential Development** **12-20 Berry Road and 11-19 Holdsworth Avenue, St Leonards**
OFFICE: Sydney	DRAWN BY: MG	
SCALE: 1:500 @ A3	DATE: 18.05.2022	

N

PROJECT No:	210589.00
DRAWING No:	1
REVISION:	1



LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Filling
- Sandstone
- Sandy Clay
- Silty Clay
- Topsoil

NOTES:

1. Subsurface conditions are accurate at the borehole locations only.
   Variations in subsurface conditions may occur between borehole locations.
   Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

ROCK STRENGTH

EL -	Extremely Low
VL -	Very Low
L -	Low
M -	Medium
H -	High
VH-	Very High

SOIL CONSISTENCY

vs -	Very Soft
s -	Soft
f -	Firm
st -	Stiff
vst -	Very Stiff
h -	Hard

TESTS / OTHER

- N - Standard penetration test value
- — ? — — - Interpreted geotechnical boundary

0 6

Horizontal Scale (metres)
Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Aqualand Projects Pty Ltd		TITLE: **Interpreted Geotechnical Cross-Section A-A'**	PROJECT No: 210589.00
OFFICE: Sydney	DRAWN BY: MG	**Proposed Residential Development**	DRAWING No: 2
SCALE: 1:300 (H) 1:150 (V) @ A3	DATE: 18.05.2022	**12-20 Berry Road & 11-19 Holdsworth Avenue, St Leonards**	REVISION: 1

B

B'

PROPOSED DEVELOPMENT BOUNDARY

PROPOSED DEVELOPMENT BOUNDARY

BH2
Offset 12.6m

st-vst
N = 48
vst-h
refusal
VL-L
H
H
Bottom Depth 15 m

BH4
Offset 12.7m

st-vst
N = 32
vst-h
VL
refusal
VL-L
M-H
M-H
H
H
Bottom Depth 15 m

BH6 BH6A
Offset 1.6m Offset 1.6m

N = 48 st-h
h
refusal
refusal
VL-L
M-H
H
H
Bottom Depth 14.7 m

UNIT 1 - FILL

UNIT 2 - CLAY

UNIT 3 - VERY LOW TO LOW STRENGTH SANDSTONE

UNIT 4 - MEDIUM TO HIGH AND HIGH STRENGTH SANDSTONE

UNIT 5 - HIGH STRENGTH SHALE

Bottom Depth 20.36 m

BULK EXCAVATION LEVEL BEL ≈ 52.1m AHD
(ASSUMING FFL ≈ 52.4m AHD)

ELEVATION (AHD)

75 70 65 60 55 50

0 10 20 30 40 50 60 70 80 90 100

DISTANCE ALONG PROFILE (m)

LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Filling
- Pavers
- Sandstone

NOTES:
1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

ROCK STRENGTH
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY
vs - Very Soft
s - Soft
f - Firm
st - Stiff
vst - Very Stiff
h - Hard

TESTS / OTHER
N - Standard penetration test value
— ? — — - Interpreted geotechnical boundary

0 6
Horizontal Scale (metres)
Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Aqualand Projects Pty Ltd		TITLE: **Interpreted Geotechnical Cross-Section B-B'**
OFFICE: Sydney	DRAWN BY: MG	**Proposed Residential Development**
SCALE: 1:300 (H) 1:150 (V) @ A3	DATE: 18.05.2022	**12-20 Berry Road & 11-19 Holdsworth Avenue, St Leonards**

PROJECT No:	210589.00
DRAWING No:	3
REVISION:	1

C

C'

PROPOSED DEVELOPMENT BOUNDARY

PROPOSED DEVELOPMENT BOUNDARY

BH6 *Offset - 0.1m*

BH6A *Offset - 0.1m*

BH5 *Offset 0.7m*

UNIT 1 - FILL

UNIT 2 - CLAY

UNIT 3 - VERY LOW TO LOW STRENGTH SANDSTONE

UNIT 4 - MEDIUM TO HIGH AND HIGH STRENGTH SANDSTONE

UNIT 5 - HIGH STRENGTH SHALE

BH6: N = 48 st-h; refusal h; refusal VL-L; M-H; H; H; *Bottom Depth 14.7 m*

BH6A: *Bottom Depth 20.36 m*

BH5: f-st; st-vst; N = 17; h; VL; refusal; VL; M; M; H; *Bottom Depth 15 m*

BULK EXCAVATION LEVEL BEL ≈ 52.1m AHD
(ASSUMING FFL ≈ 52.4m AHD)

ELEVATION (AHD)

75 70 65 60 55 50

-10 0 10 20 30 40 50 60 70 80 90

DISTANCE ALONG PROFILE (m)

LEGEND

- Core Loss
- Clay
- Pavers
- Sandstone
- Topsoil

NOTES:

1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

ROCK STRENGTH
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY
vs - Very Soft
s - Soft
f - Firm
st - Stiff
vst - Very Stiff
h - Hard

TESTS / OTHER
N - Standard penetration test value
— ? — — - Interpreted geotechnical boundary

0 6
Horizontal Scale (metres)
Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Aqualand Projects Pty Ltd		TITLE: **Interpreted Geotechnical Cross-Section C-C'**	PROJECT No: 210589.00
OFFICE: Sydney	DRAWN BY: MG	**Proposed Residential Development**	DRAWING No: 4
SCALE: 1:300 (H) 1:150 (V) @ A3	DATE: 18.05.2022	**12-20 Berry Road & 11-19 Holdsworth Avenue, St Leonards**	REVISION: 1

D

D'

PROPOSED DEVELOPMENT BOUNDARY

PROPOSED DEVELOPMENT BOUNDARY

UNIT 1 - FILL

UNIT 2 - CLAY

UNIT 3 - VERY LOW TO LOW STRENGTH SANDSTONE

UNIT 4 - MEDIUM TO HIGH AND HIGH STRENGTH SANDSTONE

BH5
Offset 0.4m

f-st
st-vst
h
VL
VL
M
M
H
N = 17
refusal
Bottom Depth 15 m

BH1BH1A
Offset - 3.0m Offset - 3.0m

f-st
refusal VL
L
L
M
M
H
Bottom Depth 15 m
Bottom Depth 24 m

BULK EXCAVATION LEVEL BEL ≈ 52.1m AHD
(ASSUMING FFL ≈ 52.4m AHD)

ELEVATION (AHD)

75 70 65 60 55 50

-20 -10 0 10 20 30 40 50 60 70 80

DISTANCE ALONG PROFILE (m)

LEGEND

- Core Loss
- Clay
- Sandstone
- Topsoil

NOTES:
1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

ROCK STRENGTH
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY
vs - Very Soft
s - Soft
f - Firm
st - Stiff
vst - Very Stiff
h - Hard

TESTS / OTHER
N - Standard penetration test value
— ? — — - Interpreted geotechnical boundary

0 6
Horizontal Scale (metres)
Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Aqualand Projects Pty Ltd		TITLE: **Interpreted Geotechnical Cross-Section D-D'**
OFFICE: Sydney	DRAWN BY: MG	**Proposed Residential Development**
SCALE: 1:300 (H) 1:150 (V) @ A3	DATE: 18.05.2022	**12-20 Berry Road & 11-19 Holdsworth Avenue, St Leonards**

PROJECT No: 210589.00
DRAWING No: 5
REVISION: 1

Appendix C

Field Work Results

Sampling Methods

Douglas Partners

Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

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

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

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

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

Soil Types

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

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

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

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

Definitions of grading terms used are:

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

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

In fine grained soils (>35% fines)

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

In coarse grained soils (>65% coarse)
- with clays or silts

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

In coarse grained soils (>65% coarse)
- with coarser fraction

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

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

Soil Descriptions

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Origin

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

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

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

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

Moisture Condition – Fine Grained Soils

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

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

Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Abbreviation	Unconfined Compressive Strength MPa	Point Load Index * $Is_{(50)}$ MPa
Very low	VL	0.6 - 2	0.03 - 0.1
Low	L	2 - 6	0.1 - 0.3
Medium	M	6 - 20	0.3 - 1.0
High	H	20 - 60	1 - 3
Very high	VH	60 - 200	3 - 10
Extremely high	EH	>200	>10

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured , usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
Note: If HW and MW cannot be differentiated use DW (see below)		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

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

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq \text{100 mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

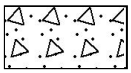
Symbols & Abbreviations

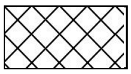
Graphic Symbols for Soil and Rock

General

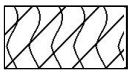

Asphalt

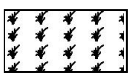

Road base

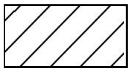

Concrete

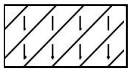

Filling

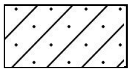
Soils


Topsoil

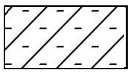

Peat

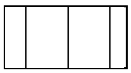

Clay

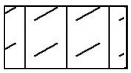

Silty clay

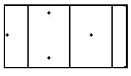

Sandy clay

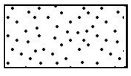

Gravelly clay

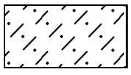

Shaly clay

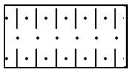

Silt


Clayey silt


Sandy silt

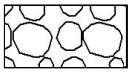

Sand

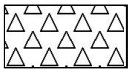

Clayey sand


Silty sand


Gravel

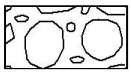

Sandy gravel


Cobbles, boulders

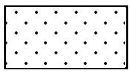

Talus

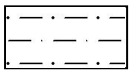
Sedimentary Rocks

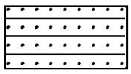

Boulder conglomerate

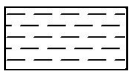

Conglomerate


Conglomeratic sandstone

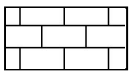

Sandstone


Siltstone

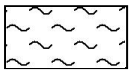

Laminite

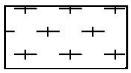

Mudstone, claystone, shale

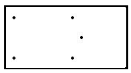

Coal


Limestone

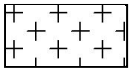
Metamorphic Rocks

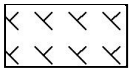

Slate, phyllite, schist

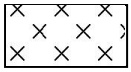

Gneiss

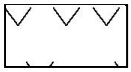

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BORE: BH1 PROJECT: ST LEONARDS DECEMBER 2021

1.20 – 5.00m

BORE: BH1 PROJECT: ST LEONARDS DECEMBER 2021

5.00 – 10.00m

BORE: BH1 PROJECT: ST LEONARDS DECEMBER 2021

10.00 –15.00m

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 210589.00
DATE: 17-12-2021
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
73	0.3	TOPSOIL/Silty CLAY: low to medium plasticity, brown, trace of rootlets and fine sand							A			
	1.0	CLAY CI-CH: medium to high plastcity, brown to orange brown, trace of silt and ironstone gravel, w<PL, firm to stiff, residual						Unless stated otherwise defects are: B0-15°, pl, ro, cly vn or cln or fe st	A			
	1.2	SANDSTONE: fine to medium grained, pale grey to pale brown, very low strength, with some red-brown iron indurated bands, Hawkesbury Sandstone							A S			15,24/80 refusal
72	2	SANDSTONE: fine to medium grained, grey-brown to brown with some dark grey interbedded siltstone, low strength with some hard clay and high strength iron indurated bands, highly weathered, highly fractured, Hawkesbury Sandstone						1.74m: B0-10°, pl, ro cly 10mm 1.78-2.00m: Cz 2m: CORE LOSS: 430mm	C	85	0	PL(A) = 2.1
	2.43							2.44m: Cs, 70mm 2.51m: Cz, 80mm				
71	3							2.77m: Cz, 20mm 2.83m: Ds, 70mm 2.94m: B0°, pl, ro, cly vn 3.11m: Ds, 30mm 3.23m: DS, 120mm	C	83	0	PL(A) = 0.05
								3.51m: B0-10°, pl, ro cly 40mm 3.68m: Ds, 40mm				PL(A) = 0.2
70	4							3.78m: CORE LOSS: 220mm				
	4.0	SANDSTONE: fine to medium grained, orange brown to pale brown, medium strength with some hard clay bands, slightly weathered, fractured, Hawkesbury Sandstone						4m: B0-10°, pl, ro cly 20mm 4.25m: J10°, pl, ro, cln	C	100	40	PL(A) = 0.97
69	5							4.84-4.94m Bx3,20°, pl, ro, cly vn 5.27m: Cs, 150mm				
68	6							5.8m: J90°, st, ro, fe st 5.86m: B5°, irr, ro, cly vn 5.94m: B5°, irr, ro, cln 6.06m: J40°, st, ro, cly vn 6.1m: J0°-75°, st, ro, fe st 6.18m: B0°, pl, ro, cly vn 6.28m: J30°, pl, ro, fe st 6.61m: Ds, 70mm	C	100	18	PL(A) = 0.91 PL(A) = 0.15
67	7							7.12 - 7.84 Bx11, 0°, pl , ro, fe st				PL(A) = 0.52
66	8											
	8.0	SANDSTONE: fine to medium grained, pale brown and pale grey, medium strength, moderately weathered to slightly weathered, fractured, Hawkesbury Sandstone							C	100	65	PL(A) = 0.35
65	9											PL(A) = 0.49
64												

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.0m, HQ to 1.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.2m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 210589.00
DATE: 17-12-2021
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
63	11	SANDSTONE: fine to medium grained, pale brown and pale grey, medium strength, moderately weathered to slightly weathered, fractured, Hawkesbury Sandstone *(continued)*						10.91m: Ds, 50mm 11.13m: J30°, pl, ro, cln 11.57m: J50, pl, ro, cly co	C	100	73	PL(A) = 0.77 PL(A) = 0.86
62	12 12.0	SANDSTONE: fine to coarse grained, pale brown to pale grey, high strengthfresh, slightly fractured, Hawkesbury Sandstone						12.06m: B0°, pl, ro, cly co 2mm 12.35m: B0°, pl, ro, cly co 2mm 12.44m: B5°, pl, ro, cly vn 12.55m: B0°, pl, ro, cly 20mm 12.96m: J15°, un, ro, sandy cly co				PL(A) = 2.5
61	13											
60	14								C	100	100	PL(A) = 1.7 PL(A) = 1
59	15 15.0	Bore discontinued at 15.0m										
58	16											
57	17											
56	18											
55	19											
54												

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.0m, HQ to 1.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.2m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 210589.00
DATE: 17-12-2021
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
73	0.3	TOPSOIL/Silty CLAY: low to medium plasticity, brown, trace of rootlets and fine sand		A	0.1–0.2				Gatic Cover; Blank pipe 0.0-7.5m
		CLAY CI-CH: medium to high plastcity, brown to orange brown, trace of silt and ironstone gravel, w<PL, firm to stiff, residual		A	0.4–0.5				
	1.0			A	0.9				
	1.2	SANDSTONE: fine to medium grained, pale grey to pale brown, very low strength, with some red-brown iron indurated bands, Hawkesbury Sandstone		S	1.0–1.2		15,24/80 refusal		
72	2	SANDSTONE: fine to medium grained, grey-brown to brown with some dark grey interbedded siltstone, low strength with some hard clay and high strength iron indurated bands, highly weathered, highly fractured, Hawkesbury Sandstone		C	1.63		PL(A) = 2.1		
	2.43			C	2.15–2.7		PL(A) = 0.05		
71	3			C	3.64		PL(A) = 0.2		Bentonite 0.1-7.0m
70	4			C	3.78–4.69		PL(A) = 0.97		
	4.0	SANDSTONE: fine to medium grained, orange brown to pale brown, medium strength with some hard clay bands, slightly weathered, fractured, Hawkesbury Sandstone		C	5.34–5.66		PL(A) = 0.91		
69	5			C	6.51		PL(A) = 0.15		
68	6			C	7.2–7.52		PL(A) = 0.52		
67	7			C	8.39		PL(A) = 0.35		
66	8			C	9.46		PL(A) = 0.49		
65	8.0	SANDSTONE: fine to medium grained, pale brown and pale grey, medium strength, moderately weathered to slightly weathered, fractured, Hawkesbury Sandstone							
64	9				10.0				

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.0m, HQ to 1.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.2m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1
PROJECT No: 210589.00
DATE: 17-12-2021
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
63	11	SANDSTONE: fine to medium grained, pale brown and pale grey, medium strength, moderately weathered to slightly weathered, fractured, Hawkesbury Sandstone *(continued)*			10.0				Machine slotted PVC screen 7.5-13.5m
					10.75		PL(A) = 0.77		
				C	11.43		PL(A) = 0.86		Gravel 7.0-15.0m
62	12 12.0	SANDSTONE: fine to coarse grained, pale brown to pale grey, high strengthfresh, slightly fractured, Hawkesbury Sandstone			12.42		PL(A) = 2.5		
61	13				13.05				
				C	13.27		PL(A) = 1.7		End cap
60	14				14.28		PL(A) = 1		
59	15 15.0	Bore discontinued at 15.0m			15.0				
58	16								
57	17								
56	18								
55	19								
54									

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.0m, HQ to 1.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.2m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

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Permeability Testing - Simple Slug Test Report

Client:	Aqualand Projects Pty Ltd	Project No:	210589
Project:	Proposed Residential Development	Date:	21-Dec-21
Location:	12-20 Berry Rd & 11-19 Holdsworth Ave	Tested by:	AT

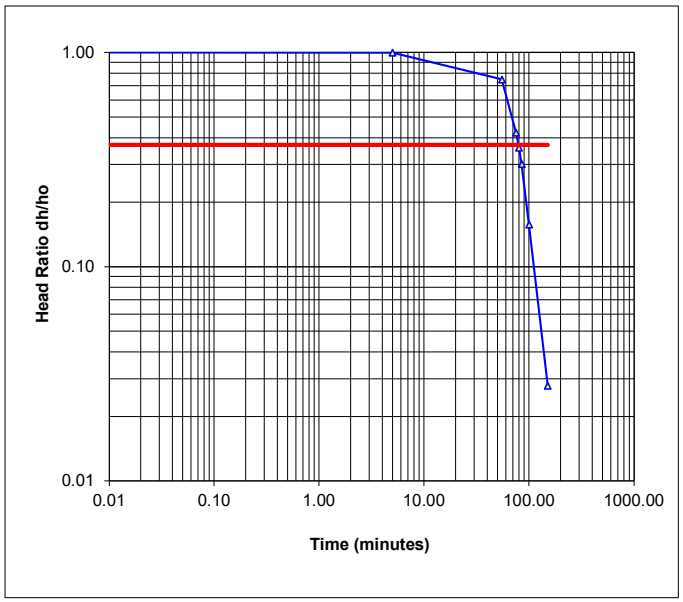
Test Location		**Test No.**	BH1	
Description:	Property of 14 Berry St, St Leonards	Easting:	332701	m
Material type:	Clay over Sandstone	Northing	6255642	m
		Surface Level:	73.9	m AHD

Details of Well Installation

Well casing diameter	50	mm	Depth to water before test	4.45	m
Well screen diameter	96	mm	Depth to water at start of test	12	m
Length of well screen	6.5	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.00	0.00	7.55	1.000
5.00	0.02	7.53	0.997
55.00	1.9	5.65	0.748
75.00	4.36	3.19	0.423
80.00	4.84	2.71	0.359
85.00	5.27	2.28	0.302
100.00	6.36	1.19	0.158
150.00	7.34	0.21	0.028



To = 80 mins
4800 secs

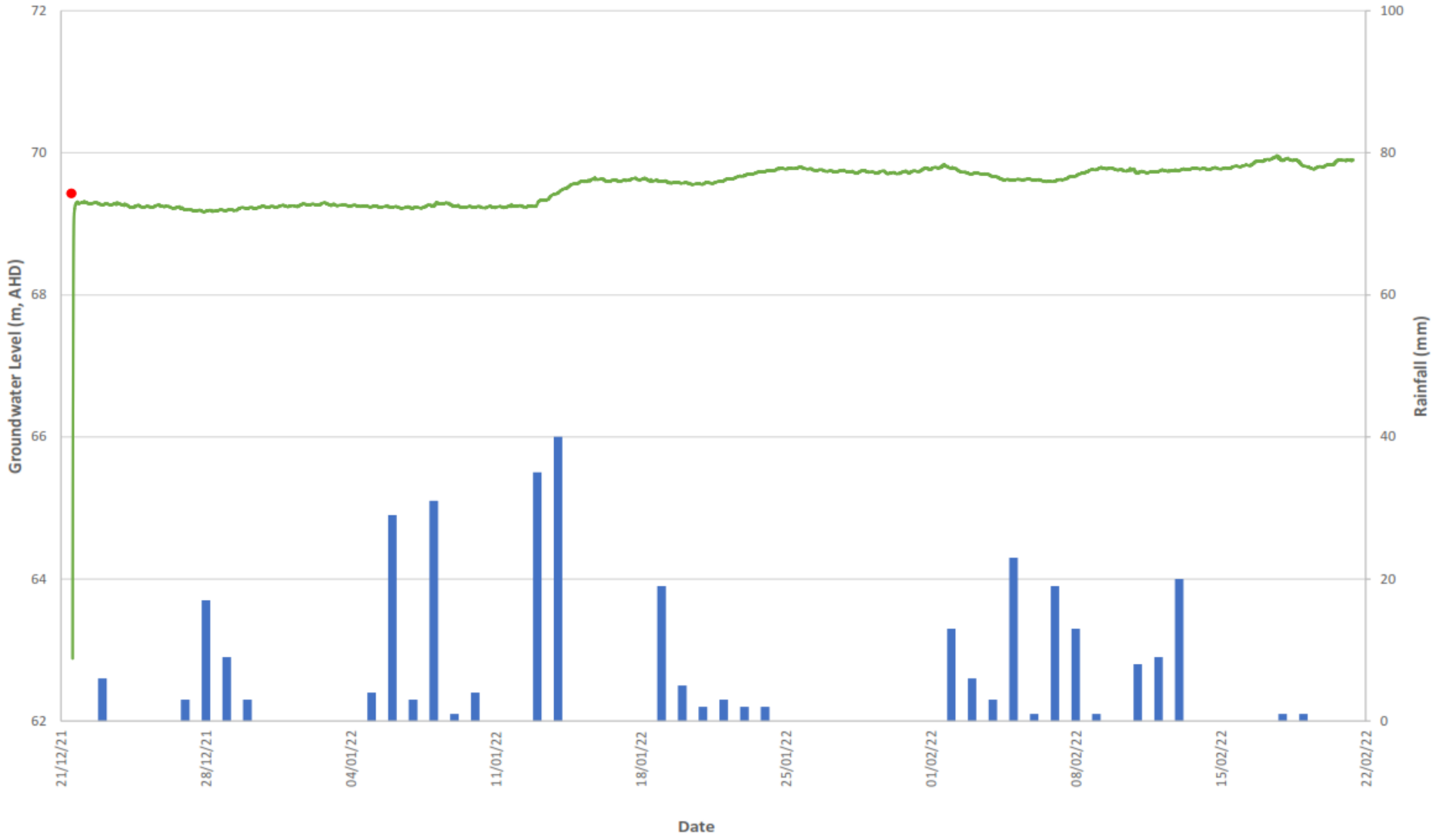
Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**4.9E-08**	m/sec
	=	**0.018**	cm/hour

BH1



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Manual Levels
Water Level
Rainfall data (ST: 066011)

Date:	From	Drawn:
16-06-22	21-12-21	TM
Project:	**To**	**Checked:**
210589.00	22-02-21	AT

BORE: BH1A PROJECT: ST LEONARDS MARCH 2022

14.83 – 19.00m

BORE: BH1A PROJECT: ST LEONARDS MARCH 2022

19.00 – 24.0m

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1A
PROJECT No: 210589.00
DATE: 24-3-2022
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
73	1	PCD to 14.83m depth										
72	2											
71	3											
70	4											
69	5											
68	6											
67	7											
66	8											
65	9											
64												

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HWT to 1.0m, HQ to 14.8m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.83m, NMLC Coring to 24.00m

WATER OBSERVATIONS: Approximately 30-40% water loss between 19.0-21.04m

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 24.0m (screen 18.0m-24.0m, PVC 0.0m-18.0m, Gravel 17.5m-24.0m, Bentonite 16.5m-17.5m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1A
PROJECT No: 210589.00
DATE: 24-3-2022
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
63	11	PCD to 14.83m depth *(continued)*										
62	12											
61	13											
60	14											
59	14.83 15	SANDSTONE: fine to medium grained, pale grey, distinct bedding and cross bedding dipping 0°-10°, high strength with some medium strength bands, fresh slightly fractured						15.34-15.35m: Cs 10mm	C	100	100	PL(A) = 1.57
58	16							15.85m: B0°, pl, ro, cln 16.24m: B5°, pl, rou, cln				PL(A) = 1.84
57	17							17m: B10°, pl, ro, cln 17.41m: B5°, pl, ro, cly co 4mm	C	100	95	PL(A) = 1.6
56	18							18.15m: B0°, pl, cly co 2mm 18.21m: B0°, pl, ro, cly vn 18.3m: B0°, pl, ro, cly vn 18.6m: B0°, pl, ro, cly vn 18.76m: B10°, pl, ro, cly vn				PL(A) = 1.2
55	19							19.15m: J35°, pl, ro, patchy cly vn 19.31-19.33m: Ds 20mm 19.36-19.39m: Ds	C	100	92	PL(A) = 0.71
54	20.0											PL(A) = 1.6

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HWT to 1.0m, HQ to 14.8m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.83m, NMLC Coring to 24.00m

WATER OBSERVATIONS: Approximately 30-40% water loss between 19.0-21.04m

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 24.0m (screen 18.0m-24.0m, PVC 0.0m-18.0m, Gravel 17.5m-24.0m, Bentonite 16.5m-17.5m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1A
PROJECT No: 210589.00
DATE: 24-3-2022
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 0.05 0.10 0.50 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
53	21	SANDSTONE: fine to medium grained, pale grey, distinct bedding and cross bedding dipping 0°-10°, high strength with some medium strength bands, fresh slightly fractured						30mm 19.45-19.48m: Cs 30mm 19.54m: cbs seam 19.66-19.67m: Cs 10mm 19.9m: B5°, pl, ro, cly vn 20.22m: J25°, pl, ro, cly vn 20.44m: B10°, pl, ro, cly vn 21.26m: B5°, pl, ro, sandy cly co 2mm 21.4m: B15°, pl, ro, cln	C	100	92	PL(A) = 2.3
52	22											PL(A) = 1.8
51	23							22.37m: J20°, pl, ro, cbs	C	100	97	PL(A) = 0.8
50	24 24.0							23.22m: J20°, pl, ro, cln 23.34m: B5°, pl, ro, cly vn 23.41m: B10°, pl, ro, sandy cly co 1mm 23.73m: J30°, pl, ro, cbs				PL(A) = 2.51
		Bore discontinued at 24.0m - Target depth reached										
49	25											
48	26											
47	27											
46	28											
45	29											
44												

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HWT to 1.0m, HQ to 14.8m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.83m, NMLC Coring to 24.00m

WATER OBSERVATIONS: Approximately 30-40% water loss between 19.0-21.04m

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 24.0m (screen 18.0m-24.0m, PVC 0.0m-18.0m, Gravel 17.5m-24.0m, Bentonite 16.5m-17.5m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1A
PROJECT No: 210589.00
DATE: 24-3-2022
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
73	1	PCD to 14.83m depth							Gatic cover; Cement 0.0-0.5m
72	2								
71	3								
70	4								
69	5								
68	6								
67	7								
66	8								Backfill 0.5-16.5m
65	9								Blank pipe 0.0-18.0m
64									

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HWT to 1.0m, HQ to 14.8m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.83m, NMLC Coring to 24.00m

WATER OBSERVATIONS: Approximately 30-40% water loss between 19.0-21.04m

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 24.0m (screen 18.0m-24.0m, PVC 0.0m-18.0m, Gravel 17.5m-24.0m, Bentonite 16.5m-17.5m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1A
PROJECT No: 210589.00
DATE: 24-3-2022
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		PCD to 14.83m depth *(continued)*							
63	11								11
62	12								12
61	13								13
60	14								14
59	14.83				14.83				
	15	SANDSTONE: fine to medium grained, pale grey, distinct bedding and cross bedding dipping 0°-10°, high strength with some medium strength bands, fresh slightly fractured		C	14.95		PL(A) = 1.57		15
58	16				15.95 16.0		PL(A) = 1.84		16
57	17				16.96		PL(A) = 1.6		17 Bentonite 16.5-17.5m
				C					
56	18				17.95		PL(A) = 1.2		18
55	19				18.96 19.0		PL(A) = 0.71		19
				C					
54	20.0				19.9		PL(A) = 1.6		

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HWT to 1.0m, HQ to 14.8m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.83m, NMLC Coring to 24.00m

WATER OBSERVATIONS: Approximately 30-40% water loss between 19.0-21.04m

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 24.0m (screen 18.0m-24.0m, PVC 0.0m-18.0m, Gravel 17.5m-24.0m, Bentonite 16.5m-17.5m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 73.9 AHD
EASTING: 332701
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH1A
PROJECT No: 210589.00
DATE: 24-3-2022
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
53	21	SANDSTONE: fine to medium grained, pale grey, distinct bedding and cross bedding dipping 0°-10°, high strength with some medium strength bands, fresh slightly fractured		C	20.95		PL(A) = 2.3		Gravel 17.5-24.0m Machine slotted PVC screen 18.0-24.0m
52	22				21.95 22.0		PL(A) = 1.8		
51	23			C	22.94		PL(A) = 0.8		
50	24 24.0				23.94 24.0		PL(A) = 2.51		End cap
49	25	Bore discontinued at 24.0m - Target depth reached							
48	26								
47	27								
46	28								
45	29								
44									

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HWT to 1.0m, HQ to 14.8m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.83m, NMLC Coring to 24.00m

WATER OBSERVATIONS: Approximately 30-40% water loss between 19.0-21.04m

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 24.0m (screen 18.0m-24.0m, PVC 0.0m-18.0m, Gravel 17.5m-24.0m, Bentonite 16.5m-17.5m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

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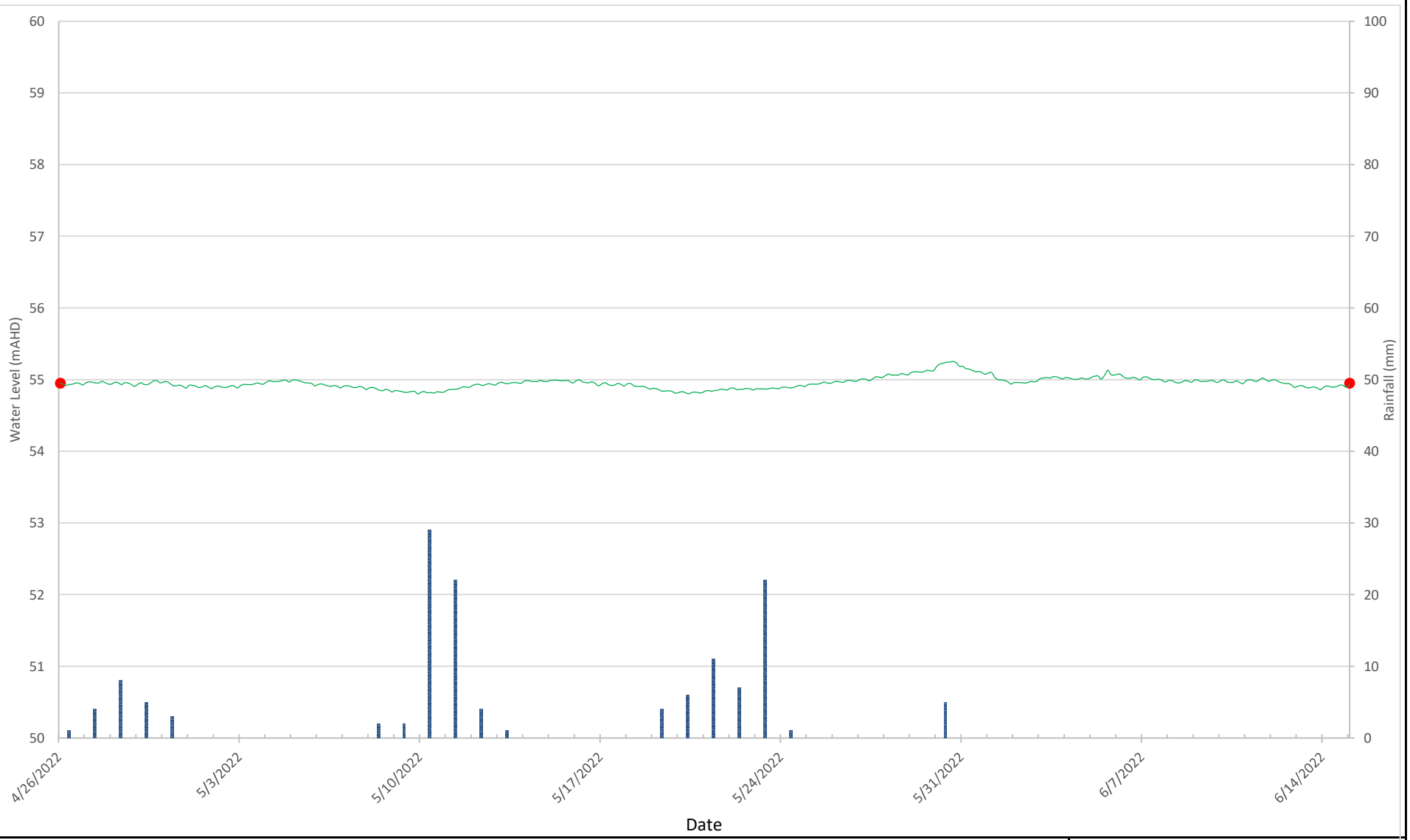
BH1A



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Date:	From	Drawn:
16-06-22	26-04-22	TM
Project:	**To**	**Checked:**
210589.00	15-06-22	AT

BORE: BH2 PROJECT: ST LEONARDS DECEMBER 2021

2.65 – 7.00m

BORE: BH2 PROJECT: ST LEONARDS DECEMBER 2021

7.00 – 12.00m

BORE: BH2 PROJECT: ST LEONARDS DECEMBER 2021

12.00 – 15.00m

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.2 AHD
EASTING: 332779
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 210589.00
DATE: 16-12-2021
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Type	Core Rec. %	RQD %	Test Results & Comments
71	0.04	ASPHALTIC CONCRETE							A			
	0.1	FILLING/Gravelly SAND: grey to grey-brown, igneous and concrete gravel, dry							A			
70	1.0	Silty CLAY CI: medium plasticity, pale grey to brown, trace sand and ironstone gravel, w<PL, stiff to very stiff							S			15,25,23 N = 48
69	2	Sandy CLAY CL-CI: low to medium plasticity, pale brown to pale red-brown, with ironstone gravels, very stiff to hard, weathered bedrock.						Unless stated otherwise defects are: B0-15°, pl, ro, cly vn or cln or fe st	S			24,20/10 refusal
68	2.65	SANDSTONE: medium grained, pale brown-grey to orange-brown, low strength with some hard clay bands, moderately weathered, fractured to slightly fractured, Hawkesbury Sandstone						2.97m: B0°, pl, ro, cly 30mm	C	80	50	PL(A) = 0.26
67	4							3.8m: J20°, pl, ro, stn, cly, vn 3.89m: J35°, pl, ro, stn, cly co	C	99	99	PL(A) = 0.2 PL(A) = 0.29
66	5.05	SANDSTONE: fine to medium grained, pale brown with some grey interbedded siltstone, high strength, fresh, slightly fractured, Hawkesbury Sandstone						5m: CORE LOSS: 50mm		98	94	PL(A) = 2.1 PL(A) = 1.5
65	6.35	SANDSTONE: medium to coarse grained, pale brown to pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone							C	100	97	PL(A) = 1.6 PL(A) = 1.5 PL(A) = 1.7
64	7											
63	8											
62	9											

RIG: Bobcat **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 2.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.65m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.2 AHD
EASTING: 332779
NORTHING: 6255642
DIP/AZIMUTH: 90°/--

BORE No: BH2
PROJECT No: 210589.00
DATE: 16-12-2021
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
61		SANDSTONE: medium to coarse grained, pale brown to pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone *(continued)*										
	11											PL(A) = 1.6
60									C	100	100	
	12											PL(A) = 1.4
59												
	13											PL(A) = 1.4
58									C	100	100	
	14											PL(A) = 1.47
57												
	15 15.0											PL(A) = 1.7
56		Bore discontinued at 15.0m										
	16											
55												
	17											
54												
	18											
53												
	19											
52												

RIG: Bobcat **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 2.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.65m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BORE: BH3 PROJECT: ST LEONARDS DECEMBER 2021

2.40– 7.00m

BORE: BH3 PROJECT: ST LEONARDS DECEMBER 2021

7.00 – 12.00m

BORE: BH3 PROJECT: ST LEONARDS DECEMBER 2021

12.00 – 15.00m

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 210589.00
DATE: 2-12-2021
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low / Very Low / Low / Medium / High / Very High / Ex High		0.01 / 0.05 / 0.10 / 0.50 / 1.00	B - Bedding J - Joint S - Shear F - Fault				
71	0.03	BRICK PAVER							D			
	0.2	FILL/Silty CLAY: low plasticity, dark grey, with ripped, iron-stained sandstone gravel, w<PL							D			
	1	CLAY CI-CH: medium to high plasticity, mottled orange-dark grey, w~PL, stiff to very stiff, residual							S			11,25/140 refusal
70	1.5	Sandy CLAY CL-CI: low to medium plasticity, orange brown to red-brown, with ironstone gravel, w<PL, hard, weathered Hawkesbury Sandstone						Unless stated otherwise defects are: B0-15°, pl, ro, cly vn or cln or fe st	D			
	2											
	2.0	SANDSTONE: fine to medium grained, pale grey-brown and red-brown, very low to low strength with some hard clay bands and high strength iron indurated bands, extremely to highly weathered, fractured, Hawkesbury Sandstone						2.6m: J40-50°, pl, ro cln				
69	3											
68								3.4m: B0-10°, pl, ro, cly 10mm				
	4							4m: CORE LOSS: 230mm	C	90	0	PL(A) = 0.88
67	4.23											
	4.6	SANDSTONE: fine to medium grained, red-brown, medium strength with some hard clay bands and high strength iron indurated bands, highly to moderately weathered, fractured, Hawkesbury Sandstone						4.54m: B0-10°, pl, ro, cly 10mm 4.55m: CORE LOSS: 50mm 4.75m: J40-50°, pl, ro, cly co 4.8m: B0-10°, pl, ro, cly 10mm 5.06m: B0-10°, pl, ro, cly 10mm 5.2m: J50°, pl, ro, healed 5.55-6.50m Jx5, 70°, pl, ro, healed				PL(A) = 0.58
66	5											
	6											PL(A) = 3.9
65	6.6	SANDSTONE: medium grained, pale grey to brown, low to medium strength, slightly weathered, fractured to slightly fractured, Hawkesbury Sandstone						6.8m: J70°, pl, ro, cly co 7.15-7.90m Jx3, 70°, pl, ro, healed	C	100	65	PL(A) = 0.4
	7											
64												PL(A) = 0.26
	8											
	8.1	SANDSTONE: medium grained, pale brown to grey, high strength, slightly weathered, slightly fractured, Hawkesbury Sandstone						8.1m: B0-10°, pl, ro, cly co 8.57m: B0-10°, pl, ro, cly co				
63	9											PL(A) = 1.3
62								9.23m: B0-10°, pl, ro, cly co 9.5m: B0-10°, pl, ro, cly co	C	100	99	
												PL(A) = 1.3

RIG: Bobcat **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 2.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.4m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 210589.00
DATE: 2-12-2021
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
61		SANDSTONE: medium grained, pale brown to grey, high strength, slightly weathered, slightly fractured, Hawkesbury Sandstone *(continued)*							C	100	99	
	11 11.0	SANDSTONE: medium grained, pale brown to pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone						10.9m: B0-10°, pl, ro, cly co				PL(A) = 2
60								11.5m: J30°, pl, ro, cly co				
	12											PL(A) = 1.3
59												PL(A) = 0.95
	13							12.9m: B0-10°, pl, ro, cly co	C	100	99	PL(A) = 1.1
58												
	14											PL(A) = 1.6
57									C	100	100	
	15 15.0	Bore discontinued at 15.0m										PL(A) = 1.9
56												
	16											
55												
	17											
54												
	18											
53												
	19											
52												

RIG: Bobcat **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 2.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.4m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 210589.00
DATE: 2-12-2021
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
71	0.03	BRICK PAVER		D	0.0				Gatic Cover
	0.2	FILL/Silty CLAY: low plasticity, dark grey, with ripped, iron-stained sandstone gravel, w<PL			0.1				Blank pipe 0.0-9.0m
				D	0.4				
		CLAY CI-CH: medium to high plasticity, mottled orange-dark grey, w~PL, stiff to very stiff, residual			0.5				
	1				1.0				
				S			11,25/140 refusal		
70	1.5				1.45				
		Sandy CLAY CL-CI: low to medium plasticity, orange brown to red-brown, with ironstone gravel, w<PL, hard, weathered Hawkesbury Sandstone		D	1.8				
	2				1.9				
	2.0	SANDSTONE: fine to medium grained, pale grey-brown and red-brown, very low to low strength with some hard clay bands and high strength iron indurated bands, extremely to highly weathered, fractured, Hawkesbury Sandstone			2.4				
69									
	3								
68									Bentonite 0.1-7.0m
	4			C	3.95		PL(A) = 0.88		
	4.23								
67	4.6	SANDSTONE: fine to medium grained, red-brown, medium strength with some hard clay bands and high strength iron indurated bands, highly to moderately weathered, fractured, Hawkesbury Sandstone			4.95		PL(A) = 0.58		
	5								
66					5.5				
	6				5.95		PL(A) = 3.9		
65	6.6	SANDSTONE: medium grained, pale grey to brown, low to medium strength, slightly weathered, fractured to slightly fractured, Hawkesbury Sandstone		C	6.95		PL(A) = 0.4		
	7								
64					7.95		PL(A) = 0.26		
	8								
	8.1	SANDSTONE: medium grained, pale brown to grey, high strength, slightly weathered, slightly fractured, Hawkesbury Sandstone			8.5				
63									
	9				8.95		PL(A) = 1.3		
				C					
62									
					9.95		PL(A) = 1.3		

RIG: Bobcat **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 2.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.4m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3
PROJECT No: 210589.00
DATE: 2-12-2021
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
61		SANDSTONE: medium grained, pale brown to grey, high strength, slightly weathered, slightly fractured, Hawkesbury Sandstone *(continued)*		C	10.95		PL(A) = 2		
11	11.0	SANDSTONE: medium grained, pale brown to pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone			11.5				11 Gravel 7.0-15.0m
60					11.95		PL(A) = 1.3		
12					12.5		PL(A) = 0.95		12 Machine slotted PVC screen 9.0-15.0m
59				C	12.95		PL(A) = 1.1		
13									13
58					13.95		PL(A) = 1.6		
14					14.5				14
57				C	14.95		PL(A) = 1.9		
15	15.0	Bore discontinued at 15.0m			15.0				15 End cap
56									
16									16
55									
17									17
54									
18									18
53									
19									19
52									

RIG: Bobcat **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 2.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.4m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
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West Ryde NSW 2114
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West Ryde NSW 1685
Phone (02) 9809 0666
Fax (02) 9809 4095

Permeability Testing - Simple Slug Test Report

Client:	Aqualand Projects Pty Ltd	Project No:	210589
Project:	Proposed Residential Development	Date:	21-Dec-21
Location:	12-20 Berry Rd & 11-19 Holdsworth Ave	Tested by:	AT

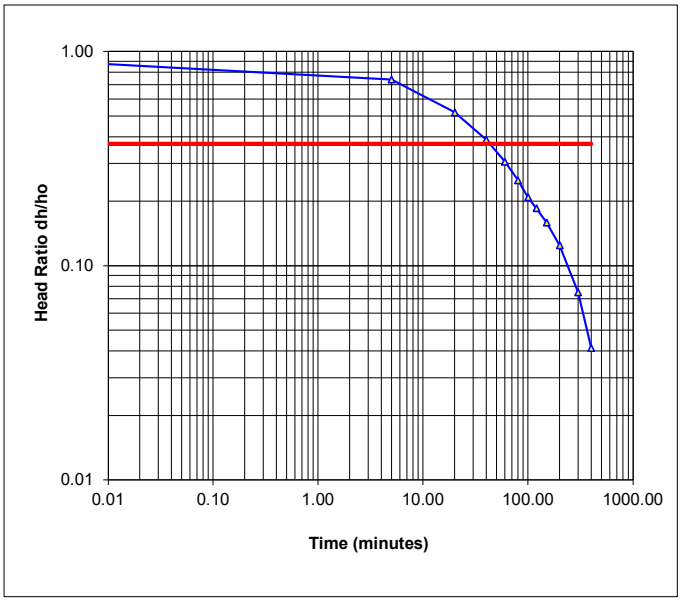
Test Location		**Test No.**	BH3	
Description:	Property of 16 Berry St, St Leonards	Easting:	332723	m
Material type:	Clay over Sandstone	Northing	6255620	m
		Surface Level:	71.5	m AHD

Details of Well Installation

Well casing diameter	50	mm	Depth to water before test	13	m
Well screen diameter	96	mm	Depth to water at start of test	0.88	m
Length of well screen	6.5	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.00	0.88	11.24	0.927
5.00	3.16	8.96	0.739
20.00	5.82	6.3	0.520
40.00	7.43	4.69	0.387
60.00	8.41	3.71	0.306
80.00	9.08	3.04	0.251
100.00	9.59	2.53	0.209
120.00	9.87	2.25	0.186
150.00	10.19	1.93	0.159
200.00	10.61	1.51	0.125
300.00	11.21	0.91	0.075
400.00	11.62	0.5	0.041
			0.000
			0.000
			0.000
			0.000
			0.000
			0.000
			0.000
			0.000
			0.000
			0.000
			0.000
			0.000
			0.000



To = 45 mins
2700 secs

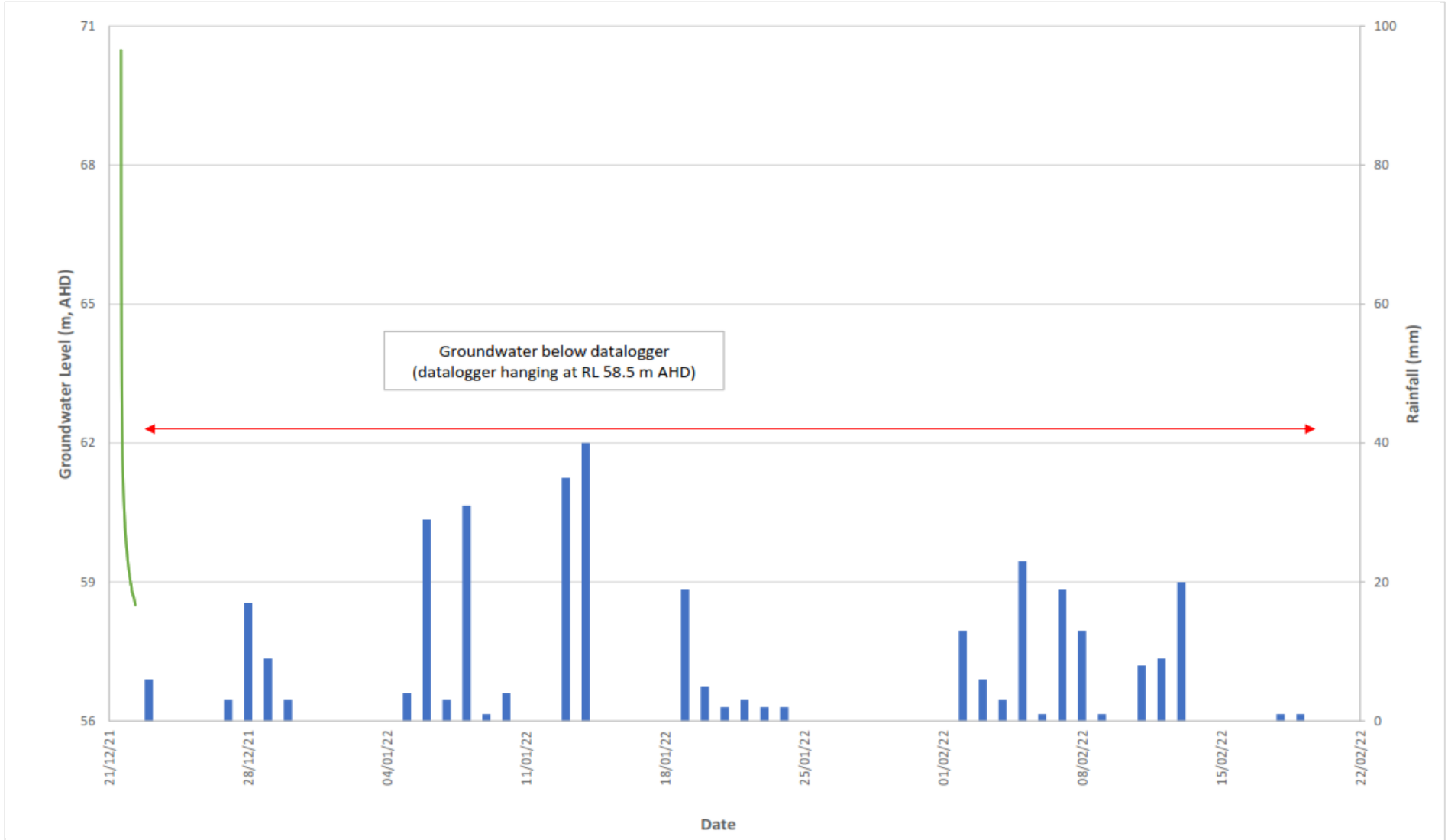
Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**8.7E-08**	m/sec
	=	**0.031**	cm/hour

BH3



Douglas Partners
Geotechnics / Environment / Groundwater

Manual Levels
Water Level
Rainfall data (ST: 066011)

Date:	From	Drawn:
16-06-22	21-12-21	TM
Project:	**To**	**Checked:**
210589.00	22-02-22	AT

BORE: BH3A PROJECT: ST LEONARDS MARCH 2022

15.00 – 20.00m

BORE: BH3A PROJECT: ST LEONARDS MARCH 2022

20.00 – 20.87m

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3A
PROJECT No: 210589.00
DATE: 28-3-2022
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
71	0	PCD to 15.0m depth										
	1											
70												
	2											
69												
	3											
68												
	4											
67												
	5											
66												
	6											
65												
	7											
64												
	8											
63												
	9											
62												

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.75m, HQ to 15.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.1m, PCD to 15.0, NMLC Coring to 20.87m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.87m (screen 14.87m-20.87m, PVC 0.0m-14.87m, Gravel 14.00m-20.87m, Bentonite 12.90m-14.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3A
PROJECT No: 210589.00
DATE: 28-3-2022
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
61	11	PCD to 15.0m depth *(continued)*										
60	12											
59	13											
58	14											
57	15											
56	15.0	SANDSTONE: fine to medium grained, pale grey, cross bedding dipping 0°-10°, thinly bedded, high strength, fresh, fractured										
55	16							15.84m: B5°, pl, ro, patchy cly vn 15.91m: B0°, pl, ro, cln 16.2m: B0°, pl, ro, cln 16.21m: B0°, pl, ro, cln	C	100	97	PL(A) = 1.1 PL(A) = 2.5
54	17							17.09m: B10°, pl, ro, cly vn 17.26m: B10°, pl, ro, cly vn 17.48m: B10°, pl, ro, patchy cly vn				PL(A) = 2.2
53	18							18.08-18.12m: Ds 40mm				PL(A) = 1.94 PL(A) = 1.7
52	19							18.75m: B20°, pl, ro, cln 18.83-18.88m: Ds 50mm 19.22m: B0°, pl, ro, cbs	C	100	91	PL(A) = 1.3 PL(A) = 1
	20.0											PL(A) = 1.4

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.75m, HQ to 15.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.1m, PCD to 15.0, NMLC Coring to 20.87m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.87m (screen 14.87m-20.87m, PVC 0.0m-14.87m, Gravel 14.00m-20.87m, Bentonite 12.90m-14.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3A
PROJECT No: 210589.00
DATE: 28-3-2022
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
51		as above						20.04m: J30°, pl, ro, cly vn	C	100	91	PL(A) = 2.1
	20.87	Bore discontinued at 20.87m - Target depth reached										
50	21											
49	22											
48	23											
47	24											
46	25											
45	26											
44	27											
43	28											
42	29											

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.75m, HQ to 15.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.1m, PCD to 15.0, NMLC Coring to 20.87m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.87m (screen 14.87m-20.87m, PVC 0.0m-14.87m, Gravel 14.00m-20.87m, Bentonite 12.90m-14.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3A
PROJECT No: 210589.00
DATE: 28-3-2022
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
71	0	PCD to 15.0m depth							Gatic cover
	1								
70	2								
69	3								
68	4								
67	5								
66	6								
65									Backfill 0.0-12.9m
64	7								
63	8								
62	9								Blank pipe 0.0-14.87m

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.75m, HQ to 15.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.1m, PCD to 15.0, NMLC Coring to 20.87m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.87m (screen 14.87m-20.87m, PVC 0.0m-14.87m, Gravel 14.00m-20.87m, Bentonite 12.90m-14.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3A
PROJECT No: 210589.00
DATE: 28-3-2022
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		PCD to 15.0m depth *(continued)*							
61	11								11
60	12								12
59	13								13
58									Bentonite 12.9-14.0m
57	14								14
56	15 15.0	SANDSTONE: fine to medium grained, pale grey, cross bedding dipping 0°-10°, thinly bedded, high strength, fresh, fractured			15.0				15
					15.79		PL(A) = 1.1		
	16				15.95		PL(A) = 2.5		16
55				C					
	17				16.95		PL(A) = 2.2		17
54									Gravel 14.0-20.87m
					17.84		PL(A) = 1.94		Machine slotted PVC screen 14.87-20.87m
	18				17.95		PL(A) = 1.7		18
					18.0				
53					18.57		PL(A) = 1.3		
					18.81		PL(A) = 1		
	19			C					19
52	20.0				19.95		PL(A) = 1.4		

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.75m, HQ to 15.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.1m, PCD to 15.0, NMLC Coring to 20.87m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.87m (screen 14.87m-20.87m, PVC 0.0m-14.87m, Gravel 14.00m-20.87m, Bentonite 12.90m-14.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332723
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH3A
PROJECT No: 210589.00
DATE: 28-3-2022
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
51		as above		C	20.82		PL(A) = 2.1		End cap
	20.87				20.87				
	21	Bore discontinued at 20.87m - Target depth reached							
50	22								
49	23								
48	24								
47	25								
46	26								
45	27								
44	28								
43	29								
42									

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.75m, HQ to 15.0m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.1m, PCD to 15.0, NMLC Coring to 20.87m

WATER OBSERVATIONS: No free groundwater observed whilst augering

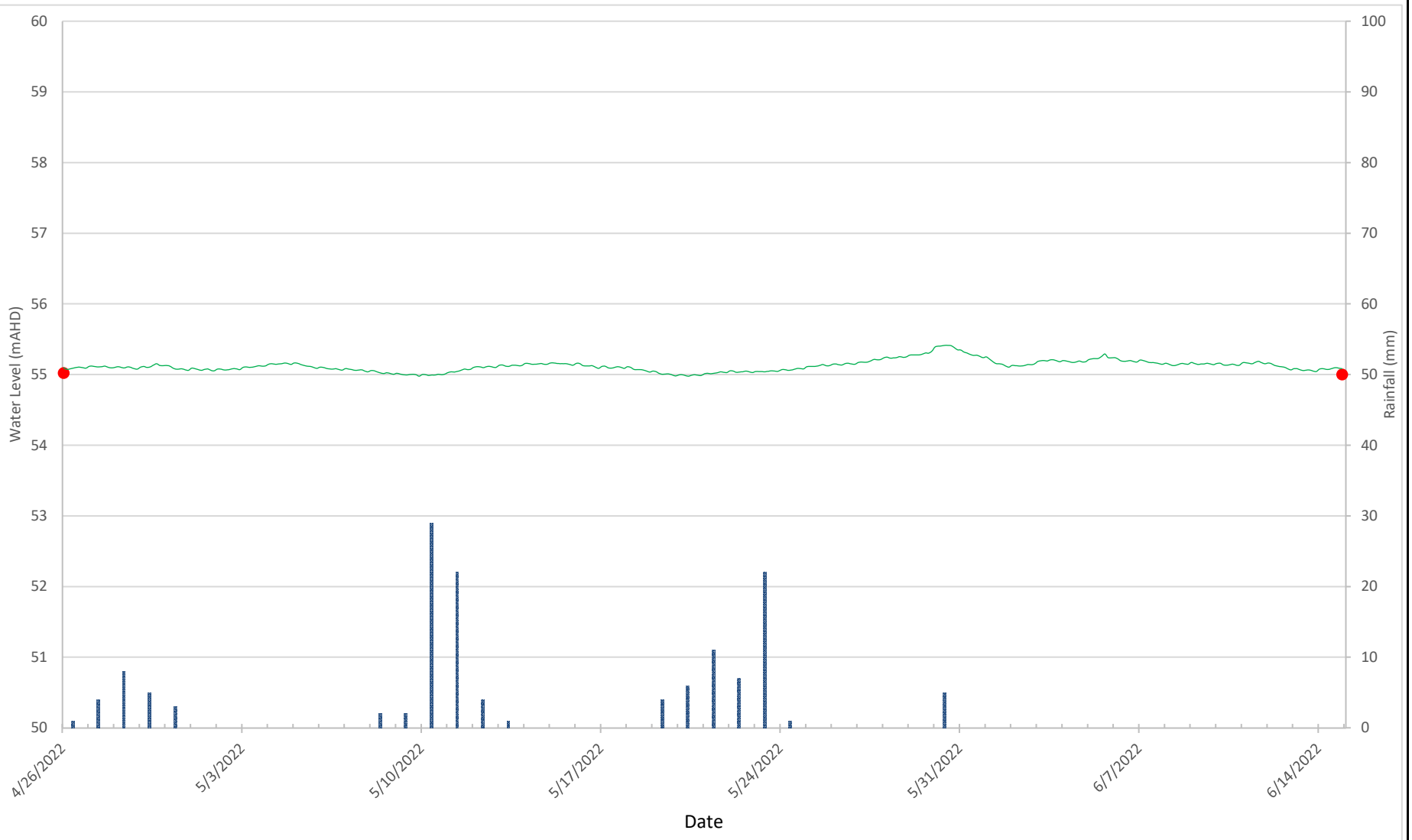
REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.87m (screen 14.87m-20.87m, PVC 0.0m-14.87m, Gravel 14.00m-20.87m, Bentonite 12.90m-14.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BH3A



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Manual Levels
Water Level
Rainfall data (ST: 066011)

Date: 16-06-22	**From** 26-04-22	**Drawn:** TM
Project: 210589.00	**To** 15-06-22	**Checked:** AT

BORE: BH4 PROJECT: ST LEONARDS DECEMBER 2021

2.60 – 5.00m

BORE: BH4 PROJECT: ST LEONARDS DECEMBER 2021

5.00 – 10.00m

BORE: BH4 PROJECT: ST LEONARDS DECEMBER 2021

10.00 – 15.00m

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.8 AHD
EASTING: 332776
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 210589.00
DATE: 16-12-2021
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
69	0.04	ASPHALTIC CONCRETE										
	0.1	FILLING/Gravelly SAND: medium to coarse, grey to grey-brown, dark grey igneous and concrete gravels, dry to moist, apparently well compacted							A			
									A			
1	1.0	Silty CLAY CI: medium plasticity, pale grey to brown, trace sand and ironstone gravel, w<PL, appears stiff to very stiff							S			13,15,17 N = 32
68		Sandy CLAY CL-CI: low to medium plasticity, pale brown to pale red-brown, with ironstone gravels, very stiff to hard, weathered bedrock.										
2	2.0	SANDSTONE: medium grained, pale grey and pale brown to red-brown, very low strength with some hard clay and medium strength iron indurated bands, highly to moderately weathered, highly fractured, Hawkesbury Sandstone						Unless stated otherwise defects are: B0-15°, pl, ro, cly vn or cln or fe st	S			20/100 refusal
67												PL(A) = 0.06
3								3.16m: CORE LOSS: 380mm				
	3.54								C	74	53	PL(A) = 0.08
66												
4	4.17	SANDSTONE: fine to medium grained, pale grey to grey, medium to high strength, slightly weathered, fractured, Hawkesbury Sandstone						4m: CORE LOSS: 170mm 4.17m: B0-10°, pl, ro, cly 30mm 4.26m: B0-10°, pl, ro, cly 15mm 4.34m: B0-10°, pl, ro, cly co 4.66m: B0-10°, pl, ro, cly 15mm 4.73m: B0-10°, pl, ro, cly co 4.78m: B0-10°, pl, ro, cly co				PL(A) = 0.9
65												PL(A) = 1.3
5	5.0	SANDSTONE: fine to medium grained, pale brown and grey, medium to high strength, fresh, unbroken, Hawkesbury Sandstone										
64									C	100	96	PL(A) = 0.88
6												PL(A) = 1.2
63												
7								6.96m: B0-10°, pl, ro, cly 20mm				
62												PL(A) = 0.92
8	8.0	SANDSTONE: fine to medium grained, pale grey and pale brown, high strength, fresh, unbroken, Hawkesbury Sandstone							C	100	100	
61												PL(A) = 1.4
9												
60												PL(A) = 1

RIG: Bobcat **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 2.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.5m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.8 AHD
EASTING: 332776
NORTHING: 6255620
DIP/AZIMUTH: 90°/--

BORE No: BH4
PROJECT No: 210589.00
DATE: 16-12-2021
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
59	11	SANDSTONE: fine to medium grained, pale grey and pale brown, high strength, fresh, unbroken, Hawkesbury Sandstone *(continued)*										PL(A) = 1.5
58	12								C	100	100	PL(A) = 1.2
57	12.32	SANDSTONE: medium to coarse grained, pale grey to pale brown, massive, high strength, fresh, unbroken, Hawkesbury Sandstone										PL(A) = 1.2
56	13											
55	14								C	100	100	PL(A) = 1
	15 15.0	Bore discontinued at 15.0m										PL(A) = 1.1
54	16											
53	17											
52	18											
51	19											
50												

RIG: Bobcat **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 2.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.5m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

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BORE: BH5 PROJECT: ST LEONARDS DECEMBER 2021

2.80 – 7.00m

BORE: BH5 PROJECT: ST LEONARDS DECEMBER 2021

7.00 – 12.00m

BORE: BH5 PROJECT: ST LEONARDS DECEMBER 2021

12.00 – 15.00m

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332693
NORTHING: 6255609
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 210589.00
DATE: 3-12-2021
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
71	0.25	TOPSOIL/Silty CLAY: low to medium plasticity, dark grey to brown, trace rootlets and sand							A			
		CLAY CI-CH: medium to high plasticity, brown mottled pale grey, w<PL, firm to stiff, residual							A			
70	1	below 1.0m: becoming stiff to very stiff, w~PL							S			3,7,10 N = 17
69	2.0	CLAY CI-CH: medium to high plasticity, pale brown and pale grey, trace ironstone gravel, w<PL, hard, weathered Hawkesbury Sandstone, residual						Unless stated otherwise defects are: B0-15°, pl, ro, cly vn or cln or fe st				
	2.4								S			9,12,20/80 refusal
68	3	SANDSTONE: fine to medium grained, pale grey and red-brown, very low strength with hard clay and medium strength iron indurated bands, highly weathered, highly fractured, Hawkesbury Sandstone							C	91	0	PL(A) = 0.22
	4							4.07m: CORE LOSS: 150mm				
67	4.22	SANDSTONE: fine to medium grained, red-brown to grey-brown, medium strength with hard clay and low to high strength iron indurated bands, highly to moderately weathered, highly fractured, Hawkesbury Sandstone										PL(A) = 0.89
66	5								C	100	72	PL(A) = 0.56
65	6											PL(A) = 0.33
	6.2	SANDSTONE: fine to medium grained, pale grey and pale brown, medium strength, slightly weathered, fractured to highly fractured, Hawkesbury Sandstone										
64	7							7.53m: J60°, pl, ro, fe stn,				PL(A) = 0.3
63	8							8.17m: J50-80°, pl, ro, fe stn, 8.47m: J70°, pl, ro, fe stn, 8.7m: Cs, 70mm	C	100	96	
	8.8	SANDSTONE: fine to medium grained, pale brown and pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone										PL(A) = 1.3
62	9											PL(A) = 1

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.0m, HQ to 2.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.6m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 71.5 AHD
EASTING: 332693
NORTHING: 6255609
DIP/AZIMUTH: 90°/--

BORE No: BH5
PROJECT No: 210589.00
DATE: 3-12-2021
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
61	11	SANDSTONE: fine to medium grained, pale brown and pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone *(continued)*						11.05m: B0-10°, pl, ro, cly 20mm	C	100	100	PL(A) = 1.6
60	12											PL(A) = 2.1
59	13							12.91m: B0-10°, pl, ro, cly 2mm				PL(A) = 1.3
58	14								C	100	100	PL(A) = 1.9
57	15 15.0											PL(A) = 1.7
		Bore discontinued at 15.0m										
56	16											
55	17											
54	18											
53	19											
52												

RIG: GT205 **DRILLER:** GT **LOGGED:** AN **CASING:** HW to 1.0m, HQ to 2.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 2.6m, NMLC to 15.0m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

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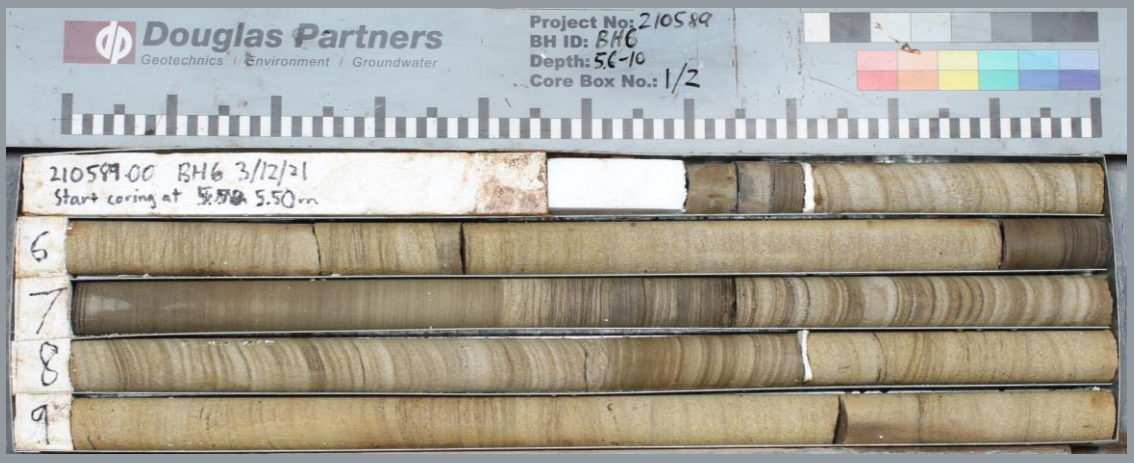
BORE: BH6 PROJECT: ST LEONARDS DECEMBER 2021



5.50 – 10.00m

BORE: BH6 PROJECT: ST LEONARDS DECEMBER 2021

7.00 – 12.00m

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 210589.00
DATE: 3-12-2021
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.07	CONCRETE PAVERS										
69		Silty CLAY CI-CH: medium to high plasticity, red-brown, trace sand, w<PL, stiff to hard, residual							D			
									D			
68	1								D			
									S			9,17,31 N = 48
67	2											
	2.0	CLAY CL-CI: low to medium plasticity, red - pale grey mottled, trace of silt, wtih ironstone bands, w<PL, hard, residual							D			
									S			14,21/60 refusal
66	3											
	3.0	SANDSTONE: fine to medium grained, red brown and pale grey, with hard clay and medium to high strength iron indurated bands, Hawkesbury Sandstone										
	4								D			
65									S			9,18,20/20 refusal
	5											
64									D			
	5.6	SANDSTONE: fine to medium grained, pale grey-brown to grey, medium to high strength, fresh, slightly fractured, Hawkesbury Sandstone						5.6m: Cs, 100mm				PL(A) = 1.5
	6							6.37m: B5°, cly co, 2mm				
63								6.89m: B0-10°, pl, ro, cly 5mm	C	100	96	PL(A) = 0.88
	7							7.63m: B0-10°, pl, ro, cly 3mm				PL(A) = 1.4
62												
	8							8.5m: B0-10°, pl, ro, cly co				
61	8.7	SANDSTONE: fine to medium grained, pale grey-brown and grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone										PL(A) = 1.6
	9								C	100	98	
60												PL(A) = 1.2

RIG: TT305 **DRILLER:** Terratest **LOGGED:** AN **CASING:** HQ to 5.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 5.5m, NMLC to 14.7m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 210589.00
DATE: 3-12-2021
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
59	11	SANDSTONE: fine to medium grained, pale grey-brown and grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone *(continued)*						11.16m: B0-10°, pl, ro, cly 5mm	C	100	98	PL(A) = 1.2
58	12											PL(A) = 1.4
57	12.9							>>				
56	13	SANDSTONE: fine to medium grained, pale grey, massvive with dark grey siltstone flecks, fresh, unbroken, Hawkesbury Sandstone							C	100	99	PL(A) = 1.5
55	14											PL(A) = 2.8
	14.7	Bore discontinued at 14.7m						14.5m: J40-50°, pl, ro, cly co				
54	15											
53	16											
52	17											
51	18											
50	19											

RIG: TT305 **DRILLER:** Terratest **LOGGED:** AN **CASING:** HQ to 5.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 5.5m, NMLC to 14.7m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 210589.00
DATE: 3-12-2021
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
69	0.07	CONCRETE PAVERS		D	0.1–0.2				Gatic Cover
		Silty CLAY CI-CH: medium to high plasticity, red-brown, trace sand, w<PL, stiff to hard, residual		D	0.4–0.5				Blank pipe 0.0-7.5m
	1			D	0.9–1.0				
68				S	1.45		9,17,31 N = 48		
	2.0	CLAY CL-CI: low to medium plasticity, red - pale grey mottled, trace of silt, wtih ironstone bands, w<PL, hard, residual		D	2.4–2.5				
67				S	2.71		14,21/60 refusal		
	3.0	SANDSTONE: fine to medium grained, red brown and pale grey, with hard clay and medium to high strength iron indurated bands, Hawkesbury Sandstone							Bentonite 0.1-7.0m
66				D	3.9–4.0				
				S	4.32		9,18,20/20 refusal		
65									
64				D	5.4–5.5–5.6				
	5.6	SANDSTONE: fine to medium grained, pale grey-brown to grey, medium to high strength, fresh, slightly fractured, Hawkesbury Sandstone			5.95		PL(A) = 1.5		
63				C	6.95		PL(A) = 0.88		
62					7.95		PL(A) = 1.4		
61	8.7	SANDSTONE: fine to medium grained, pale grey-brown and grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone		C	8.7–8.95		PL(A) = 1.6		
60					9.95		PL(A) = 1.2		

RIG: TT305 **DRILLER:** Terratest **LOGGED:** AN **CASING:** HQ to 5.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 5.5m, NMLC to 14.7m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6
PROJECT No: 210589.00
DATE: 3-12-2021
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
59	11	SANDSTONE: fine to medium grained, pale grey-brown and grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone *(continued)*		C	10.95		PL(A) = 1.2		Machine slotted PVC screen 7.5-13.5m Gravel 7.0-15.0m
58					11.7				
57	12				11.95		PL(A) = 1.4		
56	12.9 13	SANDSTONE: fine to medium grained, pale grey, massvive with dark grey siltstone flecks, fresh, unbroken, Hawkesbury Sandstone		C	12.95		PL(A) = 1.5		End cap
55	14				13.95		PL(A) = 2.8		
	14.7	Bore discontinued at 14.7m			14.7				
54	15								
53	16								
52	17								
51	18								
50	19								

RIG: TT305 **DRILLER:** Terratest **LOGGED:** AN **CASING:** HQ to 5.5m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 5.5m, NMLC to 14.7m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56.

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

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Permeability Testing - Simple Slug Test Report

Client:	Aqualand Projects Pty Ltd	Project No:	210589
Project:	Proposed Residential Development	Date:	21-Dec-21
Location:	12-20 Berry Rd & 11-19 Holdsworth Ave	Tested by:	AT

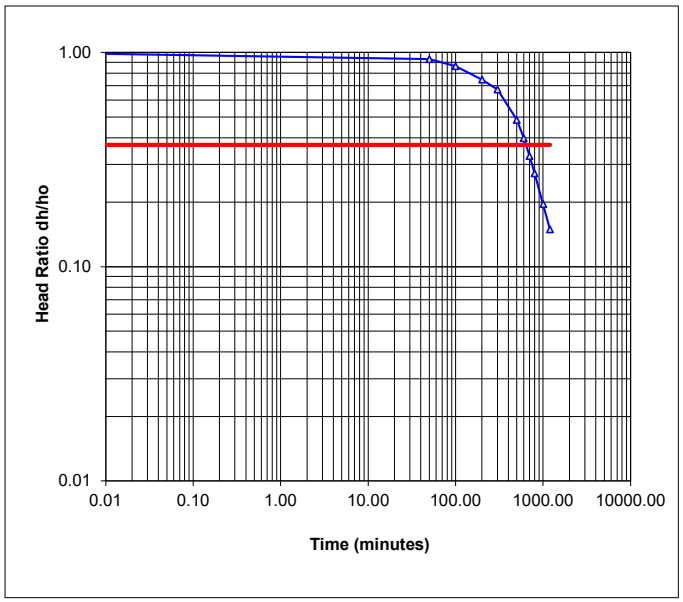
Test Location		**Test No.**	BH6	
Description:	Property of 19 Holdsworth Ave, St Leonards	Easting:	332762	m
Material type:	Clay over Sandstone	Northing	6255600	m
		Surface Level:	69.4	m AHD

Details of Well Installation

Well casing diameter	50	mm	Depth to water before test	8.76	m
Well screen diameter	96	mm	Depth to water at start of test	11.77	m
Length of well screen	6.5	m			

Test Results

Time (min)	Depth (m)	Change in Head δH (m)	δH/Ho
0.00	0.00	3.01	1.000
50.00	0.21	2.8	0.930
100.00	0.41	2.6	0.864
200.00	0.76	2.25	0.748
300.00	0.99	2.02	0.671
500.00	1.55	1.46	0.485
600.00	1.81	1.2	0.399
700.00	2.02	0.99	0.329
800.00	2.19	0.82	0.272
1000.00	2.42	0.59	0.196
1200.00	2.56	0.45	0.150



To = 600 mins
36000 secs

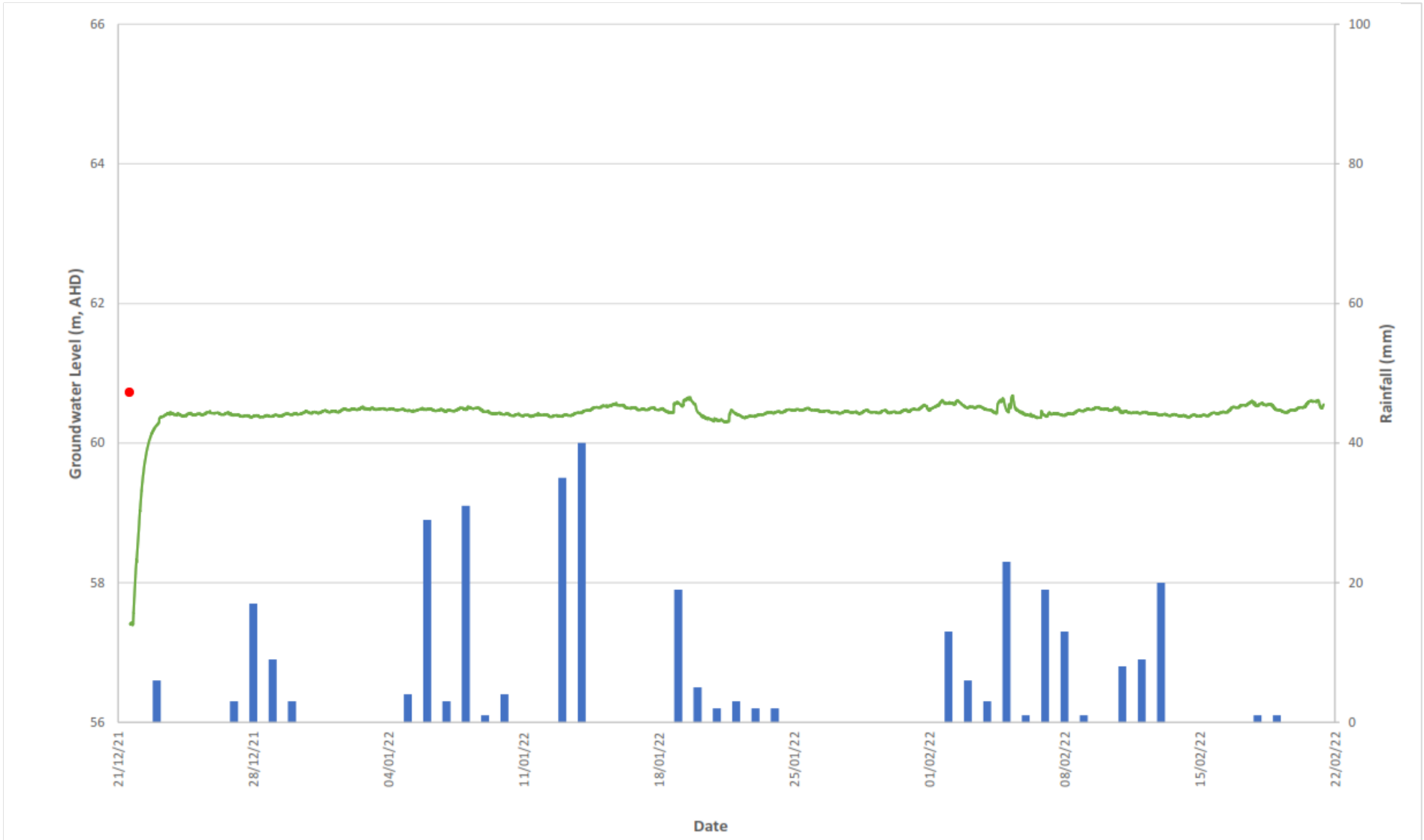
Theory: Falling Head Permeability calculated using equation by Hvorslev

$k = [r^2 \ln(Le/R)]/2Le\ To$

where r = radius of casing
R = radius of well screen
Le = length of well screen
To = time taken to rise or fall to 37% of initial change

Hydraulic Conductivity	**k =**	**6.6E-09**	m/sec
	=	**0.002**	cm/hour

BH6



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Date:	From	Drawn:
16-06-22	26-04-22	TM
Project:	**To**	**Checked:**
210589.00	15-06-22	AT

BORE: BH6A PROJECT: ST LEONARDS MARCH 2022

14.40 – 18.00m

BORE: BH6A PROJECT: ST LEONARDS MARCH 2022

18.00 – 20.36m

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6A
PROJECT No: 210589.00
DATE: 12-4-2022
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
69	0	PCD to 14.4m										
68	1											
67	2											
66	3											
65	4											
64	5											
63	6											
62	7											
61	8											
60	9											

RIG: GT205 **DRILLER:** GT **LOGGED:** TM **CASING:** HWT to 1.0m, HQ to 14.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.4m, NMLC Coring to 20.36m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.36m (screen 14.36m-20.36m, PVC 0.0m-14.36m, Gravel 13.00m-20.36m, Bentonite 12.00m-13.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6A
PROJECT No: 210589.00
DATE: 12-4-2022
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding J - Joint S - Shear F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		PCD to 14.4m *(continued)*										
59	11											
58	12											
57	13											
56	14											
55	14.4	SANDSTONE: medium to coarse, pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone										PL(A) = 0.98
54	15							15.2m: B10, Pl, ro, cly 1mm				PL(A) = 1.2
53	16								C	100	100	PL(A) = 1.3
52	17							16.8m: B10, pl, ro, cly 2mm 17.27m: J60, pl, ro, cln				PL(A) = 1.7
51	18	Below 17.9m: with some siltstone clasts and laminations							C	100	98	PL(A) = 1.5
50	19											PL(A) = 0.59
	19.1	SILTSTONE: grey to dark grey, with 5% fine grained pale grey sandstone laminations, high strength, fresh, slightly fractured, Ashfield Shale						19.08m: Cs 20mm 19.25m: J70, pl, ti 19.48m: Cs Ds 30mm				PL(A) = 1.2
	20.0											

RIG: GT205 **DRILLER:** GT **LOGGED:** TM **CASING:** HWT to 1.0m, HQ to 14.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.4m, NMLC Coring to 20.36m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.36m (screen 14.36m-20.36m, PVC 0.0m-14.36m, Gravel 13.00m-20.36m, Bentonite 12.00m-13.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6A
PROJECT No: 210589.00
DATE: 12-4-2022
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		as above							C	100	98	PL(A) = 1.7
49	20.36	Bore discontinued at 20.36m - Target depth reached										
	21											
48												
	22											
47												
	23											
46												
	24											
45												
	25											
44												
	26											
43												
	27											
42												
	28											
41												
	29											
40												

RIG: GT205 **DRILLER:** GT **LOGGED:** TM **CASING:** HWT to 1.0m, HQ to 14.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.4m, NMLC Coring to 20.36m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.36m (screen 14.36m-20.36m, PVC 0.0m-14.36m, Gravel 13.00m-20.36m, Bentonite 12.00m-13.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6A
PROJECT No: 210589.00
DATE: 12-4-2022
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
69	0	PCD to 14.4m							Gatic cover; Cement 0.0-0.5m
68	1								
67	2								
66	3								
65	4								
64	5								
63	6								Backfill 0.5-12.0m
62	7								
61	8								
60	9								Blank pipe 0.0-14.36m

RIG: GT205 **DRILLER:** GT **LOGGED:** TM **CASING:** HWT to 1.0m, HQ to 14.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.4m, NMLC Coring to 20.36m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.36m (screen 14.36m-20.36m, PVC 0.0m-14.36m, Gravel 13.00m-20.36m, Bentonite 12.00m-13.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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

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BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6A
PROJECT No: 210589.00
DATE: 12-4-2022
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		PCD to 14.4m *(continued)*							
59	11								11
58	12								12
57									Bentonite 12.0-13.0m
	13								13
56	14								14
55	14.4	SANDSTONE: medium to coarse, pale grey, high strength, fresh, slightly fractured to unbroken, Hawkesbury Sandstone			14.4				
					14.6		PL(A) = 0.98		
	15				15.0		PL(A) = 1.2		15
54				C					
	16				16.0		PL(A) = 1.3		16
53									Gravel 13.0-20.36m
	17				17.0		PL(A) = 1.7		17
52					17.4				Machine slotted PVC screen 14.36-20.36m
	18	Below 17.9m: with some siltstone clasts and laminations			18.0		PL(A) = 1.5		18
51				C					
	19				19.0		PL(A) = 0.59		19
50	19.1	SILTSTONE: grey to dark grey, with 5% fine grained pale grey sandstone laminations, high strength, fresh, slightly fractured, Ashfield Shale			19.4		PL(A) = 1.2		
	20.0								

RIG: GT205 **DRILLER:** GT **LOGGED:** TM **CASING:** HWT to 1.0m, HQ to 14.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.4m, NMLC Coring to 20.36m

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REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.36m (screen 14.36m-20.36m, PVC 0.0m-14.36m, Gravel 13.00m-20.36m, Bentonite 12.00m-13.00m, Spoil to 0.5m, cement and gatic cover at top)

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BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Aqualand Projects Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: 12-20 Berry Rd & 11-19 Holdsworth Ave, St Leonards

SURFACE LEVEL: 69.4 AHD
EASTING: 332762
NORTHING: 6255600
DIP/AZIMUTH: 90°/--

BORE No: BH6A
PROJECT No: 210589.00
DATE: 12-4-2022
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		as above		C	20.2		PL(A) = 1.7		
49	20.36	Bore discontinued at 20.36m - Target depth reached			20.36				End cap
	21								
48									
	22								
47									
	23								
46									
	24								
45									
	25								
44									
	26								
43									
	27								
42									
	28								
41									
	29								
40									

RIG: GT205 **DRILLER:** GT **LOGGED:** TM **CASING:** HWT to 1.0m, HQ to 14.4m

TYPE OF BORING: Solid Flight Auger (TC-bit) to 1.0m, PCD to 14.4m, NMLC Coring to 20.36m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: Location coordinates are in MGA94 Zone 56. Standpipe installed to 20.36m (screen 14.36m-20.36m, PVC 0.0m-14.36m, Gravel 13.00m-20.36m, Bentonite 12.00m-13.00m, Spoil to 0.5m, cement and gatic cover at top)

SAMPLING & IN SITU TESTING LEGEND

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C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
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E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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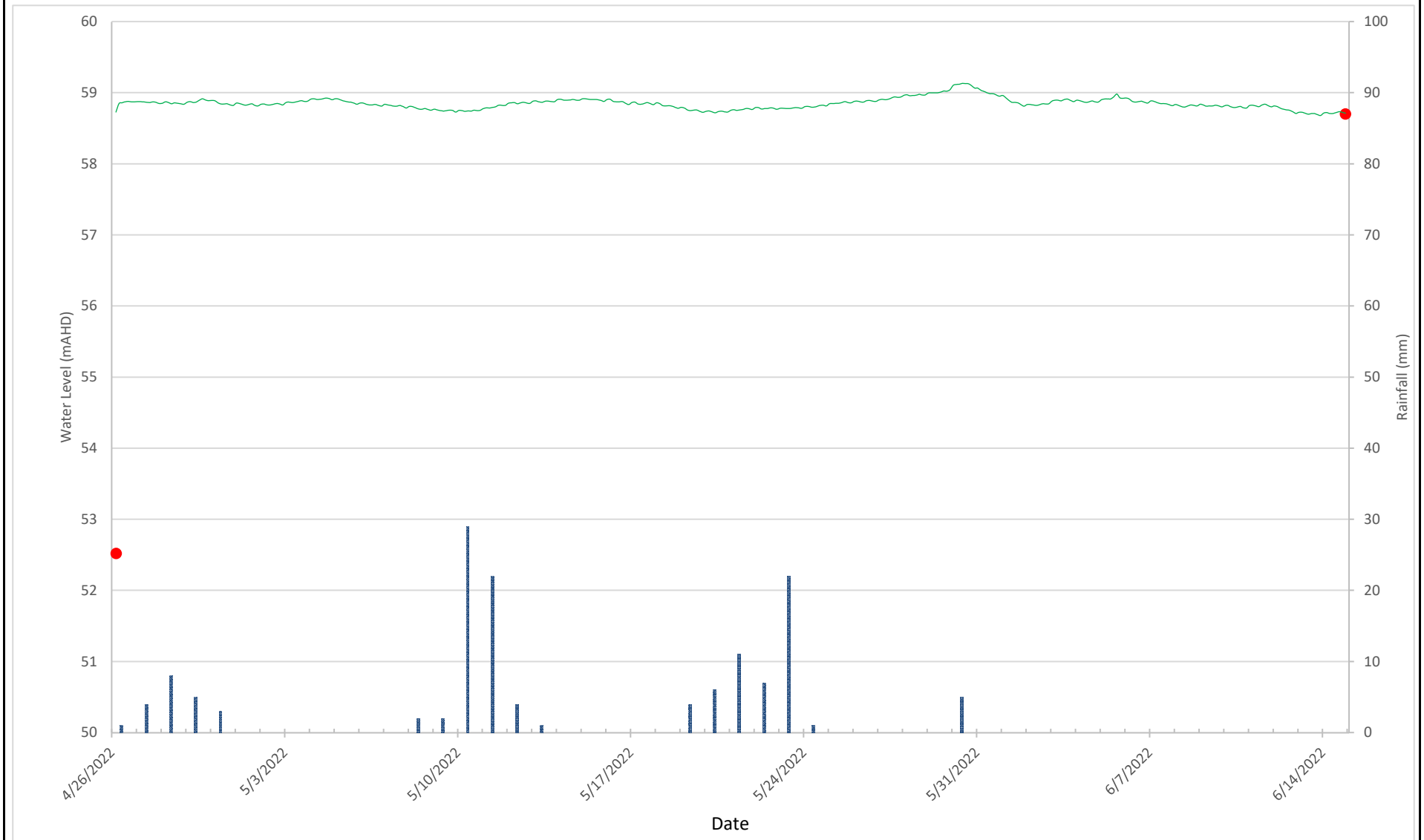
BH6A



Douglas Partners
Geotechnics / Environment / Groundwater

Manual Levels
Water Level
Rainfall data (ST: 066011)

Date:	From	Drawn:
16-06-22	26-04-22	TM
Project:	**To**	**Checked:**
210589.00	15-06-22	AT

Appendix D

Laboratory Test Results

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 286395

Client Details

Client	Douglas Partners Pty Ltd
Attention	Adam Teoh
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**210589, St Leonards**
Number of Samples	6 Soil
Date samples received	10/01/2022
Date completed instructions received	10/01/2022

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Report Details

Date results requested by	17/01/2022
Date of Issue	17/01/2022

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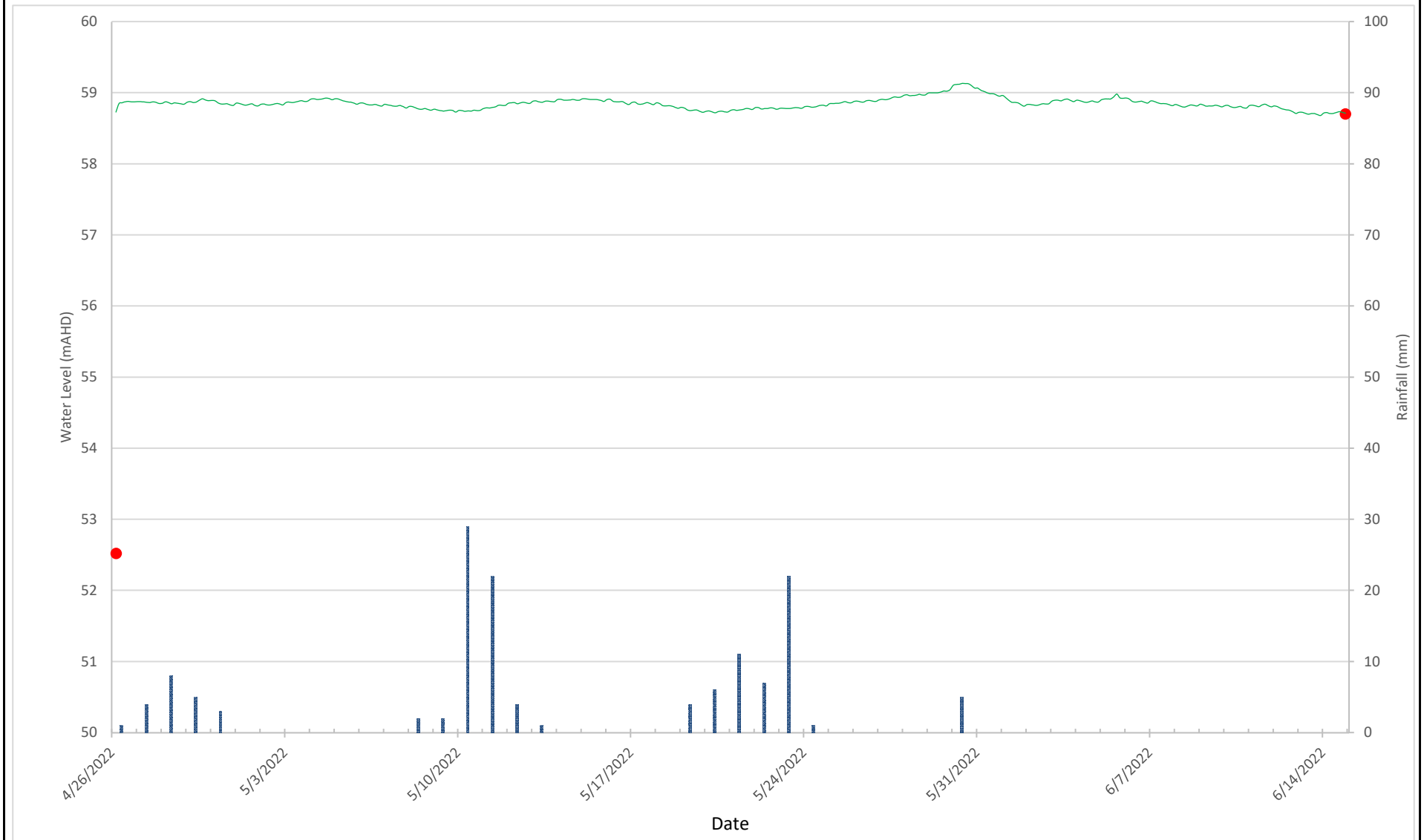
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

BH6A



Douglas Partners
Geotechnics / Environment / Groundwater

Manual Levels — Water Level

Rainfall data (ST: 066011)

Date:	From	Drawn:
16-06-22	26-04-22	TM
Project:	**To**	**Checked:**
210589.00	15-06-22	AT

Soil Aggressivity						
Our Reference		286395-1	286395-2	286395-3	286395-4	286395-5
Your Reference	UNITS	BH1	BH2	BH3	BH4	BH5
Depth		0.9-1.0	0.4-0.5	0.4-0.5	2.4-2.5	1.0-1.45
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	5.5	4.7	6.0	5.0	5.4
Electrical Conductivity 1:5 soil:water	µS/cm	100	32	28	25	19
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	170	34	<10	23	20

Soil Aggressivity		
Our Reference		286395-6
Your Reference	UNITS	BH6
Depth		4.0-4.3
Type of sample		Soil
pH 1:5 soil:water	pH Units	5.0
Electrical Conductivity 1:5 soil:water	µS/cm	53
Chloride, Cl 1:5 soil:water	mg/kg	21
Sulphate, SO4 1:5 soil:water	mg/kg	58

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Soil Aggressivity						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	286395-2
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	5.5	5.5	0	101	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	100	94	6	100	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	105	98
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	170	160	6	92	118

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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