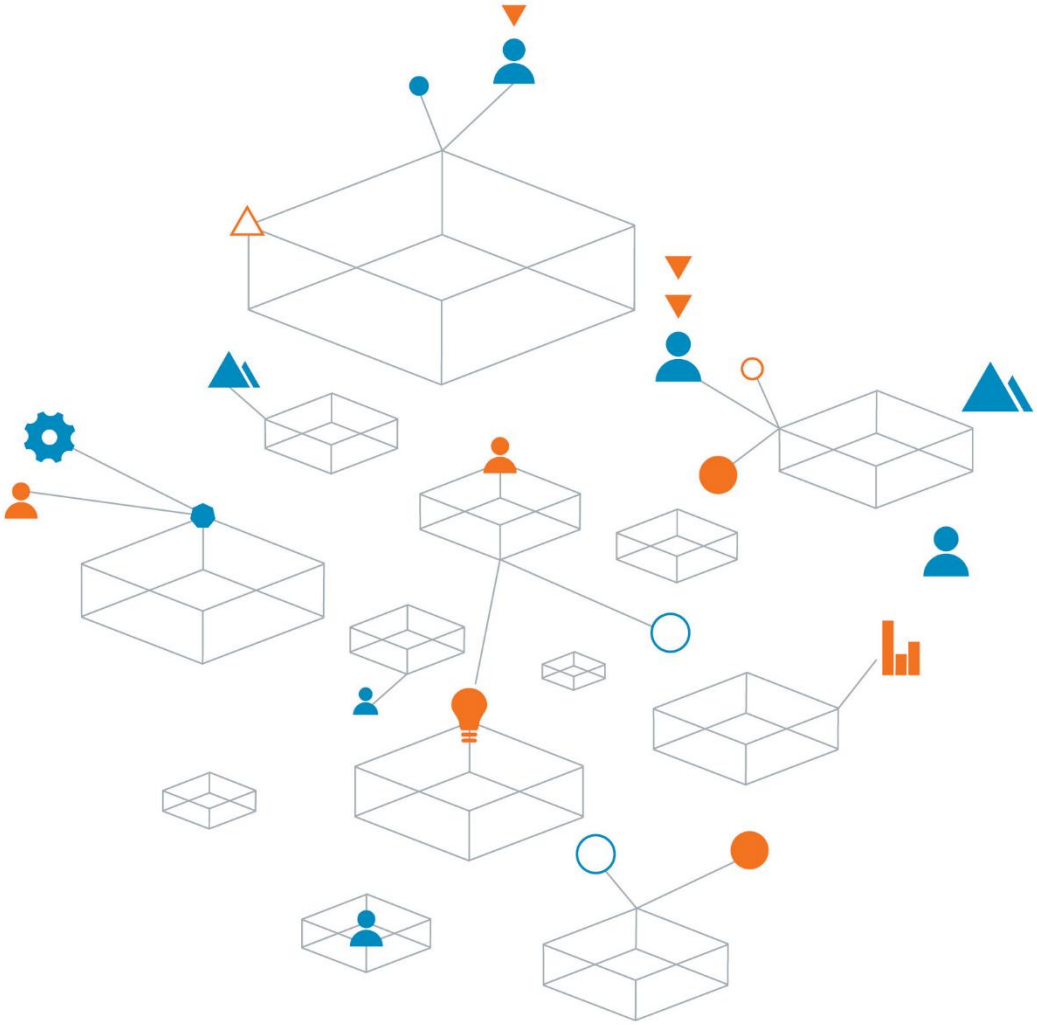
Area 23
St Leonards Development
SYDGE219558-GET-RPT-02
Geotechnical Assessment Report

30 August 2022



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Area 23: St Leonards Development

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1. Introduction

This report presents the results of a geotechnical investigation carried out for the proposed Area 23 St Leonards residential development in Sydney. The geotechnical investigation was commissioned by Berry Road Development Pty Ltd and was carried out in general accordance with Coffey fee proposal (Ref: SYDGE219558AA dated 14 June 2018). The objective of this investigation was to provide geotechnical information to support planning and design of the proposed development.

It is understood that the proposed development involves the construction of multi-unit residential buildings up to 13-storey high and residential amenities with underground car parking. At the time when this report was prepared the architectural design is still under development and with no firm details of the intended development.

2. Site Description

The site currently comprises 19 individual houses with several sheds, swimming pools and large trees within an area of 6,318 m^2 in the St Leonards South Precinct. The site is bounded by Berry Road to the West, River Road to the South, Park Road the East, houses to the north, with Berry Lane running north-south through the middle. The general topography of the site slopes south towards River Road, steepening into outcropping sandstone (approximately 5m high) at the southern end of Berry Road. Figure 1 illustrates the site locality and boundaries.

Figure 1: Site location plan

3. Desktop Study Information

3.1. Local Geology

Review of the 1:100,000 Sydney Geological Sheet indicates the site is situated near the boundary of:

- Ashfield Shale: Dark-grey to black claystone-siltstone and fine sandstone-siltstone laminite of the Wianamatta Group.
- Hawkesbury Sandstone: Medium to very coarse-grained quartz sandstone, very minor shale and laminite lenses. Typically bedded between 1 m and 3 m thickness; and

These units are typically separated by the Mittagong Formation comprising interbedded shale and sandstone of variable strength, generally less than 8m thick.

The Prospect/Parramatta River Acid Sulphate Soil Risk Map indicates that the site is in an area of no known occurrences of acid sulphate soils, consistent with the geology and site elevation.

3.2. Soil landscape and erodibility

The Sydney Soils Landscape Sheet indicates that the majority of site is within the Glenorie soil landscape with the southern boundary underlain by the Gymea soil landscape. Glenorie landscapes are characterised by undulating to rolling low hills on Wianamatta group shales. The soil horizons are typically friable to hardsetting topsoil, underlain by grey to brown, plastic clays with shale gravel. Clays within the lower horizons are typically moderately reactive, with potential for erodibility.

Gymea soil landscapes are characterised by undulating to rolling rises and low hills on benched Hawkesbury sandstone. Soil horizons below the topsoil are typically clayey sand, slightly reactive with very low erodibility, transitioning to moderately reactive, highly erodible clay.

3.3. Groundwater

Reference to the WaterNSW All Groundwater Map indicates there are no registered groundwater bores within 500 m of site. Groundwater is expected to follow regional topography, flowing south-east to Berry's Creek, towards Balls Head Bay and Sydney Harbour.

3.4. Local Coffey investigations

During an early stage of the project development, Coffey completed a geotechnical walkover of part of the site (48-54 River Rd, 47 Berry Rd and 42-50 Park Rd). The outcomes were reported in Coffey report GEOTLCOV25696AA-AC. The walkover identified sandstone outcropping in the southern portion of site at residences bounding River Road.

Coffey has conducted geotechnical investigations to the north of the Pacific Highway in this locality (about 20m higher in elevation). Those investigations have encountered ground conditions consistent with the geology, with deeply weathered Ashfield Shale over Hawkesbury Sandstone. These investigations encountered some groundwater seepage but were generally not sufficiently deep to encounter the permanent groundwater table.

3.5. Underground Services

Coffey completed a Dial Before You Dig (DBYD) request on 10/08/2018 (Attachment A) and received a response indicating the following authorities' own assets within the vicinity of the site:

- *Ausgrid*: Assets run along the site boundary with Berry Rd, as well as further west within Berry Road. Assets also run along River Rd to the south and appear to enter 50 River Road;
- *Jemena*: A 50 mm line runs along the Park Rd boundary of site and a 200 mm line runs along the Berry Rd and River Rd boundaries, with a connection entering 50 River Road. An additional 32 mm line runs parallel on the western side of Berry Rd;
- *NBN*: Fibre optic lines run along Berry, River and Park Roads on both sides of the roads, connecting to all properties;
- *Sydney Water*: Water mains run within Berry, River and Park Roads. A sewer main runs down Berry Lane, entering 38 Park Road from the west until about halfway within the property, continuing north into the abutting houses. At the intersection of Berry Lane and River Road, the sewer main heads East-North-East, traversing across 52 Park Road;
- *Telstra*: Utilities run along Park, River and Berry Roads on both side of the road, entering each property from the street. Minor connections are mapped from 40B to 40A and 48 to 46, Park Road and 43A to 43 Berry Road;
- *PIPE Networks*: A letter confirms that these utilities are within Telstra ducts and as such, a separate plan is not included.

No plans were available at the time of this report for services within the residential property bounds.

4. Fieldwork Summary

4.1. Ground Investigation

Prior to starting the intrusive investigation, Coffey cross-referenced the DBYD plans with the proposed boreholes, and engaged Geotrace Pty Ltd (Geotrace) to conduct service locating at every exploratory hole location.

Coffey commissioned Terratest Pty Ltd (Terratest) as the drilling subcontractor. The ground investigation was carried out between 20 and 24 August (Boreholes 4 to 9) and between 27 and 29 August 2018.

Each borehole was initially advanced using a hand auger to either 1.5 m below existing ground level (bgl) or refusal in case of unmapped or hard to detect underground services. After hand augering, Terratest utilised a track mounted drill rigs (Geoprobe 7822DT or Hinowa HP9503) drill rig with solid stem augers and tungsten-carbide (TC) drill bit to advance the borehole until encountering rock. Standard Penetration Tests were conducted in soils between 1.0 to 1.5 m bgl and every subsequent 1.5 m until refusal. When rock was encountered boreholes were continued by NMLC coring to target depth.

Upon reaching the target depth of 10.0 m bgl, monitoring wells were installed in boreholes BH 1, 3, 5, 7A and 9. Typically, 6 m of 50 mm slotted PVC with an end cap was installed from 10.0 m bgl to 4.0 m bgl with non-slotted PVC was installed to the surface. The wells were filled with well-graded sand to approximately 0.5 m above the top of the slotted PVC, topped by approximately 0.5 m of bentonite plug seal. The wells were finished with grout from the top of bentonite to the surface, with a roadbox cover installed flush with the existing ground level.

Boreholes BH 2, 4, 6, 7 and 8 were backfilled with soil cuttings and sand.

Refer to the Exploratory Hole Location plan in Appendix B for the locations of boreholes and groundwater monitoring wells.

4.2. Exploratory boreholes

Table 1 provides a summary of the geotechnical boreholes.

Table 1: Geotechnical boreholes

Type	Quantity	Maximum Depth (m)	Remarks	Groundwater monitoring standpipe	Rig Type
Rotary Core Drilling	10	10.48	BH1 (10.02m) BH2 (10.11m) BH3 (10.08m)	Yes (10m deep) No (backfilled) Yes (10m deep)	Hinowa HP9503
			BH4 (10.42m) BH5 (10.00m) BH6 (10.07m) BH7 (1.60m) BH7A (10.26m) BH8 (10.00m) BH9 (10.48m)	No (backfilled) Yes (10m deep) No (backfilled) No (backfilled/obstruction) Yes (10m deep) No (backfilled) Yes (10m deep)	Geoprobe 7822dt

Exploratory borehole logs are presented in Appendix B. These provide information including the methods used, samples taken, tests carried out and descriptions of the strata encountered.

4.3. Groundwater Monitoring

Details of the instrumentation installed in the exploratory holes for groundwater monitoring are shown with the relevant logs in Appendix B. Records of groundwater monitoring carried out by Coffey after the fieldwork period are presented in Appendix D.

5. Results of Investigation

5.1. Encountered Geology

The encountered subsurface ground profile at the site was consistent with the published and anticipated geology. A layer of varying thickness fill/topsoil overlying mainly residual soils derived from the underlying sandstone that increased in strength with depth.

5.2. Geotechnical Model

Using the subsurface information from the geotechnical investigation, the encountered ground conditions have been characterised into the geotechnical units presented in Table 2 below.

Table 2: Summary of geological units encountered

Unit	Material	Description	Approximate Depth to Top of unit m bgl	Range of Unit Thickness (m)
1	Fill/Topsoil	Gravelly Clayey SAND / Clayey SAND / Sandy CLAY	0.0 (Ground level)	0.15 – 3.20
2	Residual soil	Silty/clayey/gravelly SAND / Sandy CLAY / CLAY	0.15	0.15 – 3.00
3a	Hawkesbury Sandstone	Class V Sandstone – mainly highly weathered	0.57 – 3.0	3.20 – 5.80
		Class IV Sandstone – moderately to slightly weathered	0.8 - 3.2	0.5 – 4.9
3b	Hawkesbury Sandstone	Class III Sandstone – Slightly (with some moderately) weathered	2.2 -6.2	Thickness not proven, but >3.4m
		Class II Sandstone – Slightly weathered to Fresh	4.5 – 9.6	Thickness not proven, but >4.1m

Notes:

1. *The depths and unit thicknesses are based on the boreholes and may not represent the stratigraphy or the maximum or minimum depths and thicknesses of stratigraphic units across the entire site.*
2. *Rock classification is based on the system presented in "Foundations on Sandstone and Shale in the Sydney Region" Aust. Geomech. Jnl, Dec 1998, Pells et al (1998).*

Interpreted Geological cross sections (refer to Figures 3, 4 and 5 in Appendix B) illustrate the varying thicknesses of the different geological units from north to south and east to west.

5.3. Groundwater Conditions

Groundwater monitoring standpipes were installed after drilling in boreholes BH1, BH3, BH5, BH7A and BH9. Details of the installations can be found in the engineering logs (refer to Appendix C).

Groundwater levels monitored during the intrusive investigation, however as water is used in the coring process, a more reliable method of obtaining a true groundwater level is to return to the site approximately one week later, once an equilibrium has been reached.

Groundwater levels were recorded on 4 September 2018 and are tabulated in Appendix D. These groundwater levels may not have stabilised, and a further round of groundwater monitoring is recommended.

5.4. Laboratory Test Results

Geotechnical laboratory testing of soil and rock samples were carried out in accordance with:

- AS 4133 Methods of Testing Rocks for Engineering Purposes
- AS 1289 Methods of Testing Soils for Engineering Purposes

Soil tests were conducted in NATA accredited laboratories of Coffey Testing and Eurofins | MGT and rock point load tests were carried out by Coffey Services in our Chatswood core storage facility. Results are summarised in Tables 3, 4 and 5.

Table 3: Soil Index test results

Sample ID		Moisture Content	Atterberg Limits %			
BH	**Depth (m)**	%	**LL**	**PL**	**PI**	**LS**
BH1	1.0 - 1.45	8.7	28	17	11	4.0
BH2	2.5 - 2.8	11.2	28	16	12	4.5
BH3	1.0 – 1.45	15.2	41	19	22	8.0
BH4	2.5 – 2.95	10.6	31	19	12	5.0

The results of Soil Aggressivity testing were assessed in accordance with Australian Standards AS3600-2018 Concrete Structures and AS2159-2009 Piling – “Design and Installation”. Chemical test results indicated the following expected ground conditions for buried steel and concrete structural elements.

Table 4: Soil Aggressivity results

Sample ID		Moisture Content	Aggressivity	
BH	**Depth (m)**	%	**Sulphates (SO4)**	**pH**
BH4	1.0	17	<30	8.2
BH7	1.0	15	<30	8.7
BH8	0.8	18	46	8.5

Table 5: Laboratory test results – Rock Point Load tests

BH	Depth (m)	Is (50) MPA	BH	Depth (m)	Is (50) MPA	BH	Depth (m)	Is (50) MPA
BH1	1.83	0.06	BH2	9.04	1.48	BH4	5.76	1.39
BH1	2.36	0.13	BH2	10.00	1.57	BH4	5.90	0.97
BH1	3.42	0.53	BH3	2.27	0.17	BH4	6.22	1.42
BH1	4.49	0.68	BH3	3.17	0.27	BH4	6.44	0.70
BH1	5.33	0.57	BH3	4.72	0.33	BH4	7.30	0.90
BH1	6.44	0.21	BH3	5.50	0.75	BH4	8.24	0.33
BH1	7.42	0.82	BH3	6.63	0.48	BH4	9.44	1.46
BH1	8.48	0.64	BH3	7.70	1.29	BH4	10.31	2.06
BH1	9.47	0.53	BH3	8.21	0.90	BH5	1.90	0.11
BH2	3.18	0.27	BH3	9.63	0.86	BH5	2.75	1.20
BH2	4.26	1.66	BH3	10.00	0.99	BH5	3.90	0.93

BH2	5.39	2.65	BH4	3.06	0.93	BH5	4.91	1.04
BH2	5.69	0.62	BH4	3.45	0.89	BH5	5.12	0.94
BH2	7.00	1.13	BH4	4.00	1.03	BH5	5.38	1.04
BH2	8.00	1.44	BH4	4.76	1.34	BH5	6.10	1.39
BH5	6.30	1.10	BH6	9.45	0.72	BH8	6.32	1.42
BH5	7.10	1.10	BH6	10.00	1.53	BH8	7.32	0.87
BH5	7.62	0.74	BH7A	3.55	0.52	BH8	8.32	0.71
BH5	8.09	0.94	BH7A	4.60	0.62	BH8	9.30	1.09
BH5	8.89	1.30	BH7A	5.54	0.21	BH9	1.39	1.71
BH5	9.09	1.16	BH7A	6.58	1.14	BH9	2.02	0.45
BH5	9.20	1.13	BH7A	7.74	0.96	BH9	3.56	0.54
BH6	1.04	0.71	BH7A	8.00	1.02	BH9	4.43	0.77
BH6	2.07	0.28	BH7A	9.00	0.21	BH9	5.72	0.34
BH6	3.00	1.06	BH7A	10.00	0.60	BH9	6.55	0.26
BH6	4.13	0.75	BH8	1.65	0.76	BH9	7.27	0.75
BH6	5.13	0.59	BH8	2.36	0.70	BH9	8.24	0.58
BH6	6.45	0.86	BH8	2.49	1.30	BH9	9.00	1.23
BH6	7.45	0.80	BH8	3.13	1.16	BH9	10.00	0.92
BH6	8.44	0.38	BH8	5.00	1.13	BH8	6.32	1.42
BH5	7.62	0.74	BH6	9.45	0.72	BH8	7.32	0.87
BH5	8.09	0.94	BH6	10.00	1.53	BH8	8.32	0.71
BH5	8.89	1.30	BH7A	3.55	0.52	BH8	9.30	1.09
BH5	9.09	1.16	BH7A	4.60	0.62	BH9	1.39	1.71
BH5	9.20	1.13	BH7A	5.54	0.21	BH9	2.02	0.45
BH6	1.04	0.71	BH7A	6.58	1.14	BH9	3.56	0.54
BH6	2.07	0.28	BH7A	7.74	0.96	BH9	4.43	0.77
BH6	3.00	1.06	BH7A	8.00	1.02			

Point load tests were carried out at approximately 1m intervals in suitable rock core samples recovered from each of the boreholes. Tests were carried out by a suitably trained geotechnical engineer after all core samples had been transported to the Coffey storage facility in Chatswood. Axial test results have only been shown in Table 5, whereas both axial and diametrical are displayed on the engineering logs that can be found in Appendix B.

6. Geotechnical Discussion & Recommendations

6.1. Excavation

6.1.1. Excavatability

When this report was prepared, details of likely basement depths were not provided.

Excavation of Geotechnical Units 1, 2 and some 3a (mainly Class V Sandstone) should be able to be excavated using conventional earthmoving equipment such as a tracked excavator with toothed bucket or a tracked excavator. Light ripping may be necessary to assist where stronger rock bands occur. Where moderately weathered or better sandstone is present, hard rock excavation techniques such as large dozers fitted with rippers, or large excavators fitted with rock saws, rock grinders and rock hammers may be used. The use of hard rock excavation techniques will cause vibrations that could damage vibration sensitive structures, infrastructure and underground services. Assessment of the potential impacts of excavation induced vibrations should be considered as part of the detailed design and excavation planning.

6.1.2. Unsupported excavations

Batter slopes or bench excavation may be possible where excavations can be set back sufficiently from adjacent structures and roads. The batter slopes or benches should be scaled following excavation to remove all loose material which could slide or topple from the face during construction and hence pose a risk to construction personnel.

Table 5 below provides a summary of the recommended batter slopes for each geotechnical unit likely expected within the depth of excavation. It should be noted that the proposed batters in rock are subject to assessment by a geotechnical engineer during construction. If adverse joints or other defects are present, flatter batters or slope stabilisation may be required.

Table 6: Recommended batter slopes for unsupported excavations up to 3m deep Material	Maximum short-term Note 1 batter slope	Maximum long-term batter slope
Fill	2H:1V	3H:1V
Residual Soil	1.5H:1V	2.5H:1V
Class V Sandstone	1H:1V	1.5H:1V
Class IV Sandstone	0.5H:1V	1H:1V
Class III Sandstone or better	Near vertical	0.5H:1V

Note 1: Up to 3 months maximum

6.1.3. Temporary excavation supports

Where unsupported, open excavations are impracticable, a shoring wall should be required during construction. Sheet pile walls are considered impractical for the proposed excavation due to the shallow depth of rock level.

Typically, in these geological conditions a drained basement would be constructed at this site. This could comprise either anchored soldier pile retaining walls with shotcrete infill or anchored contiguous pile retaining walls as excavation support depending on wall stiffness requirements. For preliminary design Coffey recommends the piles be drilled and socketed into rock below the bulk excavation (BE) level. Where it is important to minimise adjacent ground movements due to the presence of sensitive structures or services, internal bracing and/or tie-back anchors may also be required during construction.

Based on our experience, a slope batter for fill and natural soil steeper than 1V:1H during excavation is not recommended. As is recommended in the table above, class V sandstone can be formed in a 1H:1V slope batter during construction. However, if adverse joints or other defects are present, flatter batters or slope stabilisation (such as shotcrete) may be required. Subject to the assessment of actual site conditions by an experienced geotechnical engineer or geologist during excavation, a near vertical cut in class IV sandstone can be achieved with the possibility of geotechnical stabilisation.

Table 7 presents recommended design parameters for the design of the temporary retaining wall where there is a level retained ground surface. The K_o values in Table 2 assume that some wall movement and relaxation of horizontal stress will occur due to the excavation. Actual in-situ K_o values may be higher, particularly in the rock units. Retaining wall analyses will need to consider surcharges, footing loads from adjacent structures and hydrostatic pressure. These values should be reconsidered when the nature and depth of excavation is known.

Table 7: Preliminary parameters for site retention

Table 7: Recommended parameters for temporary retaining wall designMaterial	Bulk Density γ (kN/m3)	Effective Cohesion c' (kPa)	Effective Friction Angle Φ' (degrees)	Coefficient of Active Earth pressure, Ka	Coefficient of Earth pressure at rest, Ko	Coefficient of Passive Earth pressure, Kp	Elastic modulus E_H (MPa)
Fill	19	0	25	0.4	0.50	2.5	10
Residual Soils	20	5	25	0.4	0.5	2.5	20
Class V Sandstone	22	10	30	0.3	0.5	3.5	40
Class IV Sandstone	23	30	35	0.27	0.5	3.7	100

Ground anchor design should be based on allowing effective anchorage to be developed by locating the bond length behind an 'active zone', determined by drawing a line at 45° from the base of the wall to intersect the ground surface behind the excavated face. The following ultimate bond stresses presented in Table 8 below can be adopted for ground anchor design with the provision that bond lengths are between 3 m to 5 m and anchors are to be proof loaded to at least 1.5 times their design working load.

Table 8 - Recommended bond stresses for ground anchor design

Unit / Material Description	Ultimate Bond Stress (kPa)
Class V sandstone	200
Class IV sandstone	500
Class III sandstone	800
Class II sandstone	1500

6.1.4. Excavation-induced ground movements

Excavation will cause some ground movements adjacent to the excavation site. The magnitude of the movements that will be experienced by a retaining wall will depend on various factors including the earth pressures that exist, groundwater conditions and construction sequence. Documented data has shown that for well-designed and constructed shoring, vertical and lateral movements can be about 0.1% to 0.3% of the retained height at the excavation face. Lateral ground movements can occur at distances up to twice the basement depth from the edge of excavations.

It shall be noted that the assessment of excavation-induced ground movements involves detailed soil structure interaction analysis. The accuracy of the assessment results plays an important role in determining the impact of the excavation on the adjacent structures and roads as well as evaluating the effectiveness of the proposed retaining wall. If this assessment is required, Coffey can provide the assessment (by numerical analyses) during the detailed design when more design information becomes available.

It is recommended that dilapidation surveys be carried out prior to the commencement of the excavation to assess the condition of the buildings within the zone of influence of the excavation. Potential risk of damage to buildings from ground movements during excavation should be considered during the development of the excavation methodology. Ground movements of the buildings should be monitored during excavation to reduce the risk of damage from excessive ground movements.

6.1.5. Groundwater control during excavation

Groundwater seepages in this geological setting typically occur at soil/rock interfaces, through joint swarms and in bedrock joints and partings. Bedrock seepage in sandstone bedrock could be assumed as typically flowing toward local drainage lines or the regional water table, along horizontal bedding planes and sub-vertical joints. Sandstone is not typically a highly permeable material; therefore, the rock mass permeability will be governed by joints, bedding planes, and other defects within the rock mass.

Groundwater levels recorded to date suggest basement excavation could encounter groundwater inflow. In this geology groundwater inflows into the basement can generally be controlled using conventional sump and pump techniques for discharge into stormwater or sewer systems networks, subject to regulatory approvals. For a drained basement, permanent floor and wall drainage will need to be maintained to dispose of groundwater inflows throughout the life of the structure. It is expected that such a drainage system would include a sub-floor drainage blanket with slotted drainage pipes and a sump and pump system with the ability to effectively back flush the system for long-term maintenance.

6.1.6. Excavation-induced vibrations

The use of excavation plant such as impact hammers will generate vibrations that may affect any surrounding sensitive structures and buried services. Measures to mitigate the risks associated with construction vibration such as the use of jack hammer and excavator during construction should be considered. It is recommended that vibration monitoring be undertaken on the existing structures and on the ground adjacent to the structures. The vibration limits in Table 8 are commonly recommended to reduce the risk of vibration damage to sensitive receptors.

Table 8: Recommended ground vibration limits for structures

Type of Structure	Peak Particle Velocity (mm/s)
Residential or low-rise buildings in good condition	10
Reinforced concrete commercial and industrial buildings in good condition	25

6.2. Foundations

It is understood that the foundations for the proposed development include both shallow and deep foundations.

Conventional bored piles or Continuous Flight Auger (CFA) piles are expected to be appropriate for the proposed development. Table 10 presents preliminary geotechnical parameters for pile design.

Table 9:Recommended design parameters for foundation design

Material	Ultimate End Bearing Value (MPa)	Ultimate Shaft Adhesion (kPa)	Vertical Elastic Modulus E_V (MPa)
Class V Sandstone	3	150	80
Class IV Sandstone	8	400	400
Class III Sandstone	30	1000	750
Class II Sandstone	60	1500	1000

Notes:

a) Assumes a minimum embedment depth of at least 0.5 m into the relevant bearing stratum or one pile dimeter, whichever is deeper.
b) Shaft adhesion assumes a rough socket (at least grooves of depth 1 mm to 4 mm and width greater than 5 mm at spacing of 50 mm to 200 mm)
c) Foundation unit extends to a depth of at least 5 times of pile diameter below pile toe.

A geotechnical strength reduction factor (Φ_g) of 0.5 can be adopted in limit state design of pad or strip footings. The recommended ultimate bearing pressures are contingent upon successful 'spoon testing' in drilled holes to a minimum depth of 1.5 times the footing width.

For limit state design of piles, the design ultimate geotechnical pile capacity is derived by applying a geotechnical strength reduction factor (Φ_g) to the ultimate geotechnical pile capacity assessed using the ultimate shaft resistance and end bearing values shown in Table 9. In accordance with AS2159-2009, Φ_g is dependent on an Average Risk Rating (ARR) which considers various geotechnical uncertainties, foundation system redundancy, construction supervision, quantity and type of pile testing. To assist you with preliminary design we suggest Φ_g of 0.5 could be adopted assuming some pile testing will be specified.

The use of limit state design also requires assessment of the serviceability performance of the foundation system, including pile group interaction effects. This should be carried out by an experienced geotechnical professional using well-established and soundly based methods. The elastic modulus value given in Table 10 may be adopted but it should be noted that the accuracy of settlement prediction is dependent on construction methods as well as material stiffness, both of which can involve degree of uncertainty.

6.3. Soil Aggressivity

Based on laboratory test results summarised in Table 4, the soil has an exposure classification of *'Mild'* and *'Non-aggressive'* as according to AS2159-2009 for concrete and steel.

6.4. Earthworks

6.4.1. Subgrade preparation

Prior to the construction of subgrade layers by engineered fill, the pavement layer and the underlying fill should be removed and stockpiled separately for appropriate reuse. The exposed material should be proof rolled with at least four passes of a non-vibratory smooth drum roller of minimum 12 tonne dead weight. Any soft or heaving areas should be excavated and replaced with engineered fill.

It is expected that trafficability in silty and clayey materials for wheeled vehicles can be difficult during and following rainfall due to surface heaving and / or rutting.

6.4.2. Engineered Fill compaction

For bulk earthworks using modern purpose-built earthmoving plant, fill material should be placed in layers not exceeding 300mm loose thickness and moisture conditioned to Standard Optimum Moisture Content (SOMC) ± 2%.

All engineered fill should be compacted to achieve a minimum dry density ratio of 98% SMDD (Standard Maximum Dry Density and moisture conditioned to SOMC ± 2% at the time of compaction.

Earthworks construction should be constructed under Level 1 geotechnical inspection and testing as defined in AS3798-2007.

6.4.3. Re-use of material

The following comments are made regarding the suitability of site soils for re-use in areas requiring filling:

- Where excavation or site regrade is proposed, all existing asphalt, topsoil, fill, vegetation or other potentially deleterious material should be removed to spoil or stockpiled for re-use as landscaping material only.
- If existing fill encountered, it should be carefully stripped and if suitable stockpiled for re-use as general site fill, or replacement subgrade for proposed pavement areas;
- The underlying natural soils should be carefully stripped as necessary and stockpiled for re-use as general site fill.

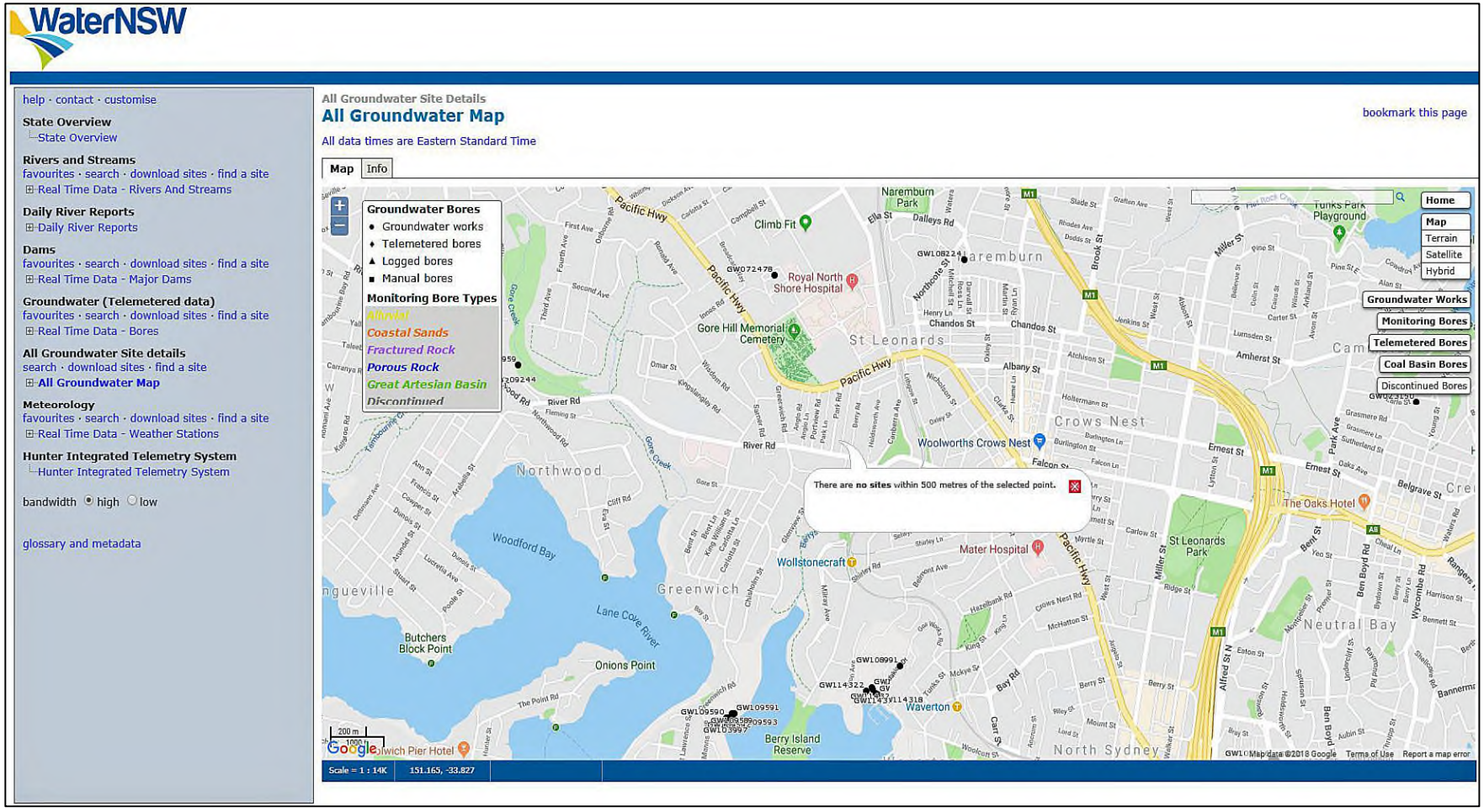
7. Limitations

Subsurface conditions can be complex and may vary over relatively short distances – and over time. The inferred geotechnical model and recommendations in this report are based on limited subsurface investigations at discrete locations. The engineering logs describe subsurface conditions only at the investigation locations. Further investigations may be required to support detailed design if there are scope limitations or changes to the nature of the project. We can assist with detailed design and/or to review designs and verify that the conditions exposed are consistent with design assumptions during construction.

The attached document entitled “Important information about your Coffey report” forms an integral part of this report and presents additional information about its uses and limitations.

Appendix A – Desktop Study Information

- WaterNSW All Groundwater Map
- DBYD Plans



Coffey Services Australia Pty Ltd
ABN 55 139 460 521

Job No 14735001

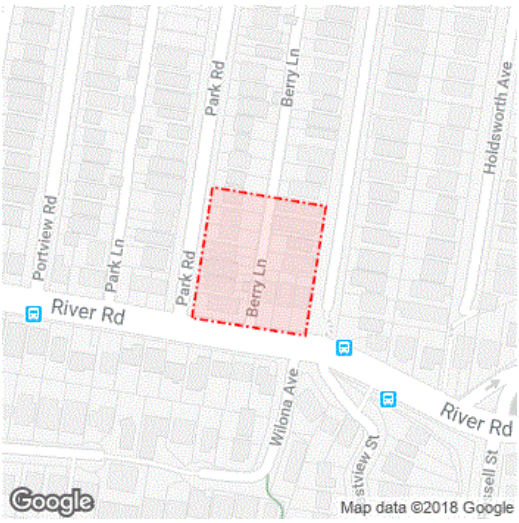
Phone: 1100
www.1100.com.au

Caller Details

Contact:	Mr Aidan McKenzie	**Caller Id:**	1728091	**Phone:**	0294061217
Company:	Coffey	**Mobile:**	0419490698	**Fax:**	Not Supplied
Address:	Level 18 799 Pacific Highway Chatswood NSW 2067	**Email:**	aidan.mckenzie@coffey.com		

Dig Site and Enquiry Details

WARNING: The map below only displays the location of the proposed dig site and does not display any asset owners' pipe or cables. The area highlighted has been used only to identify the participating asset owners, who will send information to you directly.



User Reference: country garden
Working on Behalf of: Other

Enquiry Date:	**Start Date:**	**End Date:**
10/08/2018	20/08/2018	31/08/2018

Address:
Berry Road
St Leonards NSW 2065

Job Purpose:	**Onsite Activity:**
Excavation	Vertical Boring
Location of Workplace:	**Location in Road:**
Private Property	Not Supplied

- Check the location of the dig site is correct. If not submit a new enquiry.
- If the scope of works change, or plan validity dates expire, resubmit your enquiry.
- Do NOT dig without plans. Safe excavation is your responsibility. If you do not understand the plans or how to proceed safely, please contact the relevant asset owners.

Notes/Description of Works:
Not Supplied

Your Responsibilities and Duty of Care

- If plans are not received within 2 working days, contact the asset owners directly & quote their Sequence No.
- ALWAYS perform an onsite inspection for the presence of assets. Should you require an onsite location, contact the asset owners directly. Please remember, plans do not detail the exact location of assets.
- Pothole to establish the exact location of all underground assets using a hand shovel, before using heavy machinery.
- Ensure you adhere to any State legislative requirements regarding Duty of Care and safe digging requirements.
- If you damage an underground asset you MUST advise the asset owner immediately.
- By using this service, you agree to Privacy Policy and the terms and disclaimers set out at **www.1100.com.au**
- **For more information on safe excavation practices, visit www.1100.com.au**

Asset Owner Details

The assets owners listed below have been requested to contact you with information about their asset locations within 2 working days.
Additional time should be allowed for information issued by post. It is **your responsibility** to identify the presence of any underground assets in and around your proposed dig site. Please be aware, that not all asset owners are registered with the Dial Before You Dig service, so it is **your responsibility** to identify and contact any asset owners not listed here directly.
** Asset owners highlighted by asterisks ** require that you visit their offices to collect plans.
# Asset owners highlighted with a hash require that you call them to discuss your enquiry or to obtain plans.

Seq. No.	Authority Name	Phone	Status
74378144	Ausgrid	0249510899	NOTIFIED
74378146	Jemena Gas North	1300880906	NOTIFIED
74378148	NBN Co, NswAct	1800626762	NOTIFIED
74378143	PIPE Networks, Nsw	1800201100	NOTIFIED
74378147	Sydney Water	132092	NOTIFIED
74378145	Telstra NSW, Central	1800653935	NOTIFIED

END OF UTILITIES LIST

N_74378144_GMLA3_1.hpgl2

GL64412

GL64421

PARK RD

BERRY LANE

BERRY RD

ROUTE OF 33KV CABLES SEE RP265

RIVER RD

ROUTE OF 132KV CABLES SEE

ISG GRID		
GL64233	GL64234	GL64243
GL64411	GL64412	GL64421
GL64413	GL64414	GL64423

GRID		
21J13	21K13	21L13
21J14	21K14	21L14
21J15	21K15	21L15

Page 1 of 1

Scale 1:408

0 10 metres

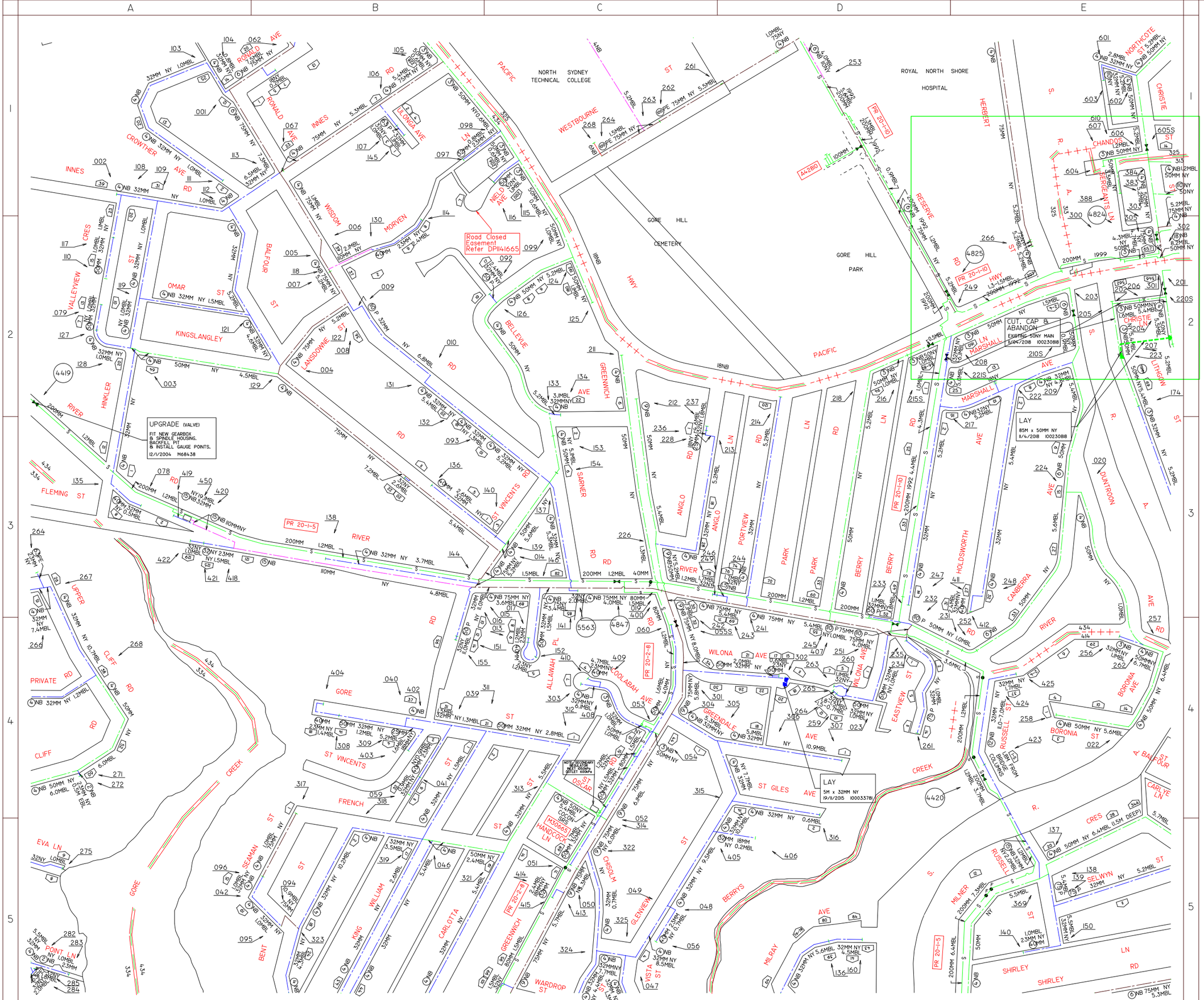
N

Distribution - 74378144
GMLA3

INFORMATION ON THIS PLAN ONLY VALID FOR 30 DAYS FROM ISSUE DATE:

11 Aug 2018

Ausgrid



GLADESVILLE 6D

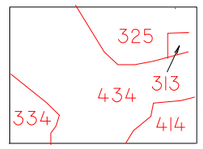
SCALE 1:2000

50 0 50 100 150 200

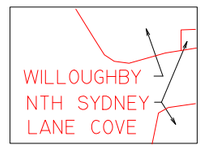
THIS MAP UPDATED ON 11/04/2018
THIS PLAN IS DIAGRAMATIC ONLY. DISTANCES SCALED FROM THIS PLAN MAY NOT BE ACCURATE.
DATE ALTERED:..... BY:.....

G6A	G6B	M04A
G6C	G6D	M07A

ADJOINING MAPS



NETWORK AREA



MUNICIPALITY AREA

Jemena

KEY

MAX ALLOWABLE OPERATING PRESSURE

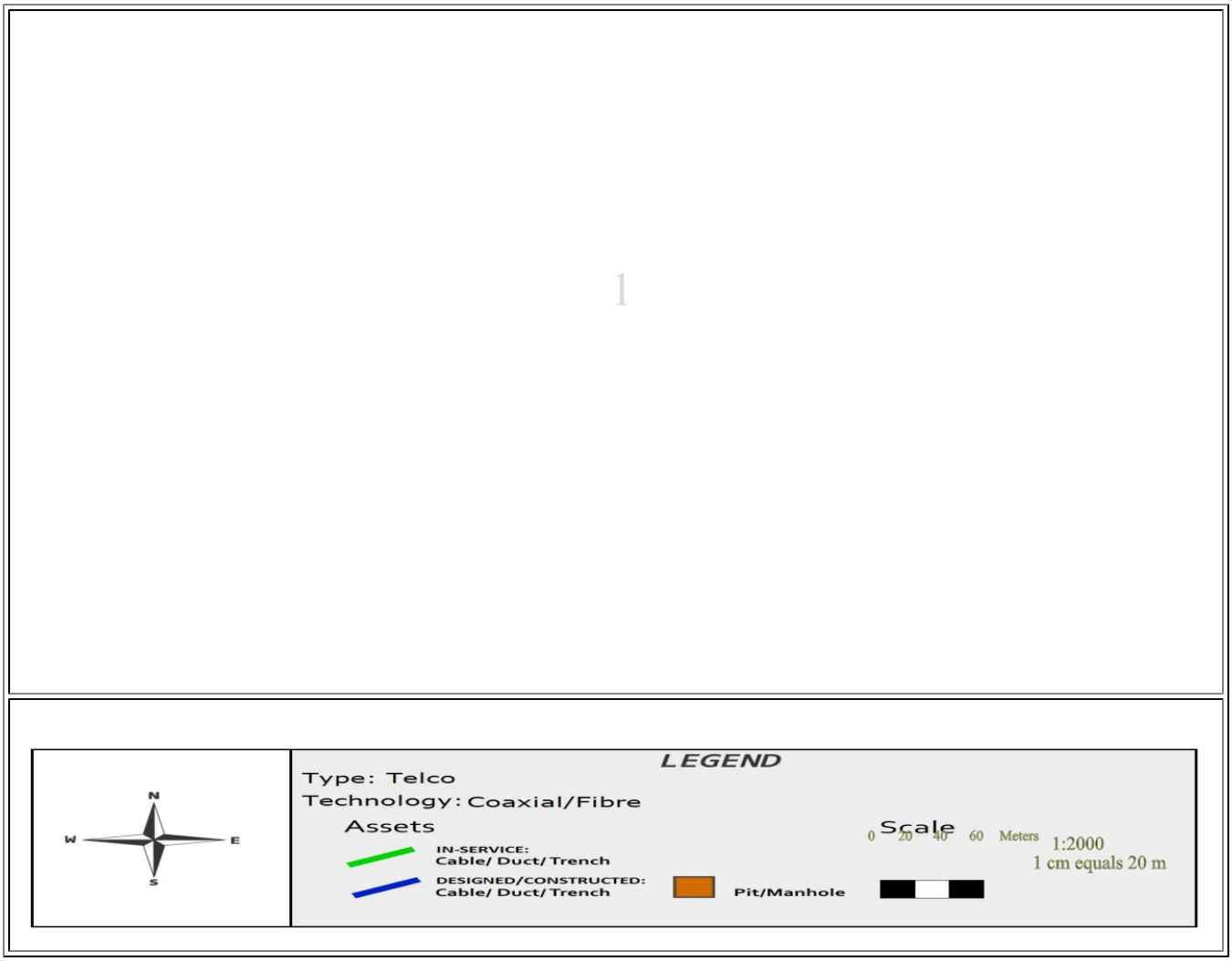
T	TRUNK PIPELINE	7000 kPa
P	PRIMARY MAIN	3500 kPa
S	SECONDARY MAIN	1050 kPa
400	NETWORK MAIN	400 kPa
	NETWORK MAIN	300 kPa
	NETWORK MAIN	210 kPa
100	NETWORK MAIN	100 kPa
30	NETWORK MAIN	30 kPa
	NETWORK MAIN	7 kPa
	NETWORK MAIN	2 kPa
	NETWORK MAIN WITH MAIN STUBS	
	PROPOSED MAINS	
PR 11-2 3	STEEL MAIN PROJECT NUMBER	
P	PRESSURE MONITORING STATION	
	VALVE	
	SYSTEM PRESSURE REGULATOR	
S	SIPHON	
123	NETWORK NODE	
123S	NETWORK VALVE NODE	
(298)	VALVE NUMBER	
6NB	6 INCH CAST IRON MAIN	
150MM	150MM STEEL MAIN	
110MM PE/NY	110MM POLYETHYLENE/NYLON MAIN	
(6)NB 50MM NY	50MM NYLON INSERTED INTO 6NB MAIN CAST IRON MAIN	
1.2MBL	DISTANCE IN METRES OF MAIN FROM BOUNDARY LINE	
1957	YEAR LAID	
-+++-	MUNICIPALITY BOUNDARY	
	NETWORK BOUNDARY	
83	HOUSE NUMBER	

GLADESVILLE 6D

Indicative Plans

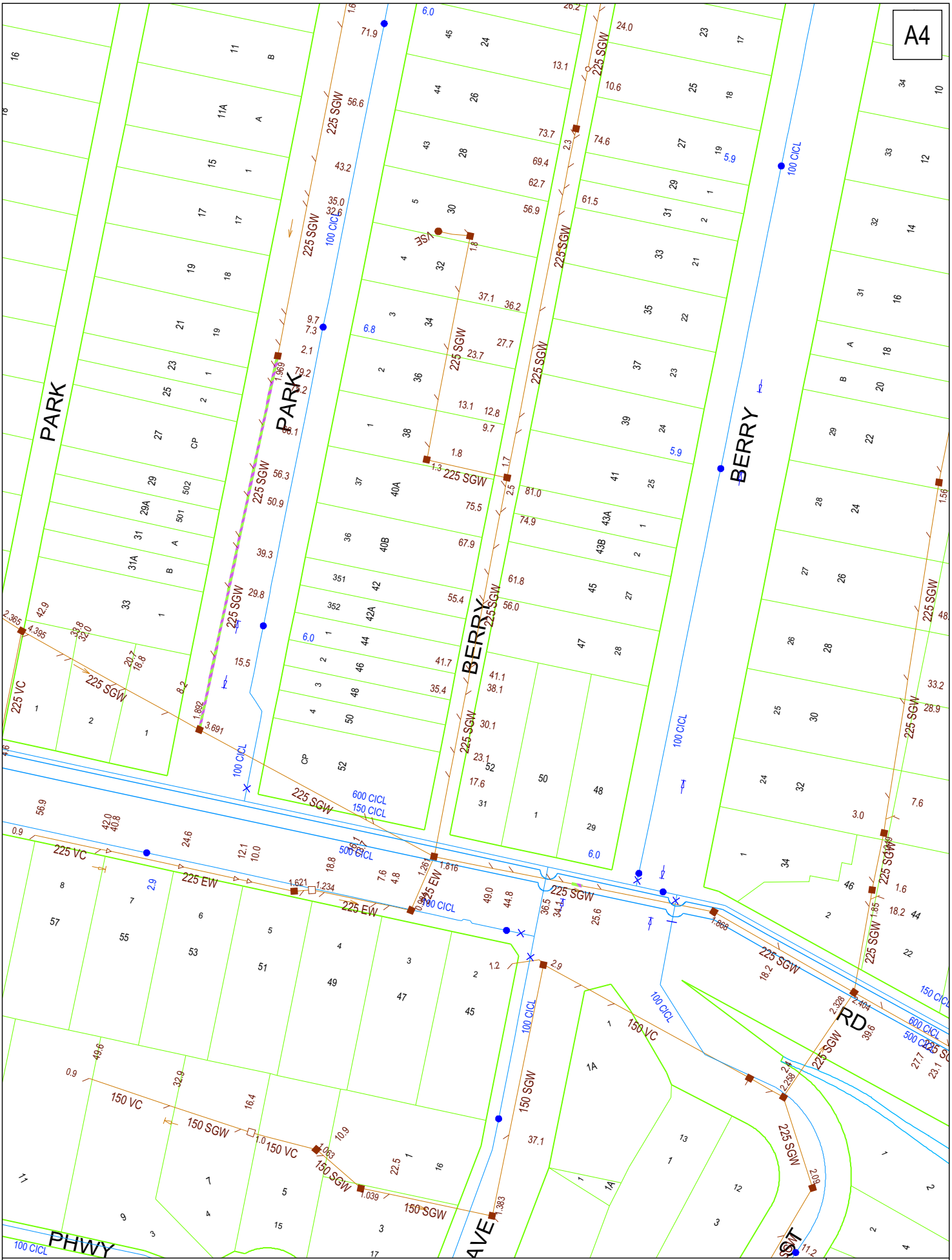
Issue Date:	10/08/2018
Location:	Berry Road,St Leonards,NSW-2065

DIAL BEFORE YOU DIG www.1100.com.au



Emergency Contacts

You must immediately report any damage to **nbn™** network that you are/become aware of. Notification may be by telephone - 1800 626 329.



DBYD Address:
n/a Berry Road
St Leonards NSW 2065

DBYD Job No: 14735001
DBYD Sequence No: 74378147

SYDNEY WATER CORPORATION

Scale: 1:1000

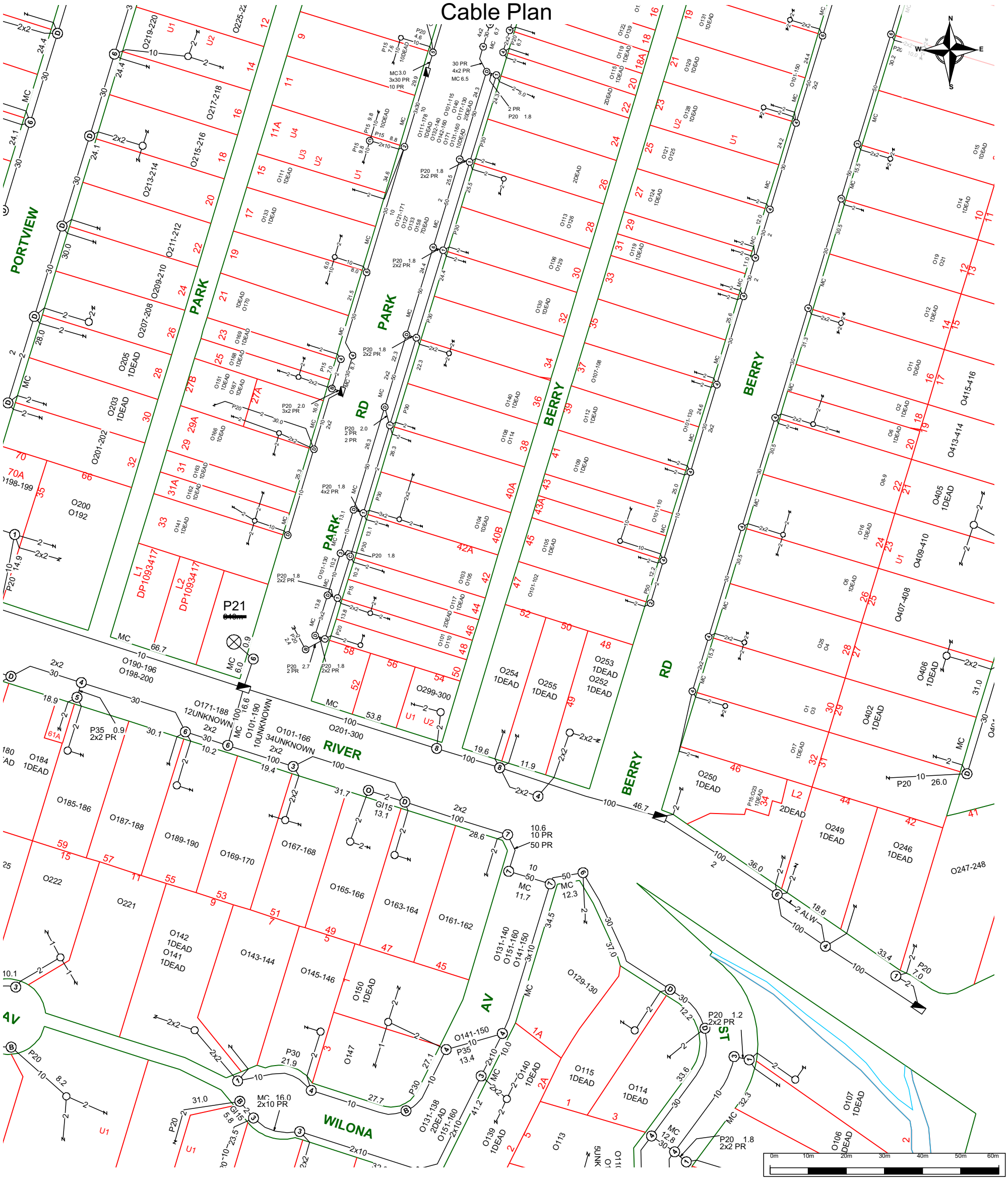
Date of Production: 10/08/2018

Plan 1 of 1

N

0m 5m 10m 15m 20m

Cable Plan



For all Telstra DBYD plan enquiries -
email - Telstra.Plans@team.telstra.com
For urgent onsite contact only - ph 1800 653 935 (bus hrs)

TELSTRA CORPORATION LIMITED A.C.N. 051 775 556

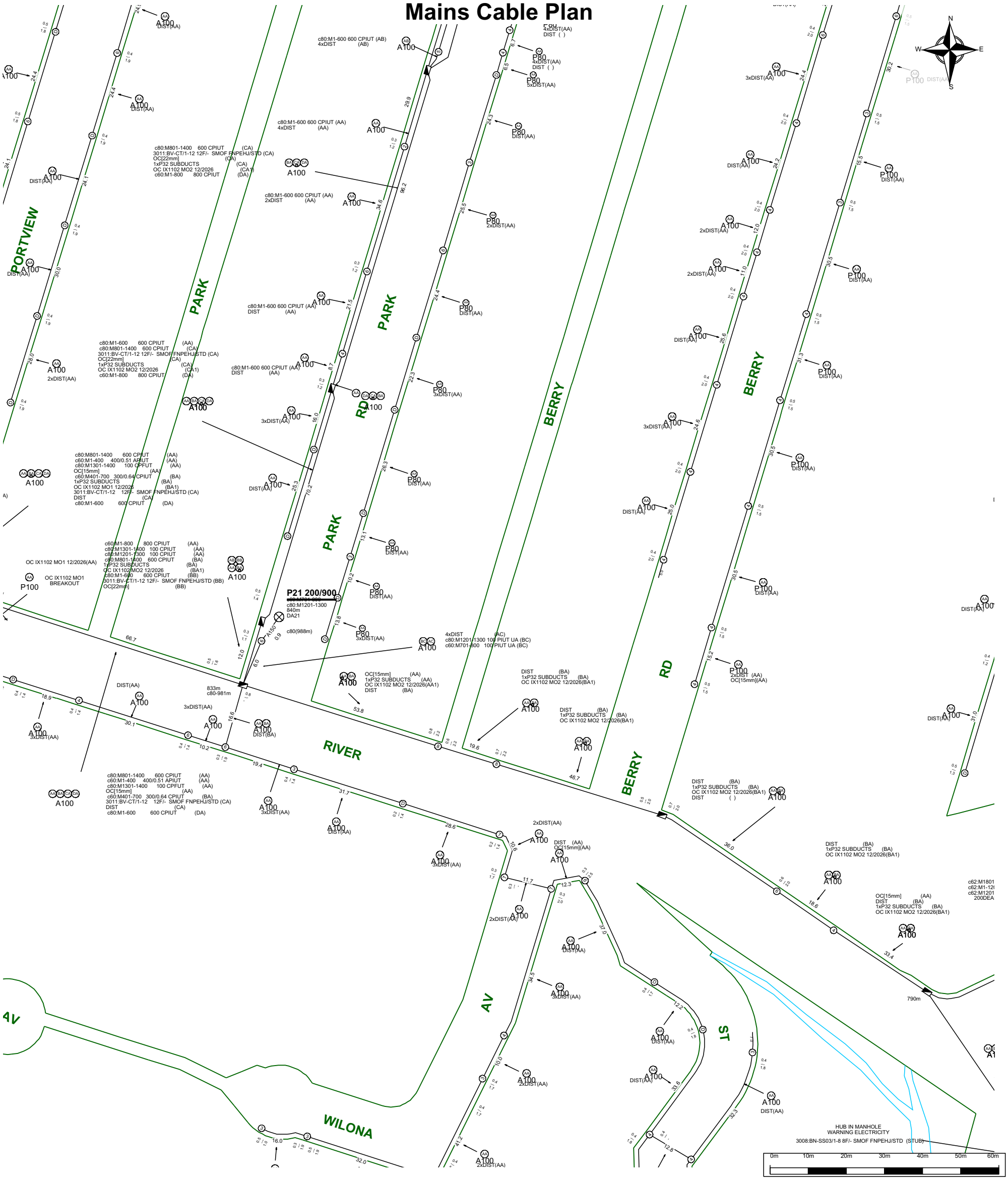
Generated On 10/08/2018 20:16:51

Sequence Number: 74378145

CAUTION: Fibre optic and/ or major network present in plot area. Please read the Duty of Care and contact Telstra Plan Services should you require any assistance.

The above plan must be viewed in conjunction with the Mains Cable Plan on the following page

Mains Cable Plan



Telstra

For all Telstra DBYD plan enquiries -
email - Telstra.Plans@team.telstra.com
For urgent onsite contact only - ph 1800 653 935 (bus hrs)

TELSTRA CORPORATION LIMITED A.C.N. 051 775 556

Generated On 10/08/2018 20:16:54

Sequence Number: 74378145

CAUTION: Fibre optic and/ or major network present in plot area. Please read the Duty of Care and contact Telstra Plan Services should you require any assistance.

Appendix B – Figures

- Figure 1: Published Geological Map
- Figure 2: Exploratory Hole Location Plan
- Figures 3, 4 and 5: Geological Cross Sections

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	AB	AB	22/10/18

LEGEND

- SITE BOUNDARY
- APPROXIMATE BOREHOLE LOCATION
- SECTION LINE

5 0 5 10 15 20

Scale (metres) 1:400

drawn	AB / AW
approved	-
date	22 / 10 / 18
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	COUNTRY GARDEN AUSTRALIA
project:	ST LEONARDS DEVELOPMENT ST LEONARDS, NSW
title:	EXPLORATORY HOLE LOCATION PLAN
project no:	754-SYDGE219558
figure no:	FIGURE 1
rev:	A

PLOT DATE: 22/10/2018 3:37:44 PM DWG FILE: F:\1. PROJECTS\4. SYD-GEOTECHNICS\2018\SYDGE219558 COUNTRY GARDEN ST LEONARDS\12. CAD\754-SYDGE219558.DWG

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE	AB	AB	22/10/18

LEGEND

- SITE BOUNDARY
- Rwa - ASHFIELD SHALE
- Rh - HAWKESBURY SANDSTONE

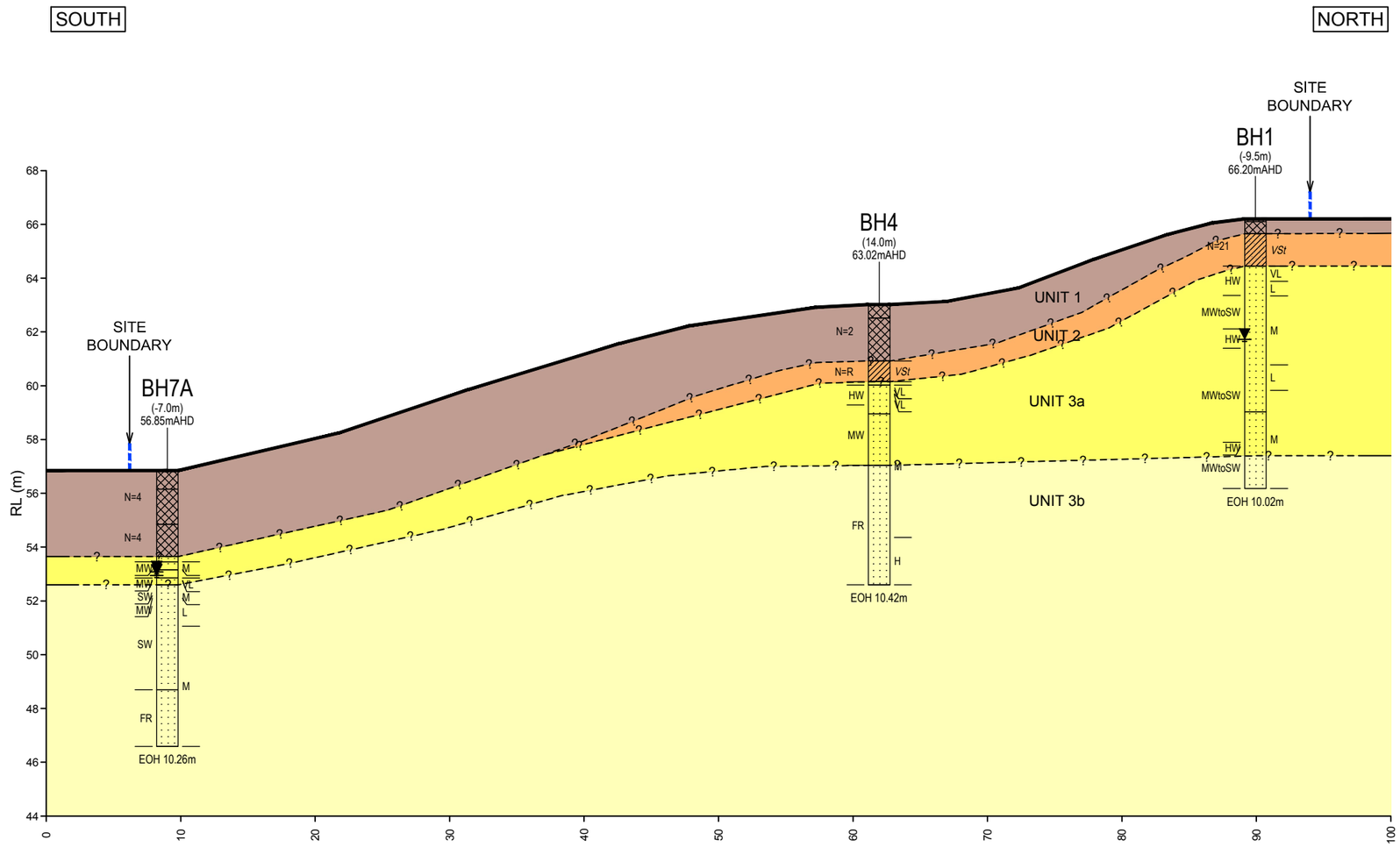
5 0 5 10 15 20

Scale (metres) 1:400

drawn	AB / AW
approved	-
date	22 / 10 / 18
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client:	COUNTRY GARDEN AUSTRALIA		
project:	ST LEONARDS DEVELOPMENT ST LEONARDS, NSW		
title:	GEOLOGY MAP		
project no: 754-SYDGE219558		figure no: FIGURE 2	rev: A



SECTION A-A'

LEGEND

TOPSOIL	XW-FR	EXTREMELY WEATHERED TO FRESH
FILL	VL-H	VERY LOW TO HIGH STRENGTH
SANDY CLAY	▼	WATER LEVEL
SANDSTONE	N*=17	STANDARD PENETRATION TEST RESULT
CLAY	———	EXISTING GROUND SURFACE
NO CORE	– –?– –	INFERRED GEOLOGICAL BOUNDARY
BITUMINOUS SEAL		

UNIT LEGEND

- UNIT 1 - FILL
- UNIT 2 - RESIDUAL SOIL
- UNIT 3a - HIGHLY TO MODERATELY WEATHERED BEDROCK
- UNIT 3b - SLIGHTLY WEATHERED TO FRESH BEDROCK

revision no.	description	drawn	approved	date
A	ORIGINAL ISSUE			

Horizontal Scale (metres) 1:400

Vertical Scale (metres) 1:200

drawn	AB / AW
approved	-
date	22 / 10 / 18
scale	AS SHOWN
original size	A3

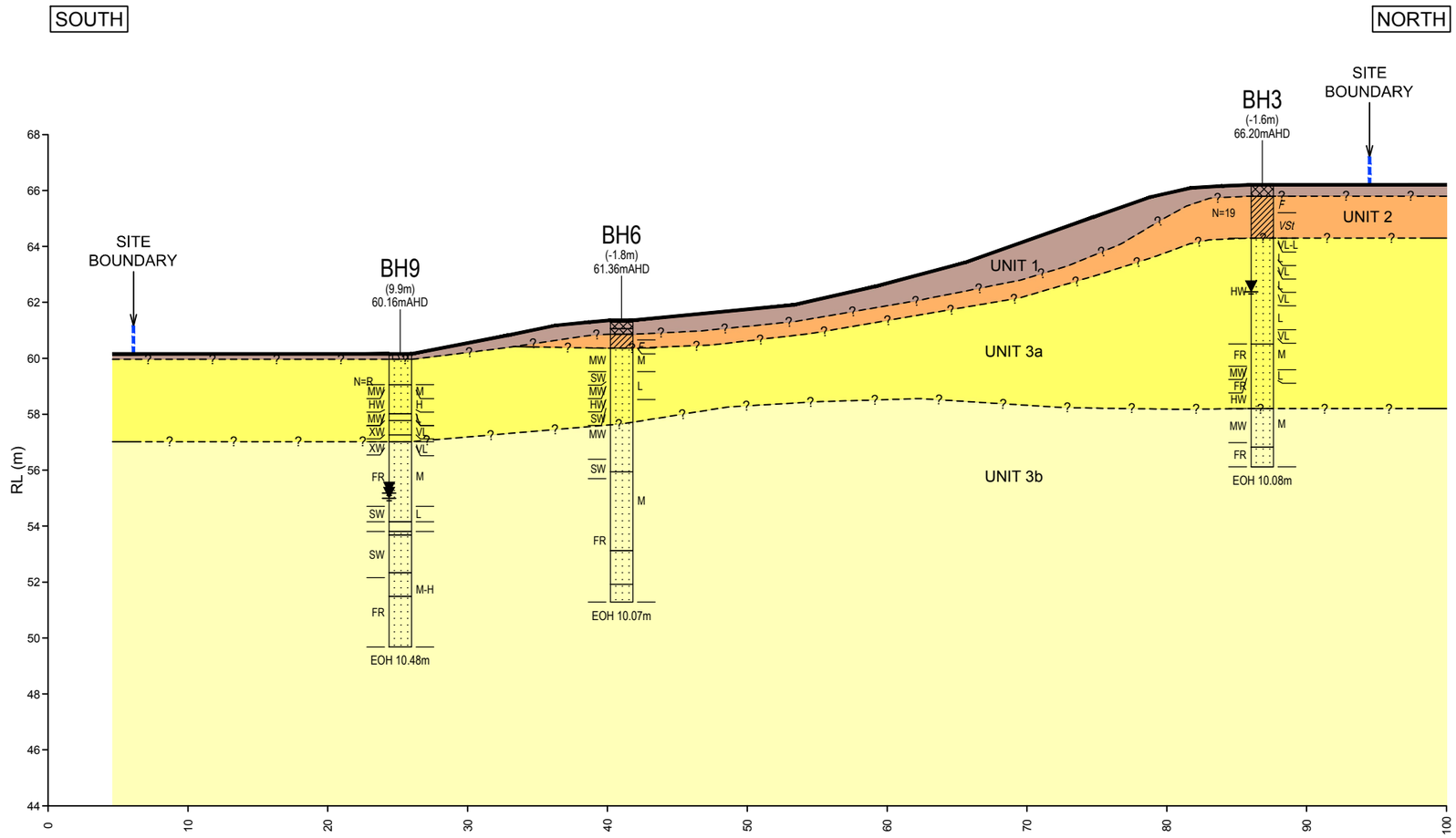
coffey
A TETRA TECH COMPANY

client: COUNTRY GARDEN AUSTRALIA

project: ST LEONARDS DEVELOPMENT
ST LEONARDS, NSW

title: SECTION A-A'

project no: 754-SYDGE219558 | figure no: FIGURE 3 | rev: A



SECTION B-B'

LEGEND

TOPSOIL	XW-FR	EXTREMELY WEATHERED TO FRESH
FILL	VL-H	VERY LOW TO HIGH STRENGTH
SANDY CLAY	▼	WATER LEVEL
SANDSTONE	N*=17	STANDARD PENETRATION TEST RESULT
CLAY	———	EXISTING GROUND SURFACE
NO CORE	– –?– –	INFERRED GEOLOGICAL BOUNDARY
BITUMINOUS SEAL		

UNIT LEGEND

- UNIT 1 - FILL
- UNIT 2 - RESIDUAL SOIL
- UNIT 3a - HIGHLY TO MODERATELY WEATHERED BEDROCK
- UNIT 3b - SLIGHTLY WEATHERED TO FRESH BEDROCK

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

Horizontal Scale (metres) 1:400

Vertical Scale (metres) 1:200

drawn	AB / AW
approved	-
date	22 / 10 / 18
scale	AS SHOWN
original size	A3

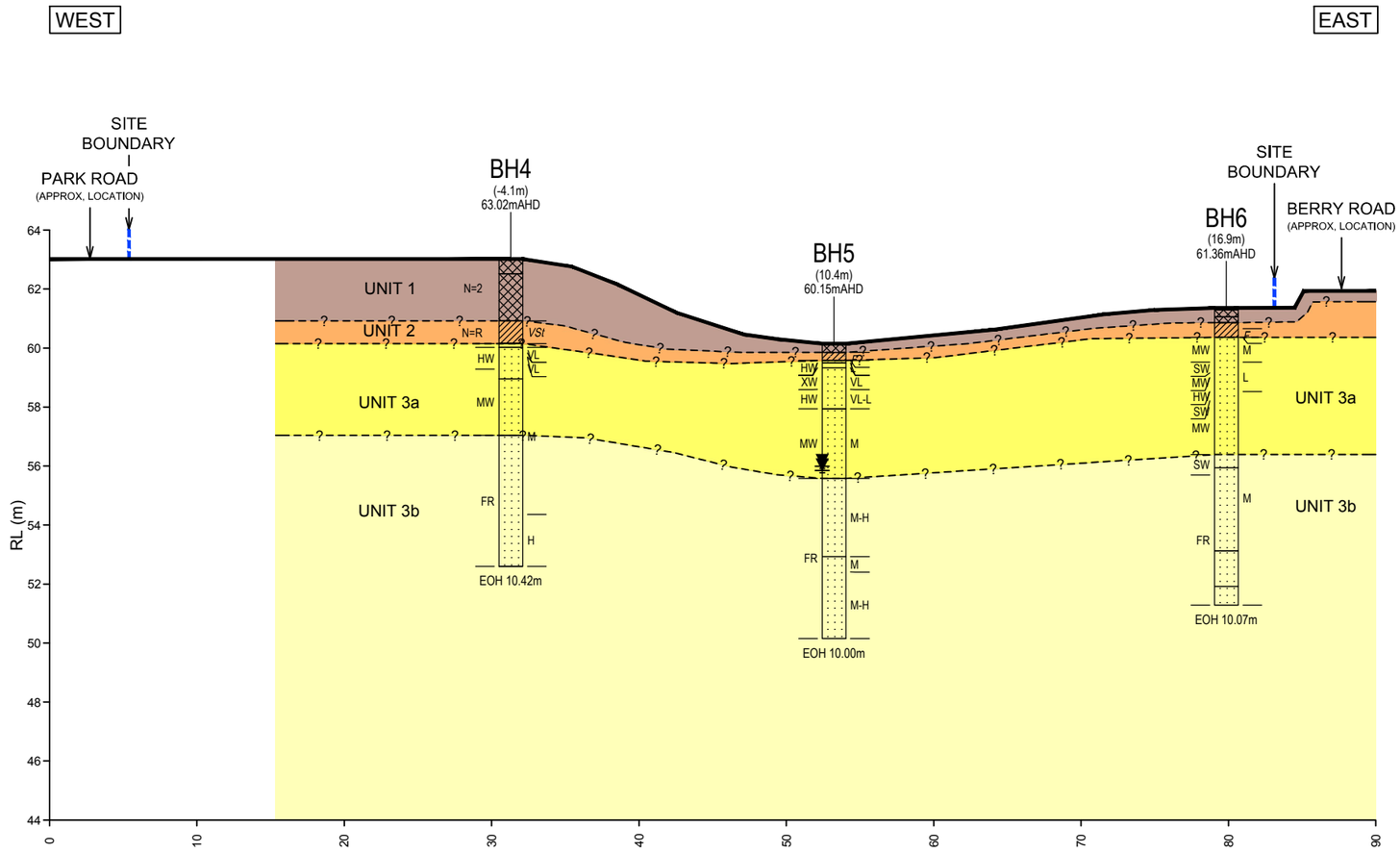
coffey
A TETRA TECH COMPANY

client: COUNTRY GARDEN AUSTRALIA

project: ST LEONARDS DEVELOPMENT
ST LEONARDS, NSW

title: SECTION B-B'

project no: 754-SYDGE219558 | figure no: FIGURE 4 | rev: A



SECTION C-C'

LEGEND

	TOPSOIL	XW-FR	EXTREMELY WEATHERED TO FRESH
	FILL	VL-H	VERY LOW TO HIGH STRENGTH
	SANDY CLAY	▼	WATER LEVEL
	SANDSTONE	N*=17	STANDARD PENETRATION TEST RESULT
	CLAY	———	EXISTING GROUND SURFACE
	NO CORE	– –?– –	INFERRED GEOLOGICAL BOUNDARY
	BITUMINOUS SEAL		

UNIT LEGEND

- UNIT 1 - FILL
- UNIT 2 - RESIDUAL SOIL
- UNIT 3a - HIGHLY TO MODERATELY WEATHERED BEDROCK
- UNIT 3b - SLIGHTLY WEATHERED TO FRESH BEDROCK

revision	no.	description	drawn	approved	date
	A	ORIGINAL ISSUE			

5 0 5 10 15 20
Horizontal Scale (metres) 1:400

2.5 0 2.5 5 7.5 10
Vertical Scale (metres) 1:200

drawn	AB / AW
approved	-
date	22 / 10 / 18
scale	AS SHOWN
original size	A3

coffey
A TETRA TECH COMPANY

client: COUNTRY GARDEN AUSTRALIA

project: ST LEONARDS DEVELOPMENT
ST LEONARDS, NSW

title: SECTION C-C'

project no: 754-SYDGE219558 | figure no: FIGURE 5 | rev: A

Appendix C – Borehole Logs and Core Photographs

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Engineering Log - Borehole

Borehole ID.	***BH1***
sheet:	1 of 3
project no.	***754-SYDGE219558***
client:	***Country Garden Australia Pty Ltd***
date started:	***28 Aug 2018***
principal:	
date completed:	***28 Aug 2018***
project:	***St Leonards Development***
logged by:	***AM***
location:	***St Leonards, NSW***
checked by:	***AB***

position: E: 332,593.14; N: 6,255,592.88 (MGA94) | surface elevation: 66.20 m (AHD) | angle from horizontal: 90°

drill model: Hinowa HP9503, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T			E	66				**TOPSOIL: SILTY SAND**: dark brown.	D			**TOPSOIL**
			E					**FILL: Gravelly SAND**: fine grained, dark brown, trace silt.				**FILL** PID: 0.3 ppm
							CL	**Sandy CLAY**: fine to medium grained, low plasticity, orange-brown, with fine gravels.	<Wp	VSt		PID: 0.3 ppm
			E SPT 4, 9, 12 N*=21	65	1.0							**RESIDUAL SOIL** PID: 0.4 ppm
N				64	2.0			Borehole BH1 continued as cored hole				
				63	3.0							
				62	4.0							
				61	5.0							
				60	6.0							
				59	7.0							

CDF_0_9_07_LIBRARY.GLB rev:AU Log COF BOREHOLE: NON CORED 754-SYDGE219558.GPJ <<DrawingFile>> 12/10/2018 09:02

method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remoulded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey
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Engineering Log - Cored Borehole

Borehole ID.	**BH1**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**28 Aug 2018**
principal:	
date completed:	**28 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,593.14; N: 6,255,592.88 (MGA94) surface elevation: 66.20 m (AHD) angle from horizontal: 90°

drill model: Hinowa HP9503, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		66									
			1.0		started coring at 1.75m						
NMLC		65									
			2.0		**SANDSTONE**: fine to medium grained, red-brown to pale grey, (Class IV to V).	HW		a=0.06 d=0.03			**HAWKESBURY SANDSTONE** PT, 6°, PL, RO, CN JT, 10°, PL, RO, CN JT, 10°, PL, RO, CN JT, 12°, PL, RO JT, 87°, RO JT, 7°, PL, RO, CN SM, Sandy clay, 91 mm JT, 6°, RO, CN SM, Clay, 27 mm JT, 29°, RO, CN JT, 32°, PL, RO, CN
		64						a=0.12 d=0.13	63%		
			3.0			MW to SW					JT, 5°, PL, RO, CN JT, 5°, RO, CO
		63						a=0.52 d=0.28			
			4.0			HW			97%		JT, 5°, RO, CN PT, 8°, RO, CN
	04/09/18	62						a=0.65 d=0.21			JT, 13°, RO, CN JT, 2°, RO
			5.0		4.80 m: Becomes Class III	MW to SW					SM, Gravelly Clay, 19 mm
		61						a=0.55 d=0.56	82%		JT, 8°, RO, X CO JT, 8°, RO, X CO
					5.61 to 5.96 m: Minor Shale Lens						JT, 15°, RO, CN PT, 12°, RO, CO
			6.0								PT, 2°, PL, RO, CN PT, 8°, RO, CN PT, 2°, PL, RO, CN PT, 8°, PL, RO, CN
		60						a=0.21 d=0.20			JT, 6°, RO, CN JT, 13°, PL, RO, CN
			7.0						88%		
		59			**SANDSTONE**: fine to coarse grained, orange-brown to pale grey, (Class III).			a=0.85 d=0.69			JT, 10°, RO, Fe SN JT, 20°, RO, CN
									76%		JT, 4°, RO, CN

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

coffey
A TETRA TECH COMPANY

Engineering Log - Cored Borehole

Borehole ID.	**BH1**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**28 Aug 2018**
principal:	
date completed:	**28 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,593.14; N: 6,255,592.88 (MGA94) surface elevation: 66.20 m (AHD) angle from horizontal: 90°

drill model: Hinowa HP9503, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		58			**SANDSTONE**: fine to coarse grained, orange-brown to pale grey, (Class III). *(continued)*	MW to SW					JT, 2°, RO, CN
											HAWKESBURY SANDSTONE
											JT, 13°, RO, CN
											PT, 18°, PL, RO, CN
						HW		a=0.66 d=0.16	76%		JT, 15°, PL, RO, CO
											JT, 34°, PL, RO, CN
											JT, 30°, PL, RO, CN
											JT, 24°, PL, RO, CN
											JT, 38°, PL, RO, CN
											JT, 16°, RO, CN
											PT, 33°, PL, RO, CN
											JT, 15°, RO, CN
											JT, 21°, PL, RO, CN
						MW to SW		a=0.55 d=0.22	100%		JT, 22°, PL, RO, Fe VN
											JT, 3°, PL, RO, Fe CO
		57	9.0								
			10.0		Borehole BH1 terminated at 10.02 m Target depth						
		56									
			11.0								
		55									
			12.0								
		54									
			13.0								
		53									
			14.0								
		52									
			15.0								
		51									

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

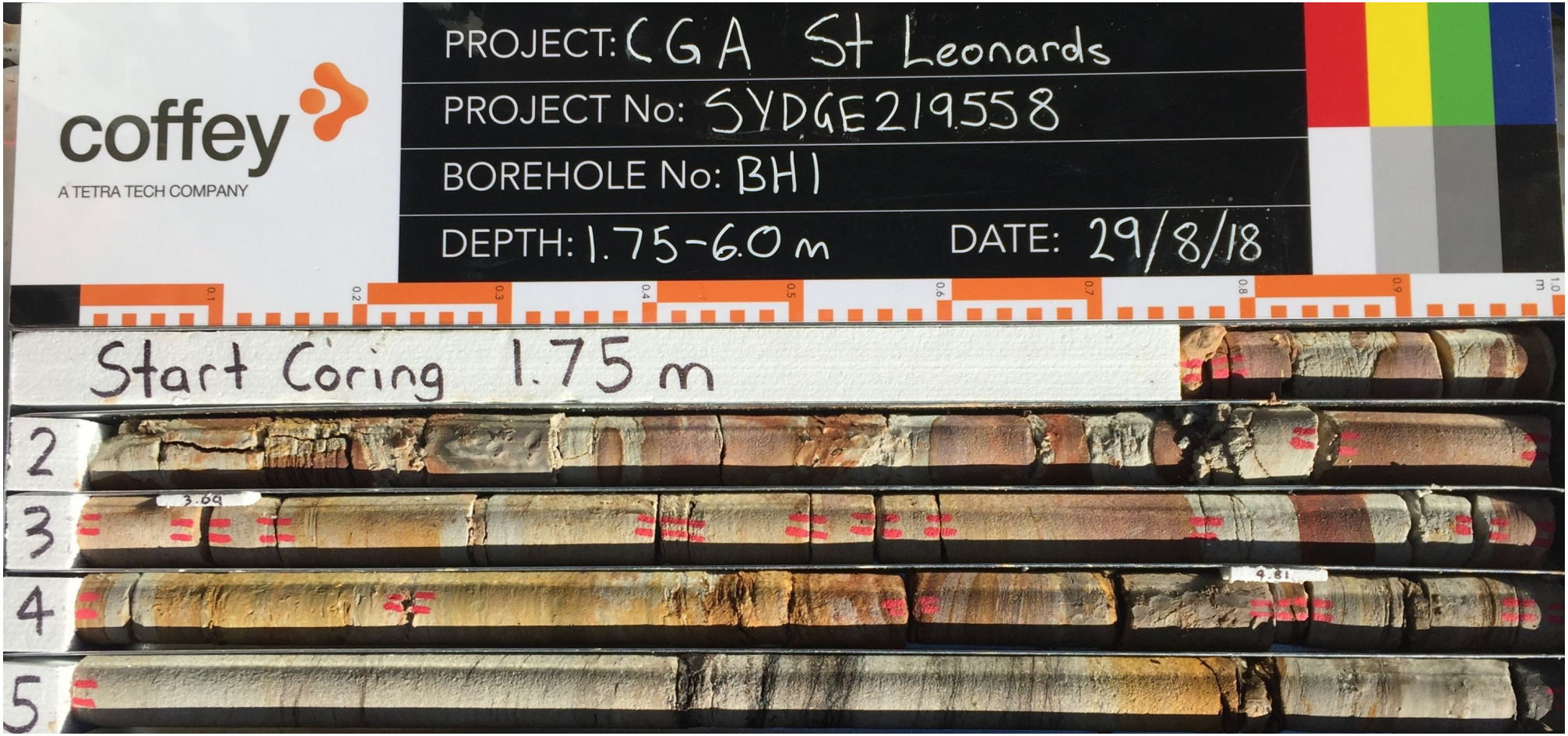
strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating



BH1 1.75 - 6.00 m

drawn	**AM**
approved	**AB**
date	**31/08/2018**
scale	**N.T.S.**
original size	**A4**

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client: Country Garden Australia Pty Ltd

project: St Leonards Development
St Leonards

title: **CORE PHOTOGRAPH**
BH1

project no: 754-SYDGE219558 | fig no: **FIGURE 1** | rev:

BH1 6.00 - 10.02 m

drawn	**AM**
approved	**AB**
date	**31/08/2018**
scale	**N.T.S.**
original size	**A4**

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client: Country Garden Australia Pty Ltd

project: St Leonards Development
St Leonards

title: **CORE PHOTOGRAPH**
BH1

project no: 754-SYDGE219558 | fig no: **FIGURE 2** | rev:

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Piezometer Installation Log

		Hole ID.	***BH1***
		sheet:	1 of 1
		project no.	***754-SYDGE219558***
client:	***Country Garden Australia Pty Ltd***	date started:	***28 Aug 2018***
principal:		date completed:	***28 Aug 2018***
project:	***St Leonards Development***	logged by:	***AM***
location:	***St Leonards, NSW***	checked by:	***AB***

position: E: 332,593.14; N: 6,255,592.88 (MGA94) | surface elevation: 66.20 m (AHD) | angle from horizontal: 90°

equipment type: Hinowa HP9503, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance** | **piezometer construction details**

method & support | water | RL (m) | depth (m) | graphic log | material name

AD/T

NMLC

N

04/09/18

66 | 64 | 62 | 60 | 58 | 56

1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11

TOPSOIL

FILL

RESIDUAL SOIL

HAWKESBURY SANDSTONE

bore construction license:
drilling company:
driller:
driller's permit no.:

BH1

Grout

Bentonite

Sand

3.00 m

3.50 m

4.02 m

10.02 m

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method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
BH1	standpipe			10.02 m			56.18	

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Engineering Log - Borehole

Borehole ID.	**BH2**
sheet:	1 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**27 Jan 1900**
principal:	
date completed:	**27 Jan 1900**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,633.74; N: 6,255,580.28 (MGA94) | surface elevation: 64.47 m (AHD) | angle from horizontal: 90°

drill model: Hinowa HP9503, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T, N			E	64				**FILL: SILTY SAND**: fine to medium grained, dark brown.	D			**FILL**
			E					**FILL: CLAYEY SAND**: fine to medium grained, orange-brown.				
			SPT 1, 1, 2 N*=3	63	1.0		CI	**FILL: Sandy CLAY**: fine to medium grained, low plasticity, dark grey.	>Wp	St		**ALLUVIUM?**
								CLAY: medium plasticity, orange-brown, trace medium grained sand.				
					2.0		CL	**Sandy CLAY**: medium to coarse grained, low plasticity, orange-brown mottled dark grey.		VSt		**RESIDUAL SOIL**
			SPT 11, 8, /0mm N*=R	62	3.0							Discontinued for fear of equipment becoming unrecoverable.
								Borehole BH2 continued as cored hole				
				61	4.0							
				60	5.0							
				59	6.0							
				58	7.0							
				57								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH2**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**27 Jan 1900**
principal:	
date completed:	**27 Jan 1900**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,633.74; N: 6,255,580.28 (MGA94) | surface elevation: 64.47 m (AHD) | angle from horizontal: 90°

drill model: Hinowa HP9503, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		64	1.0		started coring at 3.00m						
		63	2.0								
		62	3.0								
NMLC		61	4.0		**SANDSTONE**: fine to medium grained, orange-brown to pale grey, (Class V).	HW		a=0.27 d=0.10	42%		JT, 10°, CU, RO, CN JT, 10°, ST, RO, CN JT, 7°, UN, RO, CN SM, Clay, 37 mm SM, Clay, 32 mm PT, 3°, PL, RO, Fe SN SM, Clay, 24 mm JT, 6°, PL, RO, CN JT, 57°, PL, RO, CN SM, Sandy clay, 340 mm
		60	5.0		5.14 to 5.33 m: Shale laminae			a=1.63 d=0.81	87%		JT, 81°, UN, RO, CN PT, 3°, ST, RO, CN PT, 8°, ST, RO, CN SM, Clay, 42 mm
		59	6.0		**SANDSTONE**: fine to coarse grained, dark grey to pale grey, indistinctly bedded at 5°-15° (Class IV).	MW SW		a=2.56 d=1.29 a=0.61 d=0.25	100%		JT, 10°, PL, RO, Fe CO JT, 4°, UN, RO, CN JT, 6°, UN, RO, CN
		58	7.0		6.00 to 6.50 m: Dark grey, fine grained sandstone **SANDSTONE**: fine to coarse grained, pale grey, distinctly bedded at 0°-25° (Class II).	FR		a=1.15 d=1.15	100%		PT, 5°, UN, RO, Fe CO JT, 8°, UN, RO, CN
		57									

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

Borehole ID.	**BH2**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**27 Jan 1900**
principal:	
date completed:	**27 Jan 1900**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,633.74; N: 6,255,580.28 (MGA94) surface elevation: 64.47 m (AHD) angle from horizontal: 90°

drill model: Hinowa HP9503, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		56	9.0		**SANDSTONE**: fine to coarse grained, pale grey, distinctly bedded at 0°-25° (Class II). *(continued)*	FR		a=1.40 d=0.89	100%		PT, 22°, CU, RO, CN
		55						a=1.51 d=1.03	100%		
			10.0					a=1.58 d=1.06			
		54			Borehole BH2 terminated at 10.11 m Target depth						
			11.0								
		53									
			12.0								
		52									
			13.0								
		51									
			14.0								
		50									
			15.0								
		49									

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

BH2 3.00 - 8.00 m

drawn	**AM**
approved	**AB**
date	**31/08/2018**
scale	**N.T.S.**
original size	**A4**

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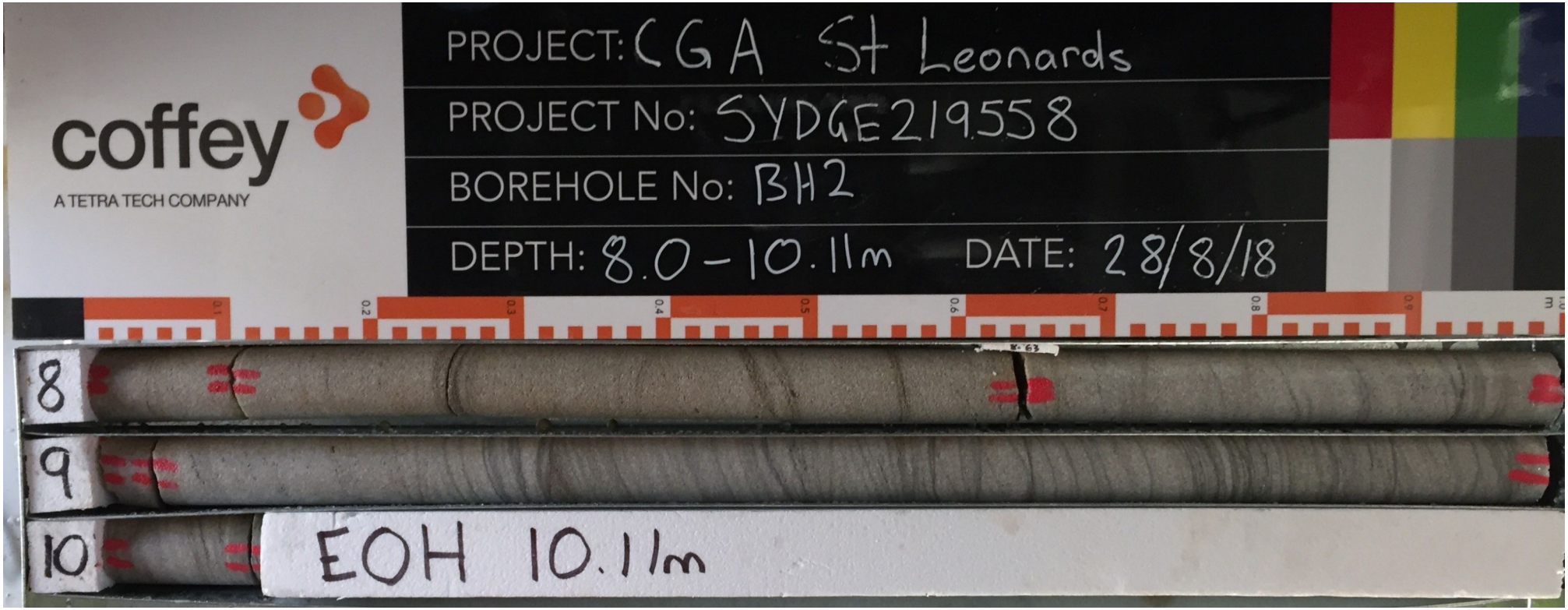
client:	Country Garden Australia Pty Ltd
project:	St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH2**
project no: 754-SYDGE219558	fig no: **FIGURE 1** rev:



BH2 8.00 - 10.11 m

drawn	**AM**
approved	**AB**
date	**31/08/2018**
scale	**N.T.S.**
original size	**A4**

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client: Country Garden Australia Pty Ltd

project: St Leonards Development
St Leonards

title: **CORE PHOTOGRAPH**
BH2

project no: 754-SYDGE219558 | fig no: **FIGURE 2** | rev:

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Engineering Log - Borehole

Borehole ID.	***BH3***
sheet:	1 of 3
project no.	***754-SYDGE219558***
client: ***Country Garden Australia Pty Ltd***	date started: ***27 Aug 2018***
principal:	date completed: ***27 Aug 2018***
project: ***St Leonards Development***	logged by: ***AM***
location: ***St Leonards, NSW***	checked by: ***AB***

position: E: 332,663.83; N: 6,255,579.14 (MGA94) | surface elevation: 66.20 m (AHD) | angle from horizontal: 90°

drill model: Hinowa HP9503, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			E	66				**FILL: SILTY SAND**: dark brown.	D			**FILL**
HA			E					**CLAY**: medium plasticity, orange brown.	<Wp	F		**RESIDUAL SOIL**
AD/T			SPT 3,3,3 N=6	65	1.0			1.0 m: trace sandstone gravels		VSt	>>X	
			SPT 7,8,11 N=19									
									>Wp			
				64	2.0			Borehole BH3 continued as cored hole				
				63	3.0							
				62	4.0							
				61	5.0							
				60	6.0							
				59	7.0							

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH3**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**27 Aug 2018**
principal:	
date completed:	**27 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,663.83; N: 6,255,579.14 (MGA94) surface elevation: 66.20 m (AHD) angle from horizontal: 90°

drill model: Hinowa HP9503, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		66									
			1.0		started coring at 1.90m						
NMLC		65	2.0		**SANDSTONE**: medium grained, red-brown to pale grey, (Class V).	HW		a=0.16 d=0.12	85%		**HAWKESBURY SANDSTONE** SM, Clay, 62 mm JT, 66°, CU, RO, CN JT, 64°, CU, RO, CN JT, 70°, CU, RO, CN
		64									PT, 5°, PL, RO, CN
			3.0					a=0.27 d=0.24	82%		SM, Clay, 200 mm SM, Clay, 8 mm PT, 15°, PL, RO, CN JT, 60°, PL, CN, Tight SM, Clay, 10 mm
	04/09/18	63									
		62	4.0								JT, 59°, CU, RO, CN
			5.0		5.26 to 5.43 m: distinctly laminated shale lens			a=0.32 d=0.32	77%		JT, 18°, PL, RO, CN SM, Clay, 16 mm SM, Sandy clay, 30 mm PT, 7°, UN, RO, Fe SN SM, Clay, 17 mm JT, 25°, CU, RO, CN JT, 16°, CU, RO, CN SM, Clay, 33 mm SM, Clay, 17 mm
		61						a=0.75 d=0.22			
			6.0		**SANDSTONE**: fine to medium grained, pale grey, distinctly cross bedded at 5-15° (Class II to III).	FR			100%		PT, 11°, PL, RO, CN
		60			6.61 to 6.91 m: fine sandstone interbedding, dark grey	MW FR		a=0.48 d=0.06	82%		PT, 7°, PL, SO, CN
			7.0			HW			100%		PT, 18°, CU, RO, VN SM, Clay, 4 mm
		59						a=1.32 d=0.38	86%		

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

coffey
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Engineering Log - Cored Borehole

Borehole ID.	**BH3**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**27 Aug 2018**
principal:	
date completed:	**27 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,663.83; N: 6,255,579.14 (MGA94) surface elevation: 66.20 m (AHD) angle from horizontal: 90°

drill model: Hinowa HP9503, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		58			**SANDSTONE**: fine to coarse grained, pale grey to orange-brown, distinctly bedded at 20-30° (Class II to III).	MW		a=0.90 d=0.78	86%		SM, Fe, 4 mm **HAWKESBURY SANDSTONE** SM, Gravelly Clay, 14 mm JT, 11°, CU, RO, Fe VN JT, 38°, CU, Fe CO, Very Narrow JT, 40°, PL, Fe CO PT, 23°, PL, RO, CN PT, 23°, PL, RO, CN PT, 23°, PL, RO, Clay CO PT, 25°, PL, RO, CN
		57	9.0			FR					
					SANDSTONE: fine to coarse grained, pale grey, indistinctly cross bedded at 10-20° (Class II).			a=0.84 d=0.88	87%		PT, 10°, PL, RO, CN JT, 7°, PL, RO, CN
			10.0					a=0.93 d=0.78			JT, 15°, PL, RO, SN
		56			Borehole BH3 terminated at 10.08 m Target depth						
			11.0								
		55									
			12.0								
		54									
			13.0								
		53									
			14.0								
		52									
			15.0								
		51									

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

BH3 1.90 - 6.00 m

drawn	
approved	
date	**28-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH3**
project no:	754-SYDGE219558
fig no:	**FIGURE 1**
rev:	

BH3 6.00 - 10.08 m

drawn	
approved	
date	**28-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH3**
project no:	754-SYDGE219558
fig no:	**FIGURE 2**
rev:	

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Piezometer Installation Log

Hole ID.	***BH3***
sheet:	1 of 1
project no.	***754-SYDGE219558***
client: ***Country Garden Australia Pty Ltd***	date started: ***27 Aug 2018***
principal:	date completed: ***27 Aug 2018***
project: ***St Leonards Development***	logged by: ***AM***
location: ***St Leonards, NSW***	checked by: ***AB***

position: E: 332,663.83; N: 6,255,579.14 (MGA94) | surface elevation: 66.20 m (AHD) | angle from horizontal: 90°

equipment type: Hinowa HP9503, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance** | **piezometer construction details**

method & support: HA, AD/T, NMLC

water: 04/09/18

RL (m): 66, 64, 62, 60, 58, 56

depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

graphic log

material name

- **FILL**
- **RESIDUAL SOIL**
- **HAWKESBURY SANDSTONE**

bore construction license:
drilling company:
driller:
driller's permit no.:

BH3

- Grout
- Bentonite
- Sand

2.96 m
3.48 m
4.08 m
10.08 m

method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 — water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
BH3	standpipe			10.08 m			56.12	

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Engineering Log - Borehole

Borehole ID.	**BH4**
sheet:	1 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**23 Aug 2018**
principal:	
date completed:	**23 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,612.49; N: 6,255,561.93 (MGA94) | surface elevation: 63.02 m (AHD) | angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			E	63				**FILL: SILTY SAND**: dark brown, with coarse gravels.	D			**FILL** PID: 0.5 ppm
			E					**FILL: CLAY**: high plasticity, some ash with gravels.	>Wp			Reworked Natural?
AD/T	N		SPT 2, 1, 1 N=2	62	1.0							PID: 0.5 ppm
				61	2.0		CL	**CLAY**: low plasticity, pale grey.	<Wp	VSt	>>X	**RESIDUAL SOIL**
			SPT 12, 9, 30/65mm N=R									
				60	3.0			**SANDSTONE**: orange-brown to pale grey, recovered as low strength gravelly sand. Borehole BH4 continued as cored hole	D			
				59	4.0							
				58	5.0							
				57	6.0							
				56	7.0							

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH4**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**23 Aug 2018**
principal:	
date completed:	**23 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,612.49; N: 6,255,561.93 (MGA94) | surface elevation: 63.02 m (AHD) | angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		63									
		62	1.0								
		61	2.0		started coring at 2.87m						
NMLC		60	3.0		**NO CORE:** 0.13 m **SANDSTONE**: fine to medium grained, orange-brown, (Class IV to V).	HW		a=0.92 d=0.88 a=0.83 d=0.84			Very low strength zone PT, 0°, PL, RO, CN SM, Clay, 58 mm
		59	4.0			MW		a=0.98 d=0.68	83%		PT, 8°, PL, RO, CN PT, 20°, PL, RO, CN
		58	5.0		**SANDSTONE**: fine to coarse grained, red-brown, distinctly bedded at 15-30° (Class IV).			a=1.37 d=1.35			SM, Sandy clay, 11 mm
		57	6.0		**SANDSTONE**: medium to coarse grained, pale grey, distinctly cross bedded at 5-25° (Class II).	FR		a=1.35 d=0.81 a=0.99 d=0.46 a=1.39 d=0.80 a=0.70 d=0.36	96%		JT, 8°, PL, RO, CN
		56	7.0					a=0.87 d=0.40			PT, 10°, PL, RO, CN JT, 8°, UN, RO, CN

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

Borehole ID.	**BH4**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**23 Aug 2018**
principal:	
date completed:	**23 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,612.49; N: 6,255,561.93 (MGA94) surface elevation: 63.02 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		55			**SANDSTONE**: medium to coarse grained, pale grey, distinctly cross bedded at 5-25° (Class II). *(continued)*	FR		a=0.32 d=0.87			SM, Clay, 10 mm
		54	9.0								PT, 11°, PL, RO, CO
		53	10.0					a=1.48 d=1.02	97%		PT, 10°, PL, RO, Clay CO SM, Clay, 8 mm
								a=2.07 d=1.15			
		52	11.0		Borehole BH4 terminated at 10.42 m Target depth						
		51	12.0								
		50	13.0								
		49	14.0								
		48	15.0								

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

BH4 2.87 - 7.00 m

drawn	
approved	
date	**23-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD		
project:	Country Garden St Leonards Development St Leonards		
title:	**CORE PHOTOGRAPH** **BH4**		
project no: 754-SYDGE219558		fig no: **FIGURE 1**	rev:

BH4 7.00 - 10.42 m

drawn	
approved	
date	**23-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH4**
project no: 754-SYDGE219558	fig no: **FIGURE 2** rev:

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Engineering Log - Borehole

Borehole ID.	**BH5**
sheet:	1 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**21 Aug 2018**
principal:	
date completed:	**21 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,631.96; N: 6,255,544.25 (MGA94) | surface elevation: 60.15 m (AHD) | angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T — HA — CASING			E	60				**FILL: SILTY SAND**: dark brown, with coarse gravels.	D			**FILL**
			E				CL	**Sandy CLAY**: low plasticity, pale orange-brown, with fine to coarse grained sand.	>Wp	F		**RESIDUAL SOIL**
								Borehole BH5 continued as cored hole				
				59	1.0							
				58	2.0							
				57	3.0							
				56	4.0							
				55	5.0							
				54	6.0							
				53	7.0							

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH5**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**21 Aug 2018**
principal:	
date completed:	**21 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,631.96; N: 6,255,544.25 (MGA94) surface elevation: 60.15 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		60			started coring at 0.57m						
NMLC	27/08/18 04/09/18	59	1.0		**SANDSTONE**: fine to coarse grained, red-brown to pale grey.	HW					**HAWKESBURY SANDSTONE**
					NO CORE: 0.17 m	XW					
					SANDSTONE: fine to coarse grained, red-brown to pale grey, (Class IV).				0%		SM, Sandy clay, 410 mm FZ, 320 mm PT, 5°, PL, RO, CN PT, 5°, PL, RO, CN PT, 5°, PL, RO, CN SM, Sandy clay, 35 mm SM, Sandy clay, 11 mm JT, 0°, PL, RO, CN
		58	2.0			HW		a=0.11 d=0.14	65%		Root jacking 65° Root jacking 65° SM, Sandy clay, 35 mm JT, 2°, PL, RO, CN Root jacking 0°
					SANDSTONE: medium to coarse grained, dark red-brown to pale orange brown, indistinctly bedded at 10-25° (Class IV).	MW		a=1.23 d=1.06			JT, 5°, CU, RO, CN
		57	3.0						94%		
		56	4.0					a=0.94 d=0.81			JT, 5°, PL, RO, CN
					SANDSTONE: fine to coarse grained, pale grey, distinctly bedded at 0-20° with carbonaceous laminae (Class II).	FR		a=1.06 d=0.98 a=0.96 d=0.84 a=1.01 d=0.74			SM, Clayey sand, 8 mm JT, 5°, PL, RO, CN JT, 5°, PL, RO, CN PT, 5°, UN, RO, CN
		55	5.0						97%		JT, 10°, CU, RO, CN
		54	6.0					a=1.36 d=1.14 a=1.10 d=1.27			JT, 5°, UN, RO, CN JT, 86°, UN, RO, CN PT, 15°, CU, RO, VN
		53	7.0					a=1.12 d=1.22	94%		JT, 10°, PL, RO, CN PT, 5°, PL, RO, Fe VN PT, 5°, PL, RO, Fe VN
					SANDSTONE: medium to coarse grained, pale grey, massive (Class II). 7.30 to 7.41 m: Minor shale breccia 7.52 to 7.74 m: dark grey, laminated at 12°			a=0.65 d=0.31			FZ PT, 20°, PL, RO, CN

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

coffey
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Engineering Log - Cored Borehole

Borehole ID.	**BH5**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**21 Aug 2018**
principal:	
date completed:	**21 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,631.96; N: 6,255,544.25 (MGA94) surface elevation: 60.15 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information				material substance					rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		52			**SANDSTONE**: medium to coarse grained, pale grey, massive (Class II). *(continued)*	FR		a=0.97 d=1.08	94%		**HAWKESBURY SANDSTONE**
		51	9.0		9.06 m: becoming indistinctly bedded at 5-10°			a=1.37 d=1.06 a=1.16 d=0.88 a=1.08 d=0.96	93%		SM, Sandy clay, 8 mm PT, 5°, PL, RO, CN PT, 10°, PL, RO, CN
		50	10.0		Borehole BH5 terminated at 10.00 m Target depth						
		49	11.0								
		48	12.0								
		47	13.0								
		46	14.0								
		45	15.0								

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

BH5 0.57 - 5.00 m

drawn	
approved	
date	22-08-2018
scale	N.T.S.
original size	A4

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH5**
project no:	754-SYDGE219558
fig no:	**FIGURE 1**
rev:	

BH5 5.00 - 10.00 m

drawn	
approved	
date	**22-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH5**
project no:	754-SYDGE219558
fig no:	**FIGURE 2**
rev:	

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Piezometer Installation Log

		Hole ID.	***BH5***
		sheet:	1 of 1
		project no.	***754-SYDGE219558***
client:	***Country Garden Australia Pty Ltd***	date started:	***21 Aug 2018***
principal:		date completed:	***21 Aug 2018***
project:	***St Leonards Development***	logged by:	***AM***
location:	***St Leonards, NSW***	checked by:	***AB***

position: E: 332,631.96; N: 6,255,544.25 (MGA94) | surface elevation: 60.15 m (AHD) | angle from horizontal: 90°

equipment type: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance** | **piezometer construction details**

method & support | water | RL (m) | depth (m) | graphic log | material name

HA | CASING | NMLC

27/08/18 | 04/09/18

60 | 58 | 56 | 54 | 52 | 50

1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11

FILL

RESIDUAL SOIL

HAWKESBURY SANDSTONE

bore construction license:
drilling company:
driller:
driller's permit no.:

BH5

0.30 m
0.60 m
1.00 m
10.00 m

Grout
Bentonite
Sand

method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
BH5	standpipe			10.00 m			50.15	

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Engineering Log - Borehole

Borehole ID.	**BH6**
sheet:	1 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**20 Aug 2018**
principal:	
date completed:	**21 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,657.29; N: 6,255,533.79 (MGA94) | surface elevation: 61.36 m (AHD) | angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			E	61				**BRICK PAVERS**.	D			**FILL**
								FILL: SAND: yellow brown.				
								FILL: SILTY SAND: pale brown, with gravels.				
							CL	**FILL: CLAYEY SAND**: orange brown.				**RESIDUAL SOIL**
AD/T			E					**CLAY**: low plasticity, orange brown.	<Wp	F		
					1.0			Borehole BH6 continued as cored hole				
				60	2.0							
				59	3.0							
				58	4.0							
				57	5.0							
				56	6.0							
				55	7.0							
				54								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH6**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**20 Aug 2018**
principal:	
date completed:	**21 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,657.29; N: 6,255,533.79 (MGA94) surface elevation: 61.36 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		61									
			1.0		started coring at 1.00m						
NMLC		60	1.0		**SANDSTONE**: medium to coarse grained, pale grey to dark red-brown, distinctly bedded at 10-20° (Class IV to V).	MW		a=0.69 d=0.72			JT, 5 - 10°, PL, RO, CN JT, 5 - 10°, PL, RO, CN JT, 5 - 10°, PL, RO, CN JT, 5 - 10°, PL, RO, CN JT, 5 - 10°, PL, RO, CN JT, 5 - 10°, PL, RO, CN
			2.0			SW		a=0.28 d=0.16	70%		PT, 18°, PL, RO, CN JT, 5°, PL, RO, CN PT, 10°, PL, RO, CN
		59				MW HW					JT, 7°, PL, RO, CN SM, Clayey sand, 11 mm SM, Clayey sand, 25 mm JT, 2°, UN, RO, Fe SN JT, 0°, PL, RO, CN
			3.0		3.00 m: becoming indistinctly bedded at 10-20°	SW		a=1.00 d=0.61			
		58				MW			100%		JT, 5°, UN, RO, CN
			4.0					a=0.73 d=0.30			
		57				SW			99%		
			5.0					a=0.59 d=0.43			
		56			**SANDSTONE**: medium to coarse grained, pale grey, distinctly to indistinctly bedded at 10-25° (Class II).	FR					SM, Sandy clay, 24 mm, grey PT, 25°, PL, RO, CN
			6.0								PT, 12°, PL, RO, CN
		55						a=0.90 d=0.60			
			7.0						91%		JT, 2°, UN, RO, CN PT, 15°, UN, RO, CN
		54									PT, 14°, UN, RO, CN
								a=0.82 d=0.86			JT, 5°, PL, RO, CN

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

Borehole ID.	**BH6**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**20 Aug 2018**
principal:	
date completed:	**21 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,657.29; N: 6,255,533.79 (MGA94) surface elevation: 61.36 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information				material substance						rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		53	9.0		**SANDSTONE**: fine to coarse grained, pale grey, distinct carbonaceous laminae at 3-10° (Class II).	FR		a=0.38 d=0.37	91%		JT, 28°, CU, RO, CN SM, Clay, 24 mm, grey PT, 10°, PL, RO, CN PT, 6°, PL, RO, CN PT, 6°, PL, RO, CN PT, 6°, PL, RO, CN PT, 6°, PL, RO, CN
		52	10.0		**SANDSTONE**: fine to medium grained, pale grey, (Class II).			a=0.73 d=0.76 a=1.44 d=0.59	100%		JT, 5°, PL, RO, CN
		51	11.0		Borehole BH6 terminated at 10.07 m Target depth						
		50	12.0								
		49	13.0								
		48	14.0								
		47	15.0								
		46									

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

BH6 1.00 - 6.00 m

drawn	
approved	
date	**27-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH6**
project no:	754-SYDGE219558
fig no:	
rev:	

BH6 6.00 - 10.07 m

drawn	
approved	
date	**27-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH6**
project no: 754-SYDGE219558	fig no:
rev:	

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Engineering Log - Borehole

Borehole ID.	***BH7***
sheet:	1 of 1
project no.	***754-SYDGE219558***
client:	***Country Garden Australia Pty Ltd***
date started:	***22 Aug 2018***
principal:	
date completed:	***22 Aug 2018***
project:	***St Leonards Development***
logged by:	***AM***
location:	***St Leonards, NSW***
checked by:	***AB***

position: E: 332,584.02; N: 6,255,511.96 (MGA94) | surface elevation: 56.93 m (AHD) | angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			E					**FILL: CLAYEY SAND**: dark brown, with coarse gravels.	D			**FILL**
AD/T			E		0.5							PID: 1.76 ppm
				56				**FILL: CLAY**: low plasticity, dark orange brown.	<Wp			
			E		1.0							PID: 0.98 ppm
			SPT 1, 1, 18 N=19									
					1.5							
				55				Borehole BH7 terminated at 1.6 m Services present				

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

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Engineering Log - Borehole

Borehole ID.	***BH7A***
sheet:	1 of 3
project no.	***754-SYDGE219558***
client:	***Country Garden Australia Pty Ltd***
date started:	***22 Aug 2018***
principal:	
date completed:	***22 Aug 2018***
project:	***St Leonards Development***
logged by:	***AM***
location:	***St Leonards, NSW***
checked by:	***AB***

position: E: 332,584.41; N: 6,255,512.40 (MGA94) | surface elevation: 56.85 m (AHD) | angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
AD/T				56	1.0			**FILL: CLAYEY SAND**: dark brown, with coarse gravels.	D			**FILL**
												PID: 2.43 ppm
			SPT 1, 1, 3 N=4					**FILL: Gravelly CLAY**: low plasticity, dark orange brown, with coarse gravels.	<Wp			PID: 2.12 ppm
				55	2.0			**FILL: Sandy CLAY**: low plasticity, dark brown, with coarse sand.				
			SPT 3, 2, 2 N=4	54	3.0				>Wp			
								SANDSTONE: medium to coarse grained, pale yellow brown, recovered as sand with clay, very low to low strength (Class V)..				**HAWKESBURY SANDSTONE**
				53	4.0			Borehole BH7A continued as cored hole				
				52	5.0							
				51	6.0							
				50	7.0							
				49								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH7A**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**22 Aug 2018**
principal:	
date completed:	**22 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,584.41; N: 6,255,512.40 (MGA94) surface elevation: 56.85 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC	27/08/18 04/09/18	56 55 54 53 52 51 50 49	1.0 2.0 3.0 4.0 5.0 6.0 7.0		started coring at 3.40m **SANDSTONE**: fine to medium grained, orange, (Class II to III). **NO CORE:** 0.31 m **SANDSTONE**: fine to medium grained, orange, (Class II). **SANDSTONE**: fine to medium grained, pale grey, (Class II), distinctly to indistinctly bedded at 15-25°.	MW MW SW MW SW		a=0.51 d=0.51 a=0.64 d=0.50 a=0.22 d=0.24 a=1.13 d=0.54 a=0.98 d=0.39	62% 92% 79%	SM, Sandy clay, 36 mm SM, Sandy clay, 34 mm Root Joint, 5°, UN, RO, Roots SM, Sandy clay, 10 mm SM, CL Clay, 8 mm PT, 18°, PL, RO, CN JT, 3°, PL, RO, CN PT, 19°, PL, RO, CN JT, 65°, PL, RO, CN SM, Sandy clay, 14 mm SM, Clay, 18 mm JT, 12°, PL, RO, CN PT, 17°, ST, RO, VN PT, 15°, PL, RO, CN PT, 15°, PL, RO, CN PT, 17°, PL, RO, CN PT, 20°, PL, RO, VN PT, 20°, PL, RO, VN PT, 21°, PL, RO, CN JT, 9°, PL, RO, CN

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

coffey
A TETRA TECH COMPANY

Engineering Log - Cored Borehole

Borehole ID.	**BH7A**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**22 Aug 2018**
principal:	
date completed:	**22 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,584.41; N: 6,255,512.40 (MGA94) surface elevation: 56.85 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		48	9.0		**SANDSTONE**: fine to medium grained, pale grey, (Class II), distinctly bedded at 20-35° with some disturbed bedding.	FR		a=1.03 d=1.50 a=0.22 d=0.79 a=0.58 d=0.74	79%		JT, 5°, CU, RO, CN JT, 5°, PL, RO, CN Defects are: PT, 25°, PL, RO, CN, unless otherwise described
		47	10.0		Borehole BH7A terminated at 10.26 m Target depth						
		46	11.0								
		45	12.0								
		44	13.0								
		43	14.0								
		42	15.0								
		41									

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

BH7A 3.40 - 8.00 m

drawn	
approved	
date	**23-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH7A**
project no:	754-SYDGE219558
fig no:	**FIGURE 1**
rev:	

BH7A 8.00 - 10.26 m

drawn	
approved	
date	**23-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH7A**
project no: 754-SYDGE219558	fig no: **FIGURE 2** rev:

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Piezometer Installation Log

		Hole ID.	***BH7A***
		sheet:	1 of 1
		project no.	***754-SYDGE219558***
client:	***Country Garden Australia Pty Ltd***	date started:	***22 Aug 2018***
principal:		date completed:	***22 Aug 2018***
project:	***St Leonards Development***	logged by:	***AM***
location:	***St Leonards, NSW***	checked by:	***AB***

position: E: 332,584.41; N: 6,255,512.40 (MGA94) | surface elevation: 56.85 m (AHD) | angle from horizontal: 90°

equipment type: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance** | **piezometer construction details**

method & support | water | RL (m) | depth (m) | graphic log | material name

bore construction license:
drilling company:
driller:
driller's permit no.:

AD/T
NMLC
27/08/18
04/09/18

56 | 54 | 52 | 50 | 48 | 46

1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11

FILL

HAWKESBURY SANDSTONE

BH7A

3.22 m
3.76 m
4.26 m
10.26 m

Grout
Bentonite
Sand

ID: BH7A PVC TYPE: uPVC
ID/OD: 51/60.2 mm
DESCRIPTION OF SLOTS: Slot Spacing = 4 mm, Slot width = 0.5 mm
SAND PACK: K2 mm

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method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
BH7A	standpipe			10.26 m			46.59	

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Engineering Log - Borehole

Borehole ID.	**BH8**
sheet:	1 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**21 Aug 2018**
principal:	
date completed:	**22 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,627.64; N: 6,255,510.97 (MGA94) | surface elevation: 54.92 m (AHD) | angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
HA AD/T CASING	1 2 3							**BRICK PAVERS**.	D			**PAVEMENT**
								FILL: SAND: pale brown.				**FILL**
								FILL: SAND: dark brown, with coarse gravels.				
				54	1.0			**CLAY**: low plasticity, orange-brown, with fine grained sand.	<Wp	St		**RESIDUAL SOIL**
								Borehole BH8 continued as cored hole				
				53	2.0							
				52	3.0							
				51	4.0							
				50	5.0							
				49	6.0							
				48	7.0							
				47								

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH8**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**21 Aug 2018**
principal:	
date completed:	**22 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,627.64; N: 6,255,510.97 (MGA94) surface elevation: 54.92 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		54	1.0		started coring at 1.33m						
NMLC		53	2.0		**SANDSTONE**: fine to coarse grained, orange-red-brown to pale grey, (Class IV), indistinctly bedded at 5-15°.	MW		a=0.78 d=0.54	81%		PT, 26°, PL, RO, CN JT, 5°, UN, RO, CN JT, 6°, CU, RO, Clay CO
		52	3.0					a=0.68 d=0.46 a=1.23 d=0.92	95%		PT, 18°, PL, RO, CN JT, 5°, UN, RO, CN JT, 33°, IR, RO, Fe SN
		51	4.0		**SANDSTONE**: fine to medium grained, pale grey, (Class II), indistinctly bedded at 5-20°.	SW - FR		a=1.17 d=0.43	81%		PT, 18°, PL, RO, CN JT, 41°, PL, RO, CN JT, 65°, PL, RO, CN
		50	5.0					a=1.13 d=0.68			SM, Clay, 11 mm SM, Sandy clay, 6 mm SM, Sandy clay, 5 mm
		49	6.0		**SANDSTONE**: fine to medium grained, orange-brown, (Class IV), indistinctly bedded at 10-25°.	MW - SW		a=1.45 d=0.48			JT, 3°, UN, RO, CN JT, 71°, PL, RO, CN JT, 3°, PL, RO, CN JT, 5°, PL, RO, CN
		48	7.0					a=0.86 d=0.46	83%		PT, 25°, PL, RO, Fe SN
		47									

Defects are: PT, 5 - 20°, PL, RO, CN, unless otherwise described

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

Borehole ID.	**BH8**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**21 Aug 2018**
principal:	
date completed:	**22 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,627.64; N: 6,255,510.97 (MGA94) surface elevation: 54.92 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		46	9.0			MW - SW					
					SANDSTONE: fine to medium grained, pale grey, (Class III), indistinctly bedded at 10-30°.	SW		a=0.74 d=0.04	83%		JT, 83°, UN, RO, CN FZ, 110 mm
					NO CORE: 0.35 m						
		45	10.0		**SANDSTONE**: fine to medium grained, pale grey, (Class II), indistinctly bedded at 10-30°.	FR		a=1.09 d=1.07	74%		SM, CL Clay, 15 mm JT, 8°, UN, RO, CN
					Borehole BH8 terminated at 10.00 m Target depth						
		44	11.0								
		43	12.0								
		42	13.0								
		41	14.0								
		40	15.0								
		39									

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

BH8 1.33 - 6.00 m

drawn	
approved	
date	**22-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH8**
project no:	754-SYDGE219558
fig no:	**FIGURE 1**
rev:	

BH8 6.00 - 10.00 m

drawn	
approved	
date	**22-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH8**
project no:	754-SYDGE219558
fig no:	**FIGURE 2**
rev:	

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Engineering Log - Borehole

Borehole ID.	**BH9**
sheet:	1 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**20 Aug 2018**
principal:	
date completed:	**20 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,666.75; N: 6,255,516.48 (MGA94) | surface elevation: 60.16 m (AHD) | angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA AD/T — CASING			E	60				**TOPSOIL: SILTY SAND**: pale yellow brown.	D			**TOPSOIL** PID: 3.5 ppm
								SANDSTONE: orange brown, recovered as low strength clayey sand.	M			**HAWKESBURY SANDSTONE**
			SPT 2, 8, /100mm HB N*=R	59	1.0			Borehole BH9 continued as cored hole				
				58	2.0							
				57	3.0							
				56	4.0							
				55	5.0							
				54	6.0							
				53	7.0							

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method
AD auger drilling*
AS auger screwing*
HA hand auger
W washbore
HA hand auger

* bit shown by suffix
e.g. AD/T
B blank bit
T TC bit
V V bit

support
M mud
C casing
N nil

penetration
1 2 3 — no resistance ranging to refusal

water
10-Oct-12 water level on date shown
water inflow
water outflow

samples & field tests
B bulk disturbed sample
D disturbed sample
E environmental sample
SS split spoon sample
U## undisturbed sample ##mm diameter
HP hand penetrometer (kPa)
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
VS vane shear; peak/remouded (kPa)
R refusal
HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
D dry
M moist
W wet
Wp plastic limit
Wl liquid limit

consistency / relative density
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH9**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**20 Aug 2018**
principal:	
date completed:	**20 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,666.75; N: 6,255,516.48 (MGA94) surface elevation: 60.16 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		60									
			1.0		started coring at 1.10m						
NMLC		59			**SANDSTONE**: medium to coarse grained, orange brown to dark red-brown, indistinctly bedded at 20-25° (Class V).	MW HW		a=1.72 d=1.90			JT, 5°, CU, RO, CN
			2.0			MW		a=0.44 d=0.44	76%		PT, 25°, PL, RO, CN JT, 2°, PL, RO, CN
		58			**NO CORE:** 0.25 m						
					SANDSTONE: medium to coarse grained, pale grey, indistinctly to distinctly cross bedded at 0-20° (Class V).	XW					Root Jacking, IR, roots Root Jacking, IR, roots
			3.0		**NO CORE:** 0.24 m						JT, 5°, UN, RO, CN
		57			**SANDSTONE**: medium to coarse grained, pale grey, indistinctly to distinctly cross bedded at 0-20° (Class II).	XW FR		a=0.54 d=0.51			SM, Clayey sand, roots PT, 8°, PL, RO, CN
			4.0								PT, 20°, PL, RO, CN
		56						a=0.80 d=0.44	77%		PT, 15°, PL, RO, CN PT, 3°, PL, RO, CN
	27/08/18		5.0								PT, 10°, PL, RO, CN
	04/09/18	55			5.45 m: orange brown to pale grey	SW					PT, 20°, PL, RO, CN PT, 20°, PL, RO, CN JT, 5°, ST, RO, CN PT, 18°, PL, RO, CN
			6.0		**NO CORE:** 0.35 m			a=0.36 d=0.21			
		54			**SANDSTONE**: as previous.	SW					JT
					SANDSTONE: medium to coarse grained, pale grey, massive (Class II).			a=0.25 d=0.26	79%		
		53	7.0					a=0.79 d=0.77			JT, 0°, PL, RO, CN JT, 0°, PL, RO, CN JT, 0°, PL, RO, CN PT, 2°, PL, RO, CN

Defects are: JT, 0 - 2°, PL, RO, CN, unless otherwise described

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

coffey
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Engineering Log - Cored Borehole

Borehole ID.	**BH9**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**20 Aug 2018**
principal:	
date completed:	**20 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,666.75; N: 6,255,516.48 (MGA94) surface elevation: 60.16 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		52			**SANDSTONE**: fine to medium grained, pale grey, distinctly bedded at 0-10° (Class II), carbonaceous laminae. *(continued)*	FR		a=0.57 d=0.75	98% 98%		SM, Clay, 8 mm
		51	9.0		**SANDSTONE**: fine to coarse grained, pale grey, massive (Class II).			a=1.26 d=0.99	100%		
		50	10.0		10.41 m: dark grey laminations Borehole BH9 terminated at 10.48 m Target depth			a=0.93 d=0.91			JT, 8°, ST, RO, CN JT, 25°, ST, RO, CN
		49	11.0								
		48	12.0								
		47	13.0								
		46	14.0								
		45	15.0								

CDF_0_9_07_LIBRARY.GLB rev:AU Log COF BOREHOLE: CORED 754-SYDGE219558.GPJ <<DrawingFile>> 12/10/2018 09:04

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

BH9 1.18 - 6.00 m

drawn	
approved	
date	**27-08-2018**
scale	**N.T.S.**
original size	**A4**

coffey
A TETRA TECH COMPANY

client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH9**
project no:	754-SYDGE219558
fig no:	
rev:	

BH9 6.00 - 10.48 m

drawn	
approved	
date	27-08-2018
scale	N.T.S.
original size	A4

coffey
A TETRA TECH COMPANY

client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH9**
project no:	754-SYDGE219558
fig no:	
rev:	

coffey
A TETRA TECH COMPANY

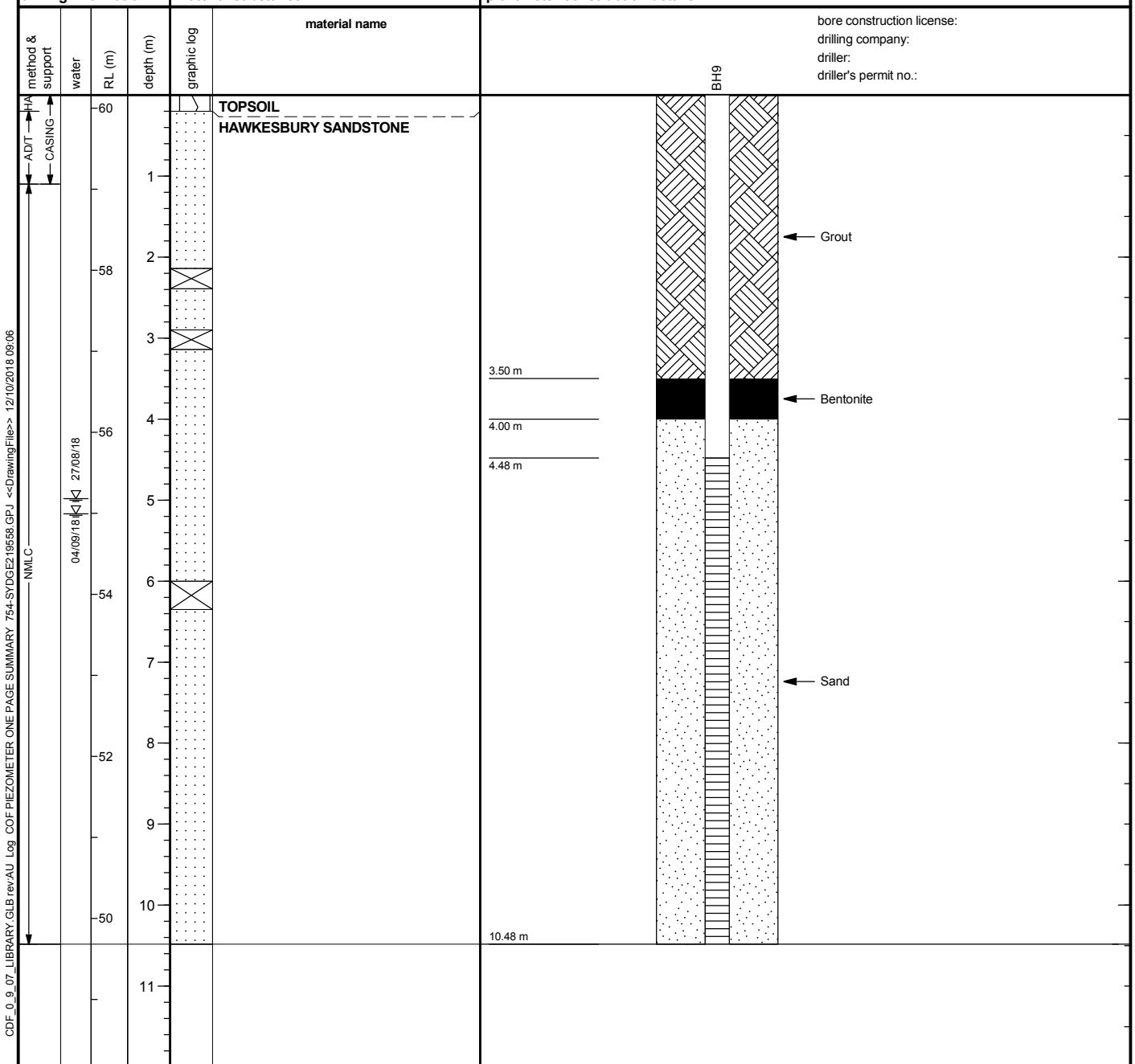
Piezometer Installation Log

Hole ID.	***BH9***
sheet:	1 of 1
project no.	***754-SYDGE219558***
client: ***Country Garden Australia Pty Ltd***	date started: ***20 Aug 2018***
principal:	date completed: ***20 Aug 2018***
project: ***St Leonards Development***	logged by: ***AM***
location: ***St Leonards, NSW***	checked by: ***AB***

position: E: 332,666.75; N: 6,255,516.48 (MGA94) | surface elevation: 60.16 m (AHD) | angle from horizontal: 90°

equipment type: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance** | **piezometer construction details**



method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
BH9	standpipe			10.48 m			49.68	

Appendix D – Groundwater Monitoring results

Groundwater monitoring results

Borehole ID	Date: 27/08/18	04/09/18
	Groundwater Level (metres below ground level)	
BH1	Not drilled	4.47
BH3	Not drilled	3.82
BH5	4.15	4.30
BH7A	3.77	3.90
BH9	4.98	5.17

Appendix E – Soil & Rock Laboratory Results

Sydney Laboratory

Coffey Services Australia Pty Ltd
ABN 55 139 460 521
31 Hope Street
Melrose Park NSW 2114

Phone: +61 (2) 8876 0500

A TETRA TECH COMPANY

Material Test Report

Report No: SYDN18S-07107-1
Issue No: 1

Client:	Coffey Services Australia Pty Ltd (Chatswood) Level 19, 799 Pacific Highway Chatswood NSW 2067
Principal:	
Project No.:	754-SYDN00220AA
Project Name:	754-SYDGE219558 - 754-CGA ST LEONARDS
Lot No.:	- **TRN:** -

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Renni Cetinich
(GeoTechnician)
NATA Accredited Laboratory Number:431
Date of Issue: 10/09/2018

Sample Details

Sample ID:	SYDN18S-07107
Client Sample:	-
Date Sampled:	
Source:	Ex. Site
Material:	Clay
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	CGA ST LEONARDS
Sample Location:	BH1 1.0 - 1.45

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	4.0	
Mould Length (mm)		125	
Liquid Limit (%)	AS 1289.3.1.1	28	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	11	
Date Tested		6/09/2018	
Moisture Content (%)	RMS T120	8.7	
Date Tested		5/09/2018	

Comments

N/A

Sydney Laboratory

Coffey Services Australia Pty Ltd
ABN 55 139 460 521
31 Hope Street
Melrose Park NSW 2114

Phone: +61 (2) 8876 0500

A TETRA TECH COMPANY

Material Test Report

Report No: SYDN18S-07108-1
Issue No: 1

Client:	Coffey Services Australia Pty Ltd (Chatswood) Level 19, 799 Pacific Highway Chatswood NSW 2067
Principal:	
Project No.:	754-SYDN00220AA
Project Name:	754-SYDGE219558 - 754-CGA ST LEONARDS
Lot No.:	- **TRN:** -

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Renni Cetinich
(GeoTechnician)
NATA Accredited Laboratory Number:431
Date of Issue: 10/09/2018

Sample Details

Sample ID:	SYDN18S-07108
Client Sample:	-
Date Sampled:	
Source:	Ex. Site
Material:	Clay
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	CGA ST LEONARDS
Sample Location:	BH2 2.5 - 2.8

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	4.5	
Mould Length (mm)		125	
Liquid Limit (%)	AS 1289.3.1.1	28	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	16	
Plasticity Index (%)	AS 1289.3.3.1	12	
Date Tested		6/09/2018	
Moisture Content (%)	RMS T120	11.2	
Date Tested		5/09/2018	

Comments

N/A

Sydney Laboratory

Coffey Services Australia Pty Ltd
ABN 55 139 460 521
31 Hope Street
Melrose Park NSW 2114

Phone: +61 (2) 8876 0500

A TETRA TECH COMPANY

Material Test Report

Report No: SYDN18S-07109-1
Issue No: 1

Client:	Coffey Services Australia Pty Ltd (Chatswood) Level 19, 799 Pacific Highway Chatswood NSW 2067
Principal:	
Project No.:	754-SYDN00220AA
Project Name:	754-SYDGE219558 - 754-CGA ST LEONARDS
Lot No.:	- **TRN:** -

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Renni Cetinich
(GeoTechnician)
NATA Accredited Laboratory Number:431
Date of Issue: 10/09/2018

Sample Details

Sample ID:	SYDN18S-07109
Client Sample:	-
Date Sampled:	
Source:	Ex. Site
Material:	Clay
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	CGA ST LEONARDS
Sample Location:	BH3 1.0 - 1.45

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	8.0	
Mould Length (mm)		125	
Liquid Limit (%)	AS 1289.3.1.1	41	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	22	
Date Tested		6/09/2018	
Moisture Content (%)	RMS T120	15.2	
Date Tested		5/09/2018	

Comments

N/A

Sydney Laboratory

Coffey Services Australia Pty Ltd
ABN 55 139 460 521
31 Hope Street
Melrose Park NSW 2114

Phone: +61 (2) 8876 0500

A TETRA TECH COMPANY

Material Test Report

Report No: SYDN18S-07110-1
Issue No: 1

Client:	Coffey Services Australia Pty Ltd (Chatswood) Level 19, 799 Pacific Highway Chatswood NSW 2067
Principal:	
Project No.:	754-SYDN00220AA
Project Name:	754-SYDGE219558 - 754-CGA ST LEONARDS
Lot No.:	- **TRN:** -

Accredited for compliance with ISO/IEC 17025 - Testing.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Approved Signatory: Renni Cetinich
(GeoTechnician)
NATA Accredited Laboratory Number:431
Date of Issue: 10/09/2018

Sample Details

Sample ID:	SYDN18S-07110
Client Sample:	-
Date Sampled:	
Source:	Ex. Site
Material:	Clay
Specification:	No Specification
Sampling Method:	Submitted by client
Project Location:	CGA ST LEONARDS
Sample Location:	BH4 2.5 - 2.95

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	5.0	
Mould Length (mm)		125	
Liquid Limit (%)	AS 1289.3.1.1	31	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	12	
Date Tested		6/09/2018	
Moisture Content (%)	RMS T120	10.6	
Date Tested		5/09/2018	

Comments

N/A

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Celebrating 30 years Testing and Protecting Human Health

Certificate of Analysis

Coffey Geotechnics Pty Ltd Chatswood
Level 18, Tower B, Citadel Tower 799 Pacific Highway
Chatswood
NSW 2067

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Aidan McKenzie**

Report **615231-S**
Project name SYDGE219558
Received Date Aug 30, 2018

Client Sample ID			**BH8/0.8**	**BH7/1.0**	**BH4/1.0**
Sample Matrix			**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**M18-Au41243**	**M18-Au41244**	**M18-Au41245**
Date Sampled			**Aug 23, 2018**	**Aug 23, 2018**	**Aug 23, 2018**
Test/Reference	LOR	Unit			
Chloride	5	mg/kg	8.4	17	29
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	35	68	39
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	8.5	8.7	8.2
Resistivity*	0.5	ohm.m	290	150	260
Sulphate (as SO4)	30	mg/kg	46	< 30	< 30
% Moisture	1	%	18	15	17

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chloride	Melbourne	Sep 03, 2018	28 Day
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Conductivity (1:5 aqueous extract at 25°C as rec.)	Melbourne	Sep 03, 2018	7 Day
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25°C as rec.)	Melbourne	Sep 03, 2018	7 Day
- Method: LTM-GEN-7090 pH in soil by ISE			
Sulphate (as SO4)	Melbourne	Sep 03, 2018	28 Day
- Method: LTM-INO-4110 Sulfate by Discrete Analyser			
% Moisture	Melbourne	Aug 31, 2018	14 Day
- Method: LTM-GEN-7080 Moisture			

eurofins | mgt

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NATA # 1261 Site # 20794

Perth
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Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Company Name: Coffey Geotechnics Pty Ltd Chatswood
Address: Level 18, Tower B, Citadel Tower 799 Pacific Highway
Chatswood
NSW 2067

Project Name: SYDGE219558

Order No.:
Report #: 615231
Phone: +61 2 9406 1000
Fax: +61 2 9406 1002

Received: Aug 30, 2018 2:07 PM
Due: Sep 6, 2018
Priority: 5 Day
Contact Name: Aidan McKenzie

Eurofins | mgt Analytical Services Manager : Nibha Vaidya

Sample Detail						Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271						X	X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
Perth Laboratory - NATA Site # 23736							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH8/0.8	Aug 23, 2018		Soil	M18-Au41243	X	X
2	BH7/1.0	Aug 23, 2018		Soil	M18-Au41244	X	X
3	BH4/1.0	Aug 23, 2018		Soil	M18-Au41245	X	X
Test Counts						3	3

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per kilogram

mg/L: milligrams per litre

ug/L: micrograms per litre

ppm: Parts per million

ppb: Parts per billion

%: Percentage

org/100mL: Organisms per 100 millilitres

NTU: Nephelometric Turbidity Units

MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery.
CRM	Certified Reference Material - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
QSM	Quality Systems Manual ver 5.1 US Department of Defense
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries: Recoveries must lie between 50-150%-Phenols & PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.1 where no positive PFAS results have been reported have been reviewed and no data was affected.

WA DWER (n=10): PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Conductivity (1:5 aqueous extract at 25°C as rec.)	M18-Au40474	NCP	uS/cm	160	190	2.3	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	M18-Au41264	NCP	pH Units	7.9	7.9	pass	30%	Pass	
Resistivity*	M18-Au40474	NCP	ohm.m	62	53	2.3	30%	Pass	
Sulphate (as SO4)	A18-Au38451	NCP	mg/kg	570	380	41	30%	Fail	Q15
% Moisture	M18-Au41243	CP	%	18	19	4.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
Q15	The RPD reported passes Eurofins | mgt's QC - Acceptance Criteria as defined in the Internal Quality Control Review and Glossary page of this report.

Authorised By

Nibha Vaidya	Analytical Services Manager
Alex Petridis	Senior Analyst-Metal (VIC)
Michael Brancati	Senior Analyst-Inorganic (VIC)

Glenn Jackson
National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Point Load Test Results

Borehole ID	Depth (m)	Is(50)
BH1	1.83	0.06
BH1	2.36	0.13
BH1	3.42	0.53
BH1	4.49	0.68
BH1	5.33	0.57
BH1	6.44	0.21
BH1	7.42	0.82
BH1	8.48	0.64
BH1	9.47	0.53
BH2	3.18	0.27
BH2	4.26	1.66
BH2	5.39	2.65
BH2	5.69	0.62
BH2	7.00	1.13
BH2	8.00	1.44
BH2	9.04	1.48
BH2	10.00	1.57
BH3	2.27	0.17
BH3	3.17	0.27
BH3	4.72	0.33
BH3	5.50	0.75
BH3	6.63	0.48
BH3	7.70	1.29
BH3	8.21	0.90
BH3	9.63	0.86
BH3	10.00	0.99
BH4	3.06	0.93
BH4	3.45	0.89
BH4	4.00	1.03
BH4	4.76	1.34
BH4	5.76	1.39
BH4	5.90	0.97
BH4	6.22	1.42
BH4	6.44	0.70
BH4	7.30	0.90
BH4	8.24	0.33
BH4	9.44	1.46
BH4	10.31	2.06
BH5	1.90	0.11
BH5	2.75	1.20
BH5	3.90	0.93
BH5	4.91	1.04
BH5	5.12	0.94
BH5	5.38	1.04
BH5	6.10	1.39
BH5	6.30	1.10
BH5	7.10	1.10

Borehole ID	Depth (m)	Is(50)
BH5	7.62	0.74
BH5	8.09	0.94
BH5	8.89	1.30
BH5	9.09	1.16
BH5	9.20	1.13
BH6	1.04	0.71
BH6	2.07	0.28
BH6	3.00	1.06
BH6	4.13	0.75
BH6	5.13	0.59
BH6	6.45	0.86
BH6	7.45	0.80
BH6	8.44	0.38
BH6	9.45	0.72
BH6	10.00	1.53
BH7A	3.55	0.52
BH7A	4.60	0.62
BH7A	5.54	0.21
BH7A	6.58	1.14
BH7A	7.74	0.96
BH7A	8.00	1.02
BH7A	9.00	0.21
BH7A	10.00	0.60
BH8	1.65	0.76
BH8	2.36	0.70
BH8	2.49	1.30
BH8	3.13	1.16
BH8	5.00	1.13
BH8	6.32	1.42
BH8	7.32	0.87
BH8	8.32	0.71
BH8	9.30	1.09
BH9	1.39	1.71
BH9	2.02	0.45
BH9	3.56	0.54
BH9	4.43	0.77
BH9	5.72	0.34
BH9	6.55	0.26
BH9	7.27	0.75
BH9	8.24	0.58
BH9	9.00	1.23
BH9	10.00	0.92

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TETRA TECH COFFEY

Area 22 Proposed Residential Development 26-36 Park Road, 27-47 Berry Road, and 48-52 River Road, St Leonards

Geotechnical Desktop Study

Berry Road Development Pty Ltd

Reference: SYGE304523-AA

06 June 2023

AREA 22 PROPOSED RESIDENTIAL DEVELOPMENT, 26-36 PARK ROAD, 27-47 BERRY ROAD AND 48-52 RIVER ROAD, ST LEONARDS

Geotechnical Desktop Study

Report reference number: SYGE304523-AA
06 June 2023

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1. INTRODUCTION

1.1 PURPOSE

Berry Road Development Pty Ltd (BRD) has acquired a parcel of land titled Area 22 at St Leonards, NSW comprising the properties at 26 – 50 Park Road, 27 – 47 Berry Road, 48 – 54 River Road, on which it proposes to construct a multi-storey residential development with associated basement carparking and amenities. A detailed investigation was not possible at this time due to site occupancy so BRD commissioned Tetra Tech Coffey Pty Ltd (Coffey) to prepare this desktop study report to assess the geotechnical feasibility of the proposed development, assist initial design and support the Development Application process. The study was conducted in accordance with Coffey proposal SYDGE21955AB dated 2 June 2022.

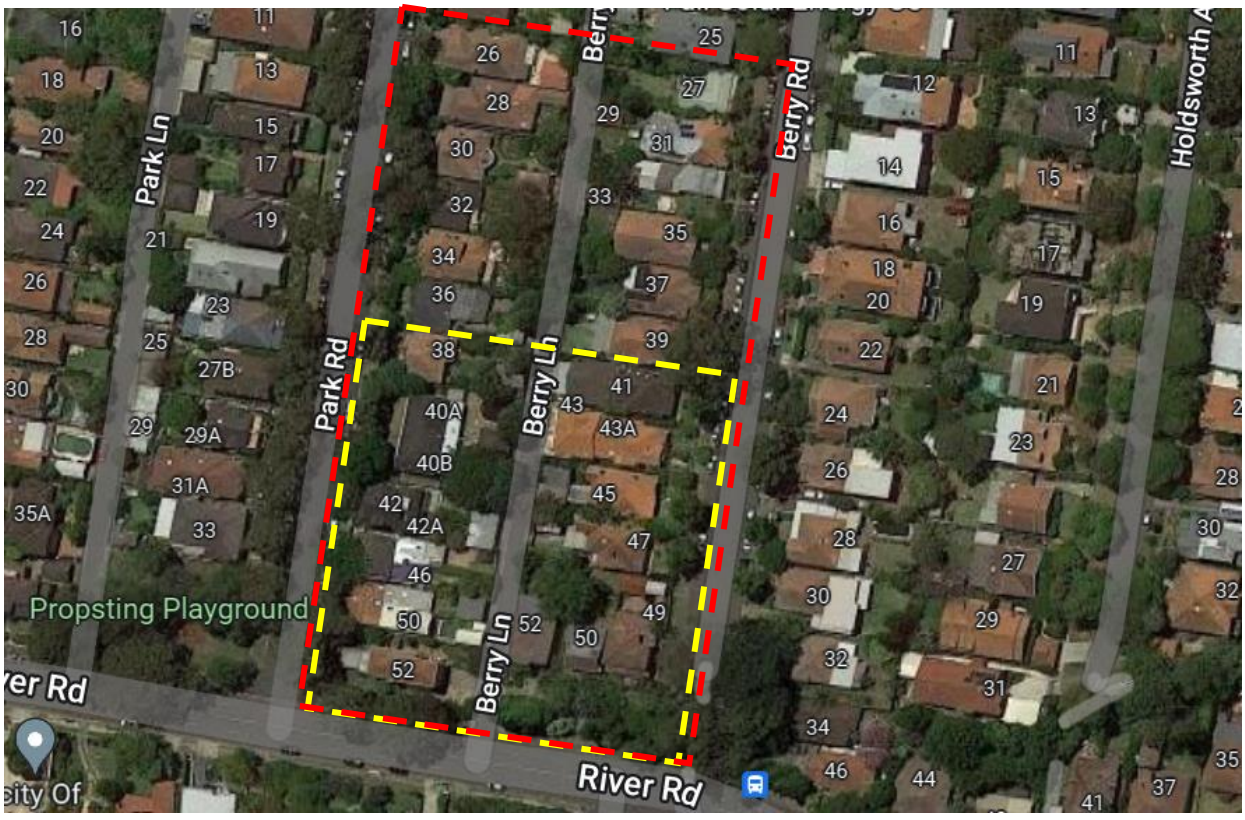
1.2 BACKGROUND

The southern portion of the site, titled Area 23 was the subject of a previous geotechnical investigation by Coffey commissioned by Country Garden Australia Pty Ltd in 2018. Outcomes were documented in Coffey report reference SYDGE219558-GAR-RPT-02 dated 19 October 2018 (Coffey 2018). Since then the site developer has acquired neighbouring land. The expanded development site is now called the Berry Road Development.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The approximate site boundary is shown in red. The yellow outline shows the site boundary at the time of the previous investigation (Coffey, 2018) (sourced from Google maps, accessed 20 June 2022).

Figure 1: Approximate Site Boundary



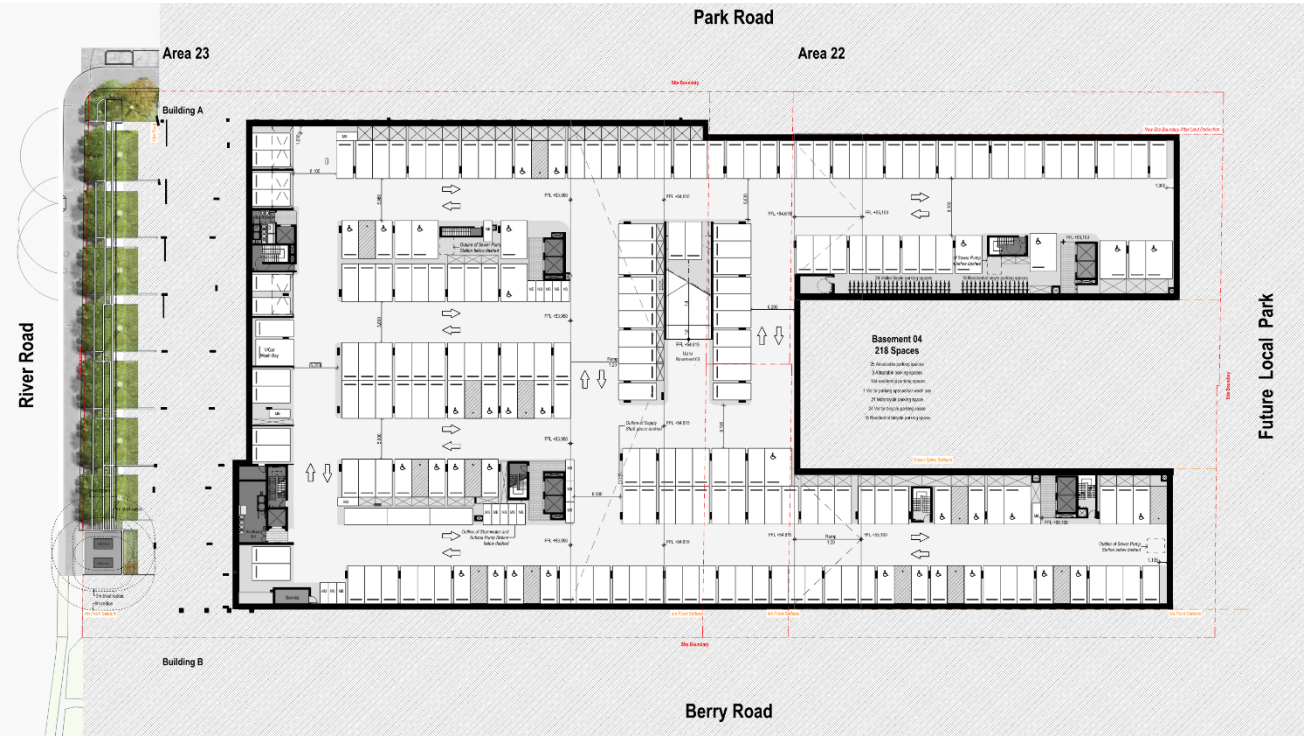
A site walkover was carried out by a Coffey on 27 June 2022. The key site features are summarised below.

- The site of about 12,450 m^2 comprises 26 residential lots bounded by Berry Road to the west, River Road to the south, Park Road the east, residential properties to the north. Berry Lane bisects the site middle.
- The lots were occupied by single or double storey residential dwellings, with some dual occupancy and townhouses, swimming pools, sheds and landscaped areas.
- The site ground levels fall from approximately 75 m AHD at the northern boundary to 57 m AHD towards River Road at grades of approximately 8 to 10 degrees, steepening into a small rock face with outcropping sandstone (approximately 5 m high) at the southern end of Berry Road.
- Cut and fill activities appear to have occurred across the site to provide level construction surfaces for individual plots. Some fill would have likely been placed beneath the existing building footprints and landscaped areas.

3. PROPOSED DEVELOPMENT

Coffey understands that BRD propose to develop a multi-storey residential development with basement carparking. The preliminary architectural plan shown in figure 2 indicates the basement will be excavated to approximately 54 mAHD. This will provide a two-level basement at the southern end of the site and a four-level basement at the northern end. This results in expected excavation depths ranging from 4m in the south west corner to 20m in the north eastern corner of the site. Coffey understands that the "U" shaped area shaded green in figure 2 has been designated as "Green Space" and will not be excavated for basement construction.

Figure 2: Preliminary Basement Plan (Source: Drawing DA200 Rev C by DKO Architecture (NSW) Pty Ltd)



4. DESKTOP STUDY INFORMATION

4.1 LOCAL GEOLOGY

Review of the 1:100,000 Sydney Geological Sheet indicates the site is bisected by the boundary between Ashfield Shale and the underlying Hawkesbury Sandstone. This boundary is located near the junction between the Coffey 2018 investigation and the newly acquired land. This is illustrated in Figure 1 by the yellow line at 38 Park Road. The bedrock units are summarised below.

- Ashfield Shale: Dark-grey to black claystone-siltstone and fine sandstone-siltstone laminite of the Wianamatta Group.
- Hawkesbury Sandstone: Medium to very coarse-grained quartz sandstone, very minor shale and laminite lenses. Typically bedded between 1 m and 3 m thickness.

These units are typically separated by the Mittagong Formation comprising interbedded shale and sandstone of variable strength. It varies in thickness in Sydney up to 10 m, with an average thickness of 2 m.

4.2 SOIL LANDSCAPE AND ERODABILITY

The Sydney Soils Landscape Sheet indicates that the majority of site is within the Glenorie soil landscape with the southern boundary underlain by the Gymea soil landscape. Glenorie landscapes are characterised by undulating to rolling low hills on Wianamatta group shales. The soil horizons are typically friable to hard setting topsoil, underlain by grey to brown, plastic clays with shale gravel. Clays within the lower horizons are typically moderately reactive, with potential for erodibility.

Gymea soil landscapes are characterised by undulating to rolling rises and low hills on benched Hawkesbury sandstone. Soil horizons below the topsoil are typically clayey sand, slightly reactive with very low erodibility, transitioning to moderately reactive, highly erodible clay.

4.3 GROUNDWATER

Groundwater at the site is likely to occur as discontinuous lenses at the soil and bedrock interface. This groundwater is likely recharged by local rainfall events and possibly by runoff from the land situated to the north (up topographical gradient) of the site.

Results from the Coffey 2018 investigation indicated that the average depth below existing surface to groundwater was 4.3m with minimum and maximum depths of 3.8m and 5.2m respectively. Typically, the measured ground water levels coincided with the very low to low strength sandstone layers.

4.4 ACID SULFATE SOILS

Reference to local acid sulfate soil (ASS) risk maps, indicates that the site is located in an area of no known occurrence of ASS.

4.5 COFFEY ARCHIVE AND OTHER INFORMATION

Coffey has prepared previous geotechnical reports for parts of the current site. The following reports were referenced for this desktop study.

- Geotechnical Desk Study - GEOTLCOV25696AA-AC, 48-54 River Rd, 47 Berry Rd and 42-50 Park Rd.
- Geotechnical Assessment Report - SYDGE219558-GAR-RPT-02 (Coffey 2018).

We also referred to 2017 report reference SYDGE25684AA-AL for a site located at the southern end of the RNSH precinct, some 400 m to the north of the subject site. That site was also located near the boundary of Ashfield Shale and Hawkesbury Sandstone. The boreholes for that investigation intersected the top of Hawkesbury Sandstone at about 70 to 74 mAHD. The Hawkesbury Sandstone dips very gently to the south so the transition from Ashfield Shale to Hawkesbury Sandstone would be expected at lower elevation on the subject site.

5. PRELIMINARY GEOTECHNICAL MODEL

Based on the mapped geological boundaries and the archival information we have provide two geotechnical models to describe the southern and northern halves of the site. The model for the southern portion of the site is informed by the Coffey 2018 investigation and the northern portion of the site is informed by the geological mapping and the Coffey 2017 investigation at the RNSH precinct reference in section 4.5 above.

The **southern** portion of the site is likely underlain by (in descending order).

- **Soil strength materials:** Variable Fill (variable depth associated with current development) overlying Residual Soil. The combined thickness of soil strength may be about 3m on average.
- **Class V and IV Sandstone -** Very low and low strength sandstone between 3m and 6m in thickness, possibly including some Mittagong Formation.
- **Class III and II Sandstone** – mainly medium and high strength, expected to be encountered from about 53 mAHD near the southern boundary to 57 mAHD at the midpoint of the site.

The **northern** portion of the site is expected to be underlain by (in descending order):

- **Soil strength materials:** Variable Fill associated with current development, overlying Residual Soil. Thickness likely to be reasonably similar to the southern portion of the site, but with slightly deeper Residual Soil and some Class Vertical Shale
- **Class IV and III Shale:** Very low and low strength. Thickness unknown
- **Class II Shale** mainly medium or high strength, more likely towards northern end of site.
- **Class V and IV Sandstone** Very low to low strength sandstone, possibly including some Mittagong Formation.
- **Class III and II Sandstone** – Sandstone (medium and then high strength) is expected to be encountered from about 57 mAHD near the midpoint of the site to between 60 and 65 mAHD at the northern boundary. Consideration should also be given to the possible impact of this sandstone layer being present up to 70 mAHD at the northern boundary.
- Not all the above soil and rock units may be present at any particular location within the northern portion of the site.

Rock classification is based on the system presented in “Foundations on Sandstone and Shale in the Sydney Region” Aust. Geomech. Jnl, Dec 1998, Pells et al (1998).

6. DISCUSSIONS AND RECOMMENDATIONS

6.1 EXCAVATIONS

6.1.1 Excavation Conditions

The proposed development comprises two or four basement levels with bulk excavation level at about 54 mAHD. Excavation of Soil Strength Materials and some Class IV Shale or Class V/IV Sandstone should be able to be excavated using conventional earthmoving equipment such as a tracked excavator with toothed bucket. Light ripping may be necessary to assist where stronger rock bands occur.

Based on the proposed bulk excavation level and the estimated site geology, it is likely that up to 5m of Class III or better Shale and/or Sandstone may have to be excavated to achieve the design bulk excavation level. Where medium strength or better shale and sandstone is present, hard rock excavation techniques such as large dozers fitted with rippers, or large excavators fitted with rock saws, rock grinders and rock hammers may be required. The use of hard rock excavation techniques will cause vibrations that could damage vibration sensitive structures, infrastructure, and underground services. Assessment of the potential impacts of excavation induced vibrations should be considered as part of the detailed design and excavation planning.

6.1.2 Bulk Excavation Support Requirements

The depth and proximity of the excavation to adjacent roads and residential properties will most likely preclude the use of unsupported excavations at this site.

It may be possible to batter or bench the excavation next to the River Road boundary if there is sufficient offset from the road. For a feasibility study of this option, the basement offset, and depth should allow for a temporary batter of 2H:1V.

Typically, in these geological conditions a drained basement would be constructed at this site. This could comprise either anchored soldier pile retaining walls with shotcrete infill or anchored contiguous pile retaining walls as excavation support depending on wall stiffness requirements. For preliminary design Coffey recommends the piles be drilled and socketed into rock below the bulk excavation (BE) level. Where Class III or better Sandstone or Shale is encountered above the BE level, it may be feasible to terminate the shoring piles in these units and progress the excavation as a vertical cut in the rock face. Where this method is adopted regular geotechnical inspections are necessary to determine if additional support mechanisms are required such as shotcrete with rock bolt anchors to stabilise the rock face.

Additional consideration will be required for the “U” shaped Green Space. The opposing internal walls may require temporary struts or passive tie rods as temporary support if inclined strand anchors cannot be installed without conflicting with the opposing piles and anchors. A second option would be to install the perimeter walls only and to then excavate the “U” to Class III rock from where it can be cut vertical. This option would then require the “U” area to be backfilled with engineered fill after the basement walls have been constructed.

Alternative shoring solutions could be considered in consultation with specialist contractors.

Basement excavations may have the potential to impact on neighbouring structures and buried services within the streets. The location and sensitivity of such structures and services should be assessed and allowed for during detailed retaining wall design works.

6.1.3 Excavation Induced Ground Movements

Excavation will cause some ground movements adjacent to the excavation site. The magnitude of the movements that will be experienced by a retaining wall will depend on various factors including the earth pressures that exist, groundwater conditions and construction sequence. Documented data in Sydney excavations has shown that for well-designed and constructed shoring, vertical and lateral movements can be about 0.1% to 0.3% of the retained height at the excavation face. Lateral ground movements can occur at distances up to twice the basement depth from the edge of excavations.

Notwithstanding typical ground movements described above, the assessment of excavation-induced ground movements involves detailed soil structure interaction analysis. The accuracy of the assessment results plays an important role in determining the impact of the excavation on the adjacent structures and roads as well as evaluating the effectiveness of the proposed retaining wall. If this assessment is required, Coffey can provide the assessment (by numerical analyses) during the detailed design when more design information becomes available.

It is recommended that dilapidation surveys be carried out prior to the commencement of the excavation to assess the condition of the buildings within the zone of influence of the excavation. Potential risk of damage to buildings from ground movements during excavation should be considered during the development of the excavation methodology. Ground movements of the buildings should be monitored during excavation to reduce the risk of damage from excessive ground movements.

6.1.4 Groundwater Control During Excavation

Groundwater seepages in this geological setting typically occur at soil/rock interfaces, through bedrock joints, bedding planes, partings, and other defects within the rock mass.

Groundwater levels recorded in the Coffey 2018 investigation suggest basement excavation could encounter groundwater inflow. In this geology groundwater inflows into the basement can generally be controlled using conventional sump and pump techniques for discharge into stormwater or sewer systems networks, subject to regulatory approvals. For a drained basement, permanent floor and wall drainage will need to be installed and maintained to relieve hydrostatic pressures on retaining walls and buoyancy pressures on basement floors. To dispose of groundwater inflows throughout the life of the structure, it is expected that the drainage system would include a sub-floor drainage blanket with slotted drainage pipes and a sump and pump system with the ability to effectively back flush the system for long-term maintenance.

As part of further site investigations, groundwater quality/chemistry testing may be necessary to obtain regulatory approvals for discharge into sewer or stormwater. Groundwater inflow assessment may also be required where a drained basement is used.

6.1.5 Excavation Induced Vibrations

The use of excavation plant such as impact hammers will generate vibrations that may affect any surrounding sensitive structures and buried services. Measures to mitigate the risks associated with construction vibration such as the use of rock hammers on excavators during construction should be considered. It is recommended that vibration monitoring be undertaken on the existing structures and on the ground adjacent to the structures.

6.2 FOUNDATIONS

It is expected that Class III Sandstone or better will be exposed at BE level over the majority of the basement footprint, so that pad/strip footing system could be adopted. A portion of the basement adjacent to the River Road boundary may expose Class IV Sandstone at BE level, so piled footings to Class III Sandstone may be needed in this area. (For structures sensitive to differential movements, Coffey would recommend all footings be founded in similar rock). A preliminary serviceability geotechnical design bearing pressure of 3,500kPa can be adopted for Class III Sandstone or better.

6.3 SOIL AGGRESIVITY

The result of laboratory testing conducted during the 2018 investigation indicated the soil has an exposure classification of 'Mild' and 'Non-aggressive' as according to AS2159-2009 for concrete and steel. It is expected that these classifications will be applicable to the current site pending detailed site investigation.

6.4 FURTHER SITE INVESTIGATIONS

We recommend that further geotechnical site investigation be carried out to augment the Coffey 2018 investigation and support detailed design. For the proposed development we recommend drilling an additional six boreholes below the proposed bulk excavation and footing levels. The aim of the investigation would be to assess and refine the site models presented here, and provide data for design.

Existing standpipes should be located and inspected to determine if they are still operational. Based on these inspections additional standpipes should be installed to ensure adequate site coverage. These standpipes are required to assess groundwater levels and enable water samples to be collected for water quality/chemistry which will most likely be required if constructing a drained basement.

7. CONCLUSION

Based on our site observations, the previous investigation conducted by Coffey, and experience on similar projects, the proposed development is considered feasible from a geotechnical perspective. In our opinion, the proposed development would present a low risk to surrounding structures and the groundwater environment, provided that a detailed geotechnical site investigation and appropriate project specific design assessments and construction monitoring normally associated with this type of development are carried out.

The attached document entitled "Important Information about your Tetra Tech Coffey Report" presents additional information about the uses and limitations of this report.

APPENDIX A: LIMITATIONS

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

As a client of Tetra Tech Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Tetra Tech Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Tetra Tech Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Tetra Tech Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Tetra Tech Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Tetra Tech Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Tetra Tech Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Tetra Tech Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Tetra Tech Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Tetra Tech Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Tetra Tech Coffey to work with other project design professionals who are affected by the report. Have Tetra Tech Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Tetra Tech Coffey for information relating to geoenvironmental issues.

Rely on Tetra Tech Coffey for additional assistance

Tetra Tech Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Tetra Tech Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Tetra Tech Coffey to other parties but are included to identify where Tetra Tech Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Tetra Tech Coffey closely and do not hesitate to ask any questions you may have.