60 & 62-64 Showground Road

Geotechnical Investigation Report

CHP Fund Pty Ltd

14 June 2021

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Document:

Date: 14 June 2021
Reference: C-0861.00 R1
Status: For Issue

Prepared for:

CHP Fund Pty Ltd

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1. Introduction

This report presents the findings of a geotechnical investigation carried out by D&N Geotechnical Pty Ltd (D&N) for the proposed redevelopment of 60 & 62-64 Showground Road, Gosford NSW (SP20058 and SP20095).

The investigation was commissioned by CHP Fund Pty Ltd (CHP) and carried out in general accordance with our fee proposal (D&N Document Reference C-0861.00 P1 Rev1, dated 21 April 2021).

The proposed redevelopment may comprise a four (4) storey building over a three (3) level basement, with bulk excavations of up to 12 m below current ground level towards the front of the block.

Under the proposed NSW legislation changes, the building comprises a Class 2 building under the BCA and practitioners will require registration under the NSW Design and Building Practitioners Act 2020 No 7, following 1 July 2021.

CHP requested a staged approach the geotechnical investigation to allow a pre-purchase assessment to be made for the potential purchase of the properties. More detailed investigations will be required for subsequent detailed structural/civil design.

The objective of this Stage 1 preliminary, pre-purchase geotechnical investigation was to assess subsurface conditions to inform geotechnical feasibility and early structural/civil design, note possible geotechnical constraints on the development and recommend future geotechnical works required for detailed design.

Our report includes a summary of the investigation methods adopted, approximate investigation locations, engineering borehole logs, and laboratory test certificates.

Geotechnical discussion and recommendations are provided for shallow and deep piled footings, excavation conditions and geotechnical design parameters for retention, groundwater management and possible effect on adjacent structures.

2. Method of Investigation

2.1. Desktop Review

A desktop review was undertaken to evaluate current and previous land uses and to assess the implications for geology and hydrology. The desktop review included:

- Assessment of historical aerial photography for the site and surrounding areas.
- Soil, geology and hydrogeological conditions review from relevant mapping and borehole logs.
- Review and summary of previous geotechnical, geological or groundwater studies from Coffey Testing Pty Ltd and publicly available information.

2.2. Planning

Prior to the commencement of fieldwork, D&N prepared a safety management plan. The field supervisor was provided with a hard copy of the plan, which was utilised on site for subcontractor induction and retained as reference for emergency management.

A pre-start meeting was held at the start of each day/when working conditions differed to assess specific hazards and update approaches to site works where the work activity/environment was observed to have changed. Services plans were reviewed in detail prior to commencing intrusive fieldwork.

2.3. Fieldwork

Fieldwork for the investigation was carried out on 19 and 20 May 2021, and included the following main site activities:

- Site walkover to map existing features of geotechnical significance.
- One (1) cored borehole to a depth of 20.8 m below ground level, at the location shown on Figure 1.
- Installation of one (1) groundwater monitoring well into BH01.

All fieldwork was carried out under the fulltime direction of a D&N engineering geologist, who was responsible for coordination of subcontractors, management of site safety, logging of subsurface conditions to AS 1726:2017 and collection of soil and rock samples for subsequent laboratory analysis.

A track mounted drilling rig was mobilised to site. The borehole was advanced initially in soil strength materials using solid flight augers equipped with a Tungsten Carbide (TC) drill bit until practical refusal at 7.9 m depth within weathered bedrock. Standard Penetration Tests (SPTs) were carried out nominally at 1.5 m centres to provide an indication of soil consistency/density and collect samples to assist logging. The boreholes were subsequently advanced to a termination depth of 20.08 m using NMLC diamond core drilling methods.

At the completion of drilling, BH01 was completed as a groundwater monitoring well. The lowermost 0.8 m was backfilled with drill cuttings, following which the lower 16.5 m of the well was provided with 50 mm internal diameter uPVC machine-slotted pipe; and extended to the surface using solid uPVC casing of 3 m length cut to the ground surface. The annulus between the uPVC casing and borehole wall was backfilled with 2 mm specialised clean filter sand above the slotted screen interval, followed by a 3.0 m bentonite plug and backfill to surface. A steel mount gatic cover was installed flush and set in concrete to enable subsequent groundwater level monitoring. The groundwater monitoring well was flushed of drilling fluids on 20 May 2021, and subsequently on 1 June 2021.

Groundwater monitoring was undertaken between 25 May 2021 and 11 June 2021.

The Engineering Borehole Log and core photographs are presented as Appendix A.

Figure 1 shows the approximate investigation location, which was located using hand-held GPS equipment (accurate to ±3 m) and by taking measurements from existing site features.

2.4. Laboratory Testing

Selected soil samples were submitted to NATA accredited laboratories for the following suites of tests:

- 1 no. Atterberg Limits and Linear Shrinkage.
- 1 no. Soil Aggressivity.
- 1 no. Groundwater Aggressivity.
- 1 no. Unconfined Compressive Strength on recovered rock core.

On completion of drilling, recovered rock cores were boxed in steel core trays and transported to our core storage facility. Following photography, Point Load Index Strength (I_{s50}) tests were performed at regular intervals of approximately 1 m on average, or where specific zones of core were of interest.

The laboratory test results are discussed in subsequent sections of this report. For detail, reference should be made to the laboratory test certificates, included as Appendix B.

3. Desktop Review and Site Walkover

3.1. Site Description

The site is located at 60 & 62-64 Showground Road, Gosford NSW (hereafter referred to as the Site) and encompasses two rectangular lots identified as SP00058 and SP20095, totalling an area of about 2,438 m^2. The site surface currently comprises multiple strata-titled residential units, associated internal hardstand(s), vehicle storage/parking and kept landscaping. The site is bound to the north by Gosford Hospital, west and south by residential dwellings and east by Showground Road and existing rail infrastructure.

The sites slopes from the north west at about 7°, with a total fall in elevation from the west of the block to Showground Road of up to 5.5 m (broadly RL 15.5 m to 10 m AHD). The site appears to have been locally levelled and terraced to facilitate the current development. Towards the high side of the block i.e. north and western boundary, concrete block retaining wall(s) up to about 2 m in height are noted from the provided site survey.

Immediately to the east of the property, a drainage culvert and associated pits appear to drain west to east, across Showground Road and to a subterranean drainage pipe located beneath existing rail infrastructure, which is inferred to drain from north to south, discharging within Brisbane Water to the south of the site vicinity. Within the immediate surrounds of BH01, the site surface was generally noted to be wet under foot with ponded water within the upper fill/topsoil layers.

3.2. Historical Land Use

A review of the NSW Historical imagery available from approximately 1966 indicates the site has generally been used for urban/suburban purposes since 1966 and likely earlier. The imagery shows the possible presence of an overland and/or subterranean drainage feature immediately between the existing rail infrastructure and Showground Road. The drainage crosses east to west beneath the railway, before turning southwards to the east of Showground Road and likely discharging at Brisbane Water. The mark up of Plates 1 to 3 below illustrates the above.

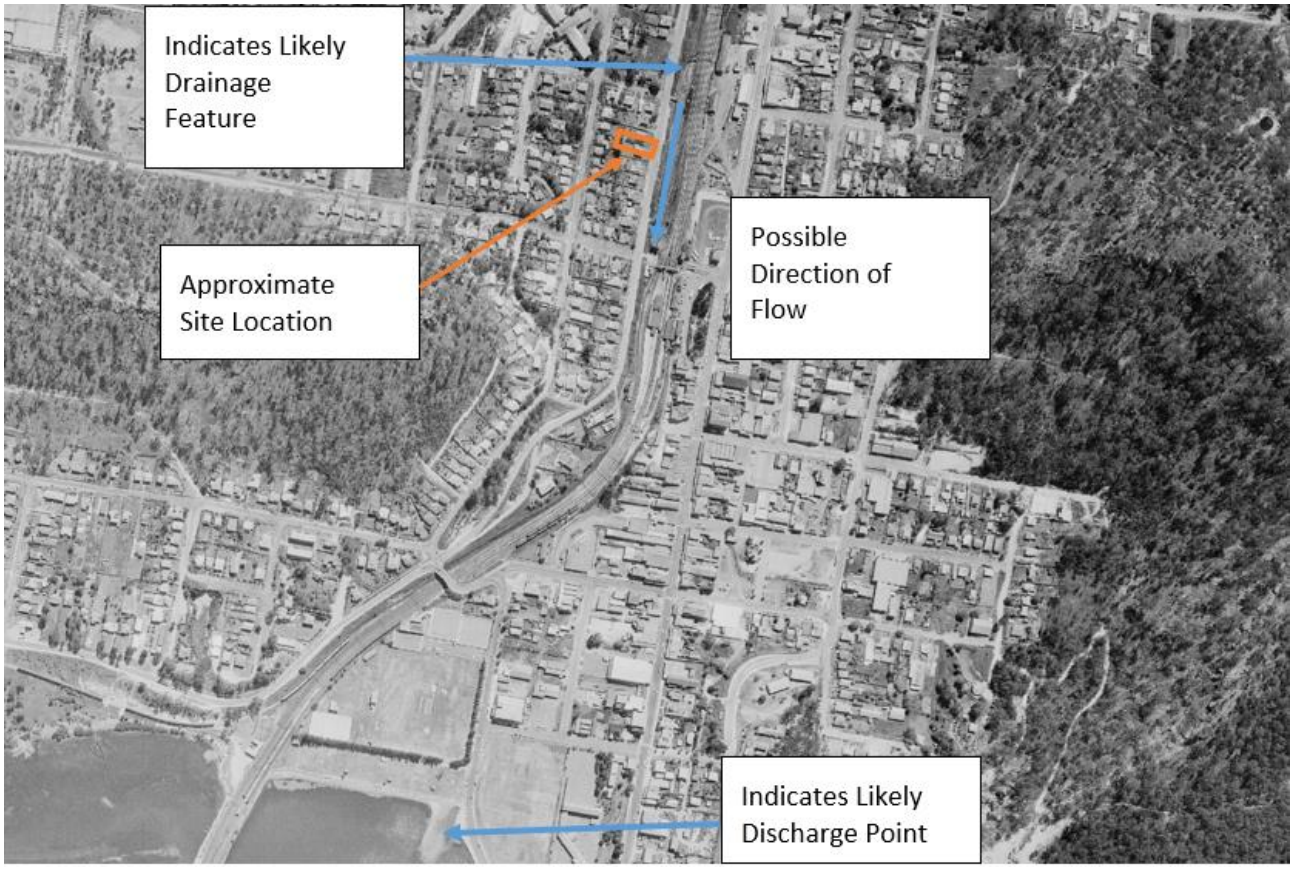

Plate 1 - Historical Imagery (circa 1966) indicates historical land use and drainage pathway

Plate 2 - Historical Imagery (circa 1966) likely drainage pathway

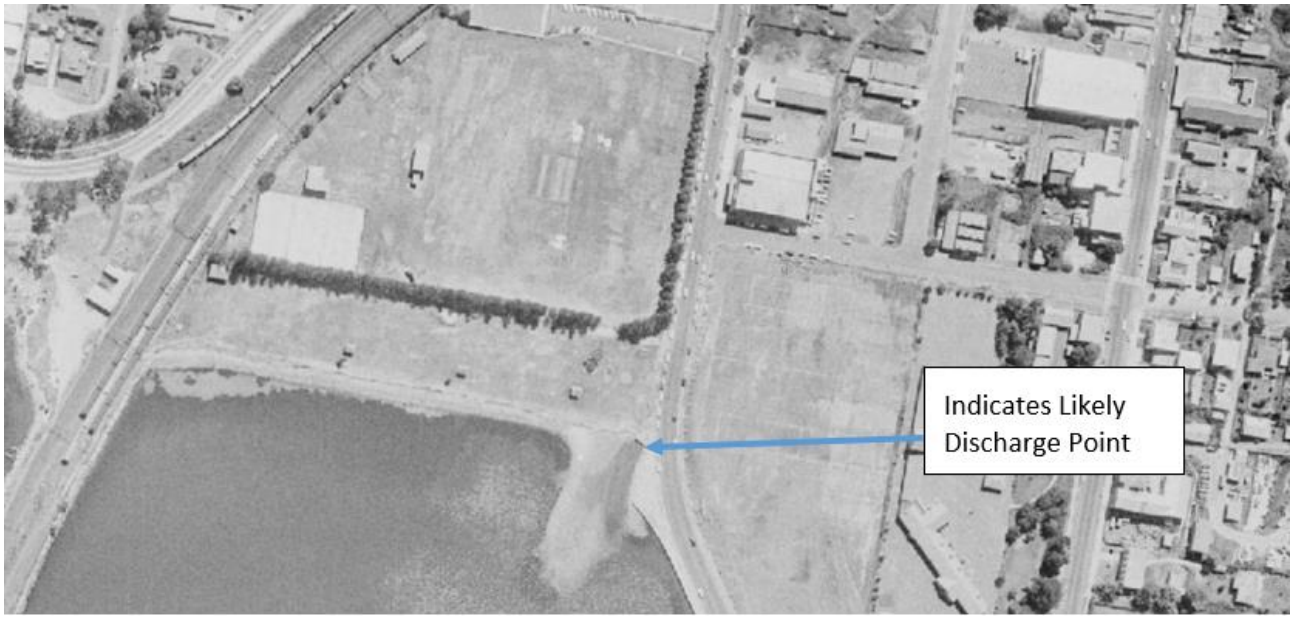

Plate 3 - Historical Imagery (circa 1966) discharge point

3.3. Regional Topography

The site is situated within a low-lying erosional landscape, namely a shallow sided drainage line surrounded by undulating to rolling rises and low hills to the east and west of the site.

The regional drainage line is aligned from the north to the south. 10 m contour levels are shown combined with the topographical map extract in Plate 4 below.

Plate 5 below sows an oblique aerial image of the region.

Plate 4 - Aerial Imagery Extracted from NSW Geoscience

Plate 5 – Oblique Aerial Imagery Extracted from Google Earth, view from the south to the north.

3.4. Soil Landscape

The 1:100,000 Gosford-Lake Macquarie Soil Landscape Series Sheet (9131-9231, First Edition 1993) indicates the site is underlain by anthropogenic disturbed terrain (denoted as "*xx*" in Plate 6 below), generally described as level plain to hummocky terrain, extensively disturbed by human activity, including complete disturbance, removal or burial of soil. Local relief and slopes are highly variable, landfill includes soil, rock, building and waste material. Original vegetation is completely cleared and is replaced with turf or grassland.

Limitations of this soil landscape are highly variable and site dependent, they may include mass movements, steep slopes, foundation hazards, unconsolidated low wet bearing strength materials, impermeable soils, poor drainage, erosion hazards, very low fertility and toxic materials.

The unit underlying the above anthropomorphic disturbance unit, are described as an erosional landscape (denoted as "*er*" in plate 6 below), with moderately deep "*Yellow Podzolic Soils*" and "*Yellow Earths*" on coarse-grained parent material with *Yellow Earths* on foot slopes and deep *Structured Loams* and *Yellow Earths* along drainage lines.

Limitations of this soil landscape is potential for localised mass movement, high erosion hazards, localised foundation hazards, localised high run-on, seasonal waterlogging of footslopes and strongly acid soils of low fertility.

The topographic highs to the west and east are described as a colluvial (or slopewash) landscape of the Hawkesbury ("*ha*" in Plate 6) and Watagan ("*wn*" in Plate 6) Landscapes respectively. Limitations of these soil landscapes include extreme soil erosion, mass movement (rock fall) hazard, steep slopes, foundation hazard, rock outcrop, shallow, stony, and highly permeable soils.

Plate 6 - Extract of the Soil Landscape

3.5. Acid Sulfate Soils

A review of the Gosford Acid Sulfate Risk Map (Edition two) indicates the site is located within an area of no known occurrences of acid sulfate soil materials. The site elevation and geology further make the occurrence of acid sulfate soil unlikely, inferring that soil disturbance would not lead to additional generation of acidity on exposure to oxygen. The site soils may, however, be naturally acidic.

3.6. Regional Geology

The 1:100,000 Gosford-Lake Macquarie Geological Map (Sheet 9131 & 9231, First Edition 2015) indicates the site is underlain by the Middle Triassic aged interbedded laminite, shale and fine to coarse grained quartz to quartz lithic sandstone; minor red claystone of the Terrigal Formation.

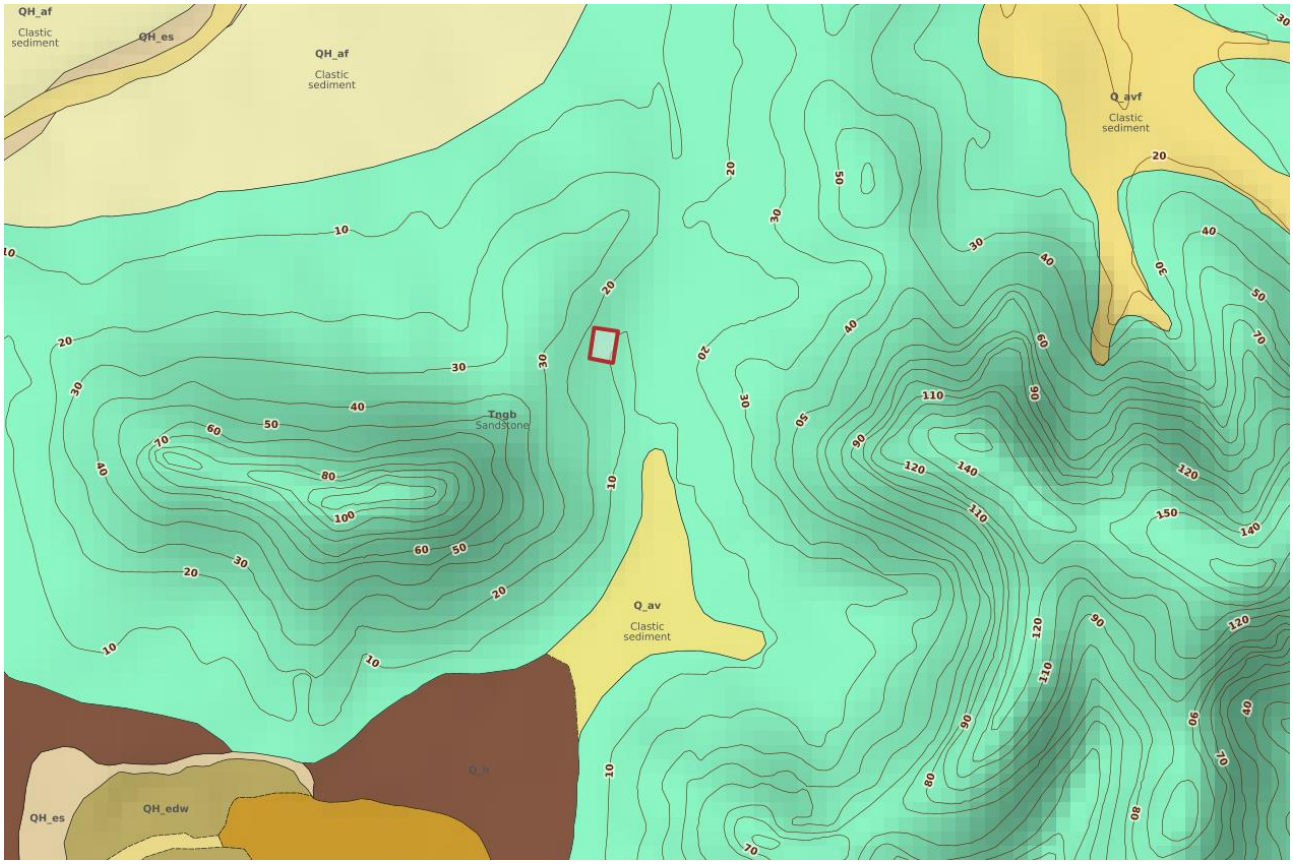

Plate 7 - Extract of the NSW Surface Geology Dataset (2021). The site is located on the Terrigal formation as noted in the 2015 edition of the 1:100,000 Gosford-Lake Macquarie Geological Map.

3.7. Hydrology and Hydrogeology

The NSW Central Coast Opportunity Assessment for Aquifer Storage and Recovery was undertaken by The Australian Government, National Water Commission, in April 2009. It indicates that within the Gosford regional, alluvial aquifers are hosted within interbedded, interlensed and stacked sequences of estuarine alluvium associated with river and coastal plain estuarine systems. These aquifers tend to consist of clayey and silty materials, with low inherent permeability and often yield poor quality groundwater.

The underlying solid geology of the Terrigal Formation is indicated to have a presumptive hydraulic conductivity through the rock mass of 0.5 m/day (6 x 10^{-6} m/s) and a salinity of 200 to 7,000 mg/L TDS.

Two published water borehole logs within 1 km radius of the site are present at Racecourse Road (Borehole Reference: GW100343.1.1), just north of Gosford Hospital and Georgiana Terrace, 160 m north of Brisbane Water (Borehole Reference: GW201893.1.1).

GW100343.1.1 is within the same geological setting as the site, with CLAY soils noted from RL 8.22 m, and weathered rock from RL -1.28 m with no recorded groundwater level within the limits of the borehole, RL -55.78 m.

GW201893.1.1 is within mapped alluvial gravel and sands underlain by the Terrigal formation. The borehole collar level is inferred as about RL 8 m, which indicates alluvial soils are present to a depth of about RL 3 m, underlain by weathered bedrock. No recorded groundwater level was noted within the limits of the borehole, about RL -70 m.

The regional aquifer depth is therefore expected to be below the proposed depth of development of 12 m below existing ground level.

3.8. Archival Information

D&N and Coffey Testing have retrieved archival information from site investigations and construction support for numerous sites in the vicinity of the site, including:

- Multiple pavement boreholes along Showground Road, dated 2016.
- Multiple foundation assessments at Gosford Hospital, dated 2008.
- Various construction observations for the Gosford Hospital, dated 2018.

Upon review of the information, the nearby geotechnical conditions are generally consistent with our desktop review and encountered during our investigation, namely:

- Presence of variable FILL deposits.
- Soil overburden comprising of stiff to very stiff cohesive slopewash, colluvial and residual soil deposits.
- Solid geology comprising shale and sandstone bedrock of the Terrigal formation.
- No groundwater was observed within the soil horizon or upper bedrock units typically to X m below ground level.

Commentary and observations of each unit at nearby works is outlined below:

Fill

- The fill appears to be variable in terms of composition, moisture and thickness which are in turn likely to be determined by the localized setting and development history of each site observed.

Soil Landscape

- The soil thickness of the slopewash material is expected to be generally increase in thickness and moisture content towards the base of slopes and diminishes with proximity to topographic highs to the west of the site.

Solid Geology

- The solid geology is expected to be shallower upslope with potential for outcrops towards the top of topographic highs.
- At shallower depths, excavators fitted with hydraulic rock hammers have been required for excavations.

Plate 8 - Showing Use of Hydraulic Rock Hammers for Excavation

- Vertical walls of bedrock appear to be stable for a temporary period to allow the construction of L-shaped gravity-type retaining walls typically 3 m to 5 m retained height.

Plate 9 - Showing Temporary Stability of Exposed Bedrock

4. Results of Investigation

4.1. Subsurface Conditions

Table 1 below provides a summary of the main geotechnical units encountered during our investigation at BH01. Reference should be made to the Engineering Borehole Log and core photographs included as Appendix A for specific detail regarding subsurface conditions at each respective investigation location.

The main geotechnical units are summarised as follows:

- **Unit 1: FILL and TOPSOIL**, silty SAND or clayey SILT. Moist to wet or equal to the liquid limit.
- **Unit 2**: **Slopewash**, sandy CLAY, medium plasticity, red-brown, mottled yellow-brown, fine to coarse sand, with fine to coarse, rounded to angular gravel and cobbles. Moisture equal or greater than the plastic limit, very stiff consistency.
- **Unit 3: Residual Soil**, silty CLAY, medium plasticity, grey, trace fine to coarse sand and fine to coarse, sub-rounded to rounded ironstone gravel. Moisture less than or equal to the plastic limit, very stiff consistency.
- **Unit 4a: Extremely Weathered Material**, recovered as silty SAND, fine to coarse, red, mottled off-white, low plasticity silt fines. Dry to moist, dense to very dense.
- **Unit 4b: Bedrock**, SANDSTONE, fine to coarse grained, layered, red-brown, mottled off-white, highly to moderately (HW to MW) weathered, low strength.
- **Unit 4c: Bedrock**, SHALE INTERBEDDED AND INTERLAMINATED WITH SANDSTONE, grey, distinct, fine to medium grained, moderately to slightly (MW to SW) weathered, generally low to medium strength.
- **Unit 4d: Bedrock**, SHALE INTERLAMINATED WITH SANDSTONE, grey, distinct, fine to medium grained, slightly weathered (SW), generally high strength with some very high strength layers.

Table 1 - Approximate Depth to Base of Main Geotechnical Units

Unit	BH01	
	Relative to Existing Surface (m)	Relative Level to AHD (m)
1	1.5	9.33
2	5.0	5.83
3	6.5	4.33
4a	7.0	3.83
4b	12.78	-1.95
4c	17.9	-7.07
4d	>20.08	>-9.25

Table 1 Notes:

1. The depths and unit thicknesses are based on information at the investigation locations and may not represent the maximum or the minimum values at other locations across the site and away from the borehole.

4.2. Groundwater Observations

Near-surface, Unit 1 Fill materials and Unit 2 Slopewash soils were noted to have a high moisture content.

During drilling, groundwater inflow was noted to occur at 4.5 m (RL 6.33 m). Unit 3 Residual Soils from 5 m (RL 5.83 m) were noted have a lower moisture content based on a tactile assessment. Weathered bedrock was noted be dry to moist to a depth of 7.9 m (RL 2.93 m). During drilling, groundwater observations were not possible at deeper depths due to the introduction of water into the drilling process to obtain NMLC core.

The groundwater monitoring well was bailed to 4.3 m on 1 June 2021, prior to water recharging at a faster rate than was able removed by conventional hand bailing methods.

Subsequent groundwater monitoring results are summarised in Table 2 below.

Table 2 - Groundwater Observations within BH01

Date Of Observations (2021)	Depth to Groundwater	
	Relative to Existing Surface (m)	Relative Level to AHD (m)
20 May 2021 (During Drilling)	4.5	6.33
25 May	1.1	9.73
28 May	1.2	9.63
1 June	1.2	9.83
4 June	1.1	9.73
8 June	1.3	9.53
11 June	1.4	9.43

4.3. Laboratory Testing

Tables 3 to 6 below provide a summary of the laboratory test results for the site soils. Test certificates are included as Appendix B, for further detail.

Table 3 - Summary of Soil Classification Results

ID	Depth (m)	Unit	LS (%)	PI (%)	LL (%)	PL (%)
BH01	2.5 – 2.95	Unit 2 Slopewash	13.5	30	48	18

Table 4 - Summary of Soil Aggressivity Results

ID	Depth (m)	Unit	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Electrical Conductivity µS/cm)	Resistivity (ohm.m)
BH01	5.5 – 6.0	3 Residual	5.4	< 10	40	28	360

Table 5 - Summary of Groundwater Aggressivity Results

ID	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Electrical Conductivity (µS/cm)
BH01	6.4	37	46	370

Table 6 - Summary of Rock Strength Testing

ID	Depth	Is (50) (MPa)		UCS (MPa)	Unit	Inferred Strength (AS1726-2017)
		Diametral	Axial			
BH01	7.95	0.19	0.19	-	4b	Low Strength
BH01	8.95	0.25	0.26	-	4b	Low
BH01	9.0	-	-	3.13	4b	Low
BH01	9.3	0.19	0.22	-	4b	Low
BH01	10.9	0.06	0.17	-	4b	Very Low to Low
BH01	11.4	0.62	0.30	-	4b	Low to Medium
BH01	12.27	0.11	0.17	-	4b	Low
BH01	13.05	-	0.46	-	4c	Medium
BH01	13.2	1.14	-	-	4c	High
BH01	14.2	0.18	0.22	-	4c	Low
BH01	15.33	0.28	0.37	-	4c	Low to Medium
BH01	16.3	0.23	0.27	-	4c	Low
BH01	17.05	1.31	2.04	-	4c	High
BH01	18.3	5.09	3.40	-	4d	High to Very High
BH01	19.5	2.39	3.37	-	4d	High to Very High

ID	Depth	Is (50) (MPa)		UCS (MPa)	Unit	Inferred Strength (AS1726-2017)
		Diametral	Axial			
BH01	20.05	3.35	-	-	4d	Very High

5. Discussion and Recommendations

5.1. Re-use of Site Won Materials

While it is expected that the basement excavations will result in significant removal of spoil from the site, from a geotechnical viewpoint, Unit 2 and Unit 3 soils and Unit 4 weathered bedrock should generally be suitable for use as controlled Engineered Fill, provided unsuitable/deleterious materials such as organics, waste or oversized particles are removed, and the moisture conditions of these materials are favourable at the time of the work.

The project geotechnical consultant should verify the suitability of excavated material for its particular intended re-use as Engineered Fill during construction to confirm the above.

High plasticity soils such as those observed within Unit 2 and Unit 3 soils will be sensitive to variations in moisture content and may be difficult to re-compact.

The Unit 2 slopewash soil is likely to be wet of optimum moisture content, indicating that handling and compaction of these soils will be difficult without moisture conditioning (e.g. drying).

5.2. Excavation Conditions

Bulk excavations are expected to be up to 12 m below current ground levels (up to about RL – 2 m) to accommodate a three (3) level basement and a four (4) storey building.

Excavations are therefore expected to penetrate Unit 1 Fill, Unit 2 Slopewash, Unit 3 Residual Soil, Unit 4a Extremely Weathered material and Unit 4b Highly Weathered Bedrock.

Excavation with Unit 1 to Unit 4a should be possible using conventional earth moving plant such as hydraulic excavators fitted with rock teeth, of say 30 tonne gross mass.

A preliminary assessment of the rippability of the rock units (Units 4b to 4d) was carried out using the Pettifer Fookes (2004) graphical method[1]. The assessment is summarised in Table 7.

In any case, excavation contractors should be provided with the Engineering Borehole Logs and be required to make their own assessment of the suitability and productivity of excavation plant. Natural variation can occur from the observed conditions to be both more, or less, favourable for excavation.

Table 7 - Preliminary Rippability Assessment – Rock Units

Unit	Typical conditions	Highest point load (strength) conditions
Unit 4b HW to MW Bedrock L Strength Defect spacing generally < 300mm	Hard Digging to Easy Ripping (D6, D7)	Easy Ripping (D6, D7)
Unit 4c MW to SW Bedrock L to M strength Defect spacing generally < 300mm	Hard Digging to Easy Ripping (D6, D7)	Hard Ripping (D8)
Unit 4d SW Bedrock H to VH strength Defect spacing generally < 300mm	Hard Ripping (D8)	Very Hard Ripping (D9)

[1] G. S. Pettifer and P. G. Fookes. *A revision of the graphical method for assessing the excavatability of rock*. Quarterly Journal of Engineering Geology and Hydrogeology 1994; v. 27; p. 145-164 doi:10.1144/GSL.QJEGH.1994.027.P2.05.

Table 7 Notes:

1. Terms describing the rippability are defined in the Pettifer-Fookes reference.

5.3. Removal of Spoil from the Site

In order to remove spoil from the site, it will be necessary to assess the excavated material for contamination and waste classification. All requirements from the NSW EPA must be adhered to in the assessment and removal of surplus materials from the site.

It is likely that the material, other than anthropogenic fill, could be classified as Excavated Natural Material (ENM) or Virgin ENM (VENM). However, environmental assessment will be required to verify that the material does not contain contamination.

5.4. Unsupported Excavations

Temporary and Permanent Batter slopes that are not supported by retention or shoring may be adopted in accordance with Table 8. These guidelines apply for batters up to 3 m in vertical height. Seek further advice from D&N Geotechnical for batters that are higher than 3 m.

For the Units 4b, 4c and 4d bedrock, unsupported batter angles are governed by long-term face degradation. Steeper batters are feasible for the bedrock units where shotcrete facing is provided. Contact D&N for assessment of shotcrete anchoring requirements if these are under consideration.

Table 8 - Temporary and Permanent Batter Slopes

Unit	Temporary Unsupported Batter Slopes Design life < 12 months	Unsupported Permanent Batter Slopes Design life > 100 years
Imported Controlled Fill	1V:1H 45°	1V:2H 27°
1 – Fill	1V:4H 14°	1V:4H 14°
2 – Slopewash	1V:2H 27°	1V:3H 18°
3 – Residual Soil	1V:1H 45°	1V:2H 27°
4a – XW Bedrock	1V:1H 45°	1V:2H 27°
4b – HW to MW Bedrock	1V:0.25H (75°) to 3 m height	1V:1.5H 34°
4c – MW to SW Bedrock	1V:0.25H (75°) to 3 m height	1V:1.5H 34°
4d – SW Bedrock	1V:0.25H 75°	1V:0.75H 53°

Notes to Table 8:

1. Rock faces shall be inspected by a qualified geotechnical professional to check potential defect-controlled faces such as but not limited to, wedge failures, block toppling, rockfalls, and boulder rolls.
2. Angles are shown above the horizontal plane.

5.5. Retention and Shoring Methods

It is expected there will be insufficient room to form the above recommended batters, and near-vertical excavations will be required to form part of the permanent structure, therefore a retention system will be required.

It is likely that retention would comprise solider pile walls with infill panels (usually shotcrete or precast concrete panels) using the earth pressure coefficients recommended in Table 9 below. Coefficients are provided for the following cases:

- Case 1 = Active conditions, where deflections would be greater to mobilise active connections.
- Case 2 = At-rest conditions, where deflections are required to be reduced (e.g., below existing structures or settlement-sensitive features).

It is recommended detailed geotechnical analysis be undertaken for the retention system at detailed design stage. For the proposed excavation depth of some 12 m, it is unlikely that cantilevered piles (without anchoring or propping) will be efficient or feasible to maintain appropriate lateral or vertical deflections of the ground behind the system. Therefore, a combination of temporary anchoring and permanent propping is recommended.

- Permanent propping of the retention system can be provided by the structure of the building. In this event, propping would only be available from the time of construction of the building; accordingly, temporary anchoring (or temporary propping) of the piles would be required. Permission from neighbouring properties would be required to install temporary anchors. It is anticipated that permanent anchors would not be permissible across the property boundaries.
- Propping of the retention system can also be provided by temporary or permanent propping independent of the building structure. Independent temporary props could then be removed once the building structure is constructed to provide permanent propping to the soldier piles.

D&N can assist with the above assessments and in the development of retention concepts to carry the basement design further.

A retention monitoring and action plan shall be prepared in the detailed design phase to:

- Specify monitoring locations on the walls.
- Specify magnitudes of movements of the walls for acceptable movements, and trigger levels for caution and emergency levels.
- Specify actions to be taken where deflections beyond anticipated serviceability limits occur during excavation.

Table 9 - Material Parameters and Earth Pressure Co-efficients for Level Ground above the retention

Geotechnical Unit	Mohr-Strength Envelope Material Properties		Value of Lateral Earth Pressure Coefficient		Passive Earth Pressure Coefficient, Kp	Bulk Density (kN/m^3)	Modulus (MPa)
	Effective Cohesion	Effective Friction Angle	Case 1, K_a	Case 2, K_0			
Controlled General fill (e.g. Local materials re-used)	2	32	0.31	0.47	3.2	20	30
Controlled Granular fill	0	36	0.26	0.41	3.8	20	30
1 - Fill	0	25	0.41	0.58	2.5	19	10

Geotechnical Unit	Mohr-Strength Envelope Material Properties		Value of Lateral Earth Pressure Coefficient		Passive Earth Pressure Coefficient, Kp	Bulk Density (kN/m^3)	Modulus (MPa)
	Effective Cohesion	Effective Friction Angle	Case 1, K_a	Case 2, K_0			
2 – Slopewash	0	28	0.36	0.53	2.8	19	20
3 – Residual soil	2	30	0.33	0.50	3.0	20	35
4a – XW Bedrock	5	34	0.28	0.44	3.5	22	50
4b – HW to MW Sandstone, L strength σ'_v = 0.15 to 0.8 MPa	120	36	0.26	0.41	3.8	24	180
4c – MW to SW Shale, L strength σ'_v = 0.2 to 0.7 MPa	90	29	0.35	0.52	2.8	25	160
4d – SW Shale, H strength σ'_v = 0.0 to 1.0 MPa	700	48	0.15	0.26	6.7	26	> 1,300

Notes to Table 9:

1. Rock Mohr Strength parameters are provided based on stress ranges for slopes up to 3 m. Rock properties do not include consideration of defect-controlled failures, which will need to be assessed at the time of exposure of rock cuttings.

5.6. Potential Effect on Adjacent Structures

5.6.1. Location of Adjacent Footings

The location, footing type, layout and founding depth for adjacent structures should be determined before excavation commences.

Where adjacent structures are located within the zone of influence of the excavation (nominally a line extending at a slope of 1H:1V (in Units 4b or better), or 1V:2H (in Units 1, 2, 3, 4a) up from the base of the proposed excavation), the foundation stratum may experience horizontal and vertical movements from excavation induced ground movements due to retention deformation and this should be adequately assessed as part of excavation retention design.

Notwithstanding the above guidance, the scale of excavation is significant and will require a FEM analysis to estimate settlements behind the retention system.

5.6.2. Vibration Effects

The potential effects of noise and vibration on adjacent structures results from excavation equipment and methods, particularly where excavation of hard rock is required, will need to be carefully considered by the contractor as part of the construction management plan.

It may be necessary to limit the size of excavation plant such as impact hammers and/or limit the use of impact hammers within determined distances of sensitive receptors.

Dilapidation surveys should be carried out on neighbouring structures or sensitive services prior to commencing excavation. Vibration trials should be carried out to assess appropriate distances for the

plant to be used on site to limit vibrations. Vibration monitoring should continue during site works to confirm that the limits are not exceeded.

5.6.3. Expected Work Methods

The predominant construction activities are anticipated to comprise of:

- Excavation equipment – hydraulic excavators, ripping equipment (e.g., dozer or excavator tynes).
- Excavation equipment – hydraulic rock breaker.
- Rotary drilling equipment – pile boring or temporary anchor installation.

It is not expected that blasting would be carried out given the sensitive site setting.

5.6.4. Criteria For Vibration Limits

A wide range of criteria exist at which limits of vibrations (Peak Particle Velocity (PPV)) should be applied to avoid damage, for example:

- DIN4150 (German standard):
  - 2 mm/s PPV structures (e.g., heritage structures).
  - 4 mm/s PPV for poor condition residential structures.
  - 8mm/s PPV for sound structures.
  - 10 – 40 mm/s PPV for industrial structures.
- US and Canadian guides (Wiss, 1981): upper limit of 2 inches or 50 mm/s PPV.
- Australian Standard AS2187.2-1993 (explosives) (via Hackney, n.d.) upper limits:
  - 2 mm/s PPV structures (e.g., heritage).
  - 10 mm/s PPV for residential structures.
  - 25mm/s PPV for industrial structures.

Based on the above we recommend that the DIN4150 guidance be adopted, with allowances for the frequency of vibrations. Higher PPV values are feasible/tolerable for higher vibration frequencies in accordance with DIN4150.

5.6.5. Vibration Monitoring and Offsets

Vibration monitoring of existing structures should be carried out during construction where work is within 40m of existing structures. The monitoring is recommended due to the preliminary nature of this assessment, natural variations in ground conditions, variations in the induced vibrations from equipment in practical conditions, and the combined vibration response of ground conditions and natural frequencies of the structures, all of which would require extensive and detailed studies.

Vibration monitoring equipment shall have audio and visual alarms to alert construction staff of exceedances of the vibration limits. On-site calibration for actual equipment should also be used to develop site-specific relationships between offsets and observed PPV at the monitoring stations, when work first commences.

Condition surveys should be carried out of the existing structures prior to the construction work, to establish baseline building conditions.

The offsets for a range of equipment in Table 10 are provided on a preliminary basis. The contractor for the work shall prepare a vibration management plan to describe the equipment to be used, and likely vibrations with distance from the plant, and detail any protection methods or specialised equipment to reduce vibrations where required.

It is noted that vibrations beyond 0.1mm/s PPV will be perceptible to persons, for frequency ranges between 8 and 80 Hz. Vibrations beyond 1mm/s PPV would typically annoy persons as vibration effects may be visible and keenly perceived. This perception will need to be managed during the works (e.g.,

notices regarding potential vibration perception, and discussion of monitoring and offset controls on the vibration to avoid damage).

Table 10 - Preliminary Offsets of Construction equipment (Wiss, 1981)[2] and Hackney (n.d.)[3]

Equipment	Minimum offset of equipment, from existing structure to limit PPV to 8 mm/s at the existing structure	Minimum offset of equipment, from existing structure, to limit PPV to 2 mm/s at the existing structure
Tracked crane, idling	1 m	2 m
Trucks, pile boring, large bulldozers, soil nailing	5 m	10 m
Rock breaking equipment (hammer up to 1.5 tonnes)	15 m	30 m
Rotary Rock Grinder	8 m	15 m
Vibratory rollers	12 m	25 m
Padfoot compactor (non-vibratory)	8 m	15 m

5.7. Groundwater Conditions

Ground water inflow was observed at RL 6.33 m and generally at about RL 9.7 m during subsequent groundwater well monitoring.

At this stage, it likely that the inflow and standing levels is representative of a perched flow path through the colluvial soil mantle (slopewash) rather than a standing groundwater level given that hydrostatic groundwater at neighbouring developments has not been encountered during our desktop review. We infer that rainfall following our investigation has led to significant through-flows in the colluvium, and that the underlying rock units reduces drainage away from the borehole, leading to the standing water levels observed.

Additional investigation(s) and monitoring weeks should be undertaken/installed upslope as part of Stage 2 works. Additional monitoring wells, with screens isolated into the weathered bedrock units below say 8 m below ground level, should be considered.

Nevertheless, drainage behind basement retention/slabs will be required to discharge to the site stormwater/drainage/pumping system, to allow drainage of seepage and avoid building pore pressures behind the walls in excess of the design allowances. Typically, these drainage measures include strip drains behind the shotcrete facing between piles; discharging to a collector drain at the base of the walls. Sump dewatering is then required.

Dewatering of the site may result in effects on adjacent structures such as building/ pavement/footing settlement which will require detailed analysis as part of the design phase of the development.

5.8. High Level Footings

Design parameters for high level footings are shown in Table 11.

[2] Wiss, J.F. 1981. *Construction Vibrations – State of the Art*, ASCE Proceedings, Journal of the Geotechnical Engineering Division, Vol. 107 No. GT2.
[3] Hackney, n.d. *Excavation Induced Vibrations in Sydney Sandstones*.

Table 11 - Geotechnical Design Parameters – High Level Footings

Unit	Allowable Bearing Pressure, kPa	Young's Modulus, MPa, long-term loading
2 - Slopewash	150	20
3 – Residual soil	200	35
4a – XW Bedrock	400	50
4b – HW to MW Bedrock	1,100	180
4c – MW to SW Bedrock	1,100	160
4d – SW Bedrock	2,500	> 1,300

Notes to Table 11:

1. The values apply for footings to a maximum of 3 m width and founded at least 0.5m below finished surface level. Larger footings would require more detailed assessment.
2. The values apply for footings located away from batters or excavations below the footing, by a distance of at least twice the footing diameter. Footings closer to batters or excavation with require more detailed assessment.
3. The values are based on foundation excavations free of deleterious materials, including water, remnant soil, loose soil or fragments of rock.
4. Within rock footing excavations, the rock surface should be prepared to provide consistent foundation materials, i.e., removal of all weaker materials and zones is required, followed by cleaning of the rock surface with compressed air or water.
5. Settlement of the footings is expected to be limited to 1% of the footing width.
6. Footings shall not be supported on uncontrolled fill or deleterious materials.

5.9. Piled Footings

Design parameters for high level footings are shown in Table 12. For this site, low-displacement piles such as open bored piles (with or without casing) are recommended.

Table 12 - Geotechnical Design Parameters – Low Displacement (Bored) Piled Footings

Unit	Ultimate end bearing capacity, f_{bu}, MPa	Serviceability end bearing capacity, f_{bs}, MPa	Ultimate Shaft Adhesion, f_{su}, MPa See Note 1	Vertical Modulus, MPa See note 2	Ultimate Lateral Yield Capacity, MPa
3 – Residual soil	1.0	-	0.06	35	0.5
4a – XW Bedrock	3.0	-	0.10	50	0.7
4b – HW to MW Bedrock	8	1.5	0.6	180	2 (note 3) 4 (note 4)
4c – MW to SW Bedrock	8	1.5	0.6	160	4
4d – SW Bedrock	20	6.0	1.0	> 1,300	10

Notes to Table 12:

1. Shaft adhesion values are provided for downwards loading (not uplift). For uplift, include an additional reduction factor of 0.7 when uplift resistance is relied upon in the stability limit case. Shaft adhesion is provided on the basis that the socket roughness

classification would be minimum R2. Shaft adhesion shall only be considered below four pile diameters depth below finished surface level.

2. Lateral moduli may be taken as 70% of the vertical values.

3. For that zone within 1 pile diameter from the top of the unit

4. For that zone below 1 pile diameter from the top of the unit.

5. Ultimate end bearing resistance occurs at > 5% settlement. Service end bearing occurs at < 1% settlement.

The use of pile casing is recommended for the construction of bored piles, particularly in the soil strength units. There may be efficiencies if the Slopewash and Residual soil is stable on excavation of the pile holes. Where groundwater inflow occurs, it is likely that pile hole sidewalls would be unstable. Following exposure of the rock units, it is expected that casing within the rock units is not required if the performance of the pile sidewalls is acceptable during construction.

Groundwater inflows may occur at any level but typically within Unit 2 Slopewash and possibly at the top of the rock shelf, where infiltration groundwater collects, or through defects within the rock units themselves. Where groundwater is encountered:

- The pile hole shall be dewatered before concreting of the pile, if the rate of inflow is sufficiently slow to allow dewatering.
- Concrete shall be placed using a tremie to the base of the pile, if groundwater is left in the hole and not able to be practically dewatered. Pile base cleanliness will need to be verified indirectly (e.g. through checking of the hardness of the base of the hole that is underwater or through de-sanding operations).

5.10. Geotechnical Strength Reduction Factor

D&N have carried out an assessment of the geotechnical strength reduction factor for pile design in accordance with AS2159-2009. The assessment is preliminary as several inputs to the assessment is required to be selected by the pile designer. The input descriptions and ranges of values for the inputs are described in AS2159.

The basic geotechnical strength reduction factor shall be taken as ϕ_{gb} = 0.40 for preliminary design. Once additional boreholes are undertaken, to assess variability across the site, and pile testing is considered, the assessment may be reconsidered.

5.11. Foundation Verification Requirements

Foundation exposures for high level footings shall be inspected by a geotechnical professional to confirm that the design intent has been achieved with respect to foundation materials and bearing pressures.

Piled foundations shall be inspected similarly, and where pile bases are directly visible, an assessment of pile base cleanliness shall be made. The contractor will remain responsible for achievement of the design intent where pile base cleanliness cannot be verified (e.g. covered in water).

5.12. Soil and Groundwater Aggressivity

An assessment of soil aggressivity to buried structural elements was made in accordance with AS2159-2007: *Piling – Design and Installation*. The test results from Tables 4 and 5 were referenced as follows:

Based on the test results the assessed aggressivity to buried structural elements is:

- Concrete elements:
  - Mild when in contact with Fresh Water.
  - Mild for cohesive soils and all materials above the groundwater table.
  - Moderate for sands and gravels below the water table.
- Steel elements:
  - Moderate when in contact with Fresh Water.

- Non-aggressive in contact with soil.

5.13. Recommendations for Earthquake Provisions

The following parameters have been selected from AS1170.0:2002 and AS1170.4:2007 for earthquake design of structures:

- Hazard factor Z of 0.09 for Gosford (expressed as a proportion of g = 9.81 m/s^2).
- Site Sub-Soil Class of C_e – Soil.

6. Recommendations for Further Geotechnical Studies

Given the development is anticipated to require relatively deep excavations adjacent to sensitive structures, further geotechnical information is recommended to inform design. These assessments shall include:

- Additional cored boreholes to 20 m depth below ground, or to 5 pile diameters below the pile toe where preliminary pile design has been carried out. The additional boreholes will provide further information with respect to excavatability, which will assist in reducing unforeseen excavation variations.
- Installation of additional groundwater monitoring wells isolated within the weathered rock to assess groundwater pressures within the excavation depths.
- Detailed design and analysis of the shoring system, to verify:
  - Shoring system requirements (e.g. pile toe level, size and spacing).
  - Nature of propping/anchoring and associated loads per stage.
  - Deflection of the retention system and ground behind the system, and the effect of the excavation on nearby properties.
  - Effect of dewatering from the excavation/basement.

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.

Figure

C-0861.00 | 60 & 62-64 Showground Road | Geotechnical Investigation

Legend

- Borehole

Data Source:

https://data.nsw.gov.au/data/

Cartographic Data and Orientation:

N

1:1,000
Datum: GDA2020
Coordinate Unit: Metres

0 — 40 m

D&N Geotechnical

Company: D&N Geotechnical
Drawn: LC
Approved: DB
Original size: A3
Project: 60 & 62-64 Showground Road Geotechnical Investigation

Date:	Client:	Figure 1
31/05/2021	CHP Fund Pty Ltd	

Appendix A – Engineering Borehole Log and Core Photographs

D&N Geotechnical

Engineering Log - Borehole

Borehole ID.	**BH01**
sheet:	1 of 4
project no.	**C-0861.00**
client:	**CHP Fund Pty Ltd**
date started:	**19 May 2021**
principal:	
date completed:	**20 May 2021**
project:	**60 & 62-64 Showground Road**
logged by:	**SM**
location:	**Gosford NSW**
checked by:	**LC**

position: E: 345802; N: 6300757 (MGA94) | surface elevation: 10.83 m (AHD) | angle from horizontal: 90°

drill model: Komatsu, Track mounted | drilling fluid: Water | casing diameter : HW

drilling information | **material substance**

method & support	penetration	water	samples & field tests	RL (m)	depth (m)	graphic log	classification symbol	material description (SOIL TYPE: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa)	structure and additional observations
AD/T, HW casing				10	0.0		SM	**FILL: SILTY SAND**: fine to coarse grained, grey, low plasticity silt fines, trace fine to medium, sub-angular to angular gravel. 0.5 to 1.0 m: trace fibrous wood and fabric	M to W			**FILL**
			SPT 1, 1, 2 N=3		1.0		ML	**TOPSOIL: Clayey SILT**: low liquid limit, grey, mottled off-white, trace fine to coarse sand, and fine, rounded to sub-rounded gravel.	~Wl			**TOPSOIL**
				9			Cl	**Sandy CLAY**: medium plasticity, red-brown, mottled yellow-brown, fine to coarse sand, trace fine to medium, rounded to sub-rounded gravel.	~Wp	VSt		**SLOPEWASH**
			D		2.0			2.0 to 2.5 m: with fine to coarse, sub-angular to angular shale gravel, trace sub-angular to angular shale cobbles				
			SPT 4, 6, 10 N=16	8								HP 250 kPa
					3.0							
			D					3.5 m: colour change, red-brown, mottled pale grey				
				7								
			SPT 7, 9, 11 N=20		4.0							HP 230 kPa HP 250 kPa
									~Wp to >Wp			HP 250 kPa
				6								
					5.0		Cl	**Silty CLAY**: medium plasticity, grey, trace fine to coarse sand and fine to coarse, sub-rounded to rounded ironstone gravel.	<Wp to ~Wp	VSt		**RESIDUAL SOIL**
			SPT 6, 10, 11 N=21	5								HP 260 kPa HP 350 kPa
					6.0							HP 360 kPa
				4			SM	**SILTY SAND**: fine to coarse grained, red, mottled off-white, low plasticity silt fines.	D to M	D to VD		**EXTREMELY WEATHERED MATERIAL**
			SPT 12, 23 HB N=R		7.0			**SANDSTONE**: fine to coarse grained, red-brown, off-white, high weathered, low strength.				**BEDROCK**
				3				Borehole BH01 continued as cored hole				

D&N_AU_LIBRARY.GLB rev:AM Log COF BOREHOLE: NON CORED C-0861.00.GPJ <<DrawingFile>> 09/06/2021 14:32

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

* 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

classification symbol & soil description based on Unified Classification System

moisture
- 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

D&N Geotechnical

Engineering Log - Cored Borehole

Borehole ID.	**BH01**
sheet:	2 of 4
project no.	**C-0861.00**
client:	**CHP Fund Pty Ltd**
date started:	**19 May 2021**
principal:	
date completed:	**20 May 2021**
project:	**60 & 62-64 Showground Road**
logged by:	**SM**
location:	**Gosford NSW**
checked by:	**LC**

position: E: 345802; N: 6300757 (MGA94) | surface elevation: 10.83 m (AHD) | angle from horizontal: 90°

drill model: Komatsu, Track mounted | drilling fluid: Water | casing diameter : HW | vane id.:

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
		10	1.0								
		9	2.0								
		8	3.0								
		7	4.0								
		6	5.0								
		5	6.0								
		4	7.0								
		3			start coring at 7.90m						JT, 5°, PL, VR, CN

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method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

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
- DW distinctly 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
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

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

coating
- CN clean
- SN stain
- VN veneer
- CO coating

D&N Geotechnical

Engineering Log - Cored Borehole

Borehole ID.	**BH01**
sheet:	3 of 4
project no.	**C-0861.00**
client:	**CHP Fund Pty Ltd**
date started:	**19 May 2021**
principal:	
date completed:	**20 May 2021**
project:	**60 & 62-64 Showground Road**
logged by:	**SM**
location:	**Gosford NSW**
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position: E: 345802; N: 6300757 (MGA94) | surface elevation: 10.83 m (AHD) | angle from horizontal: 90°

drill model: Komatsu, Track mounted | drilling fluid: Water | casing diameter : HW | vane id.:

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		2	9.0		**SANDSTONE**: fine to coarse grained, layered, red-brown, off-white. *(continued)*	HW		a=0.19 d=0.19	84%		JT, 10°, PL, VR, CN JT, 30°, IR, VR, CN JT, 10°, PL, VR, CN
									84%		JT, 50°, UN, VR, CN JT, 5°, PL, VR, CN JT, 5°, IR, VR, CN
								a=0.26 d=0.25			JT, 5°, IR, VR, CN
		1	10.0			MW		a=0.22 d=0.19			JT, 0°, IR, VR, CN JT, 0°, PL, VR, CN
						XW to HW					JT, 30°, IR, VR, CN JT, 10°, IR, VR, CN
						MW			78%		JT, 5°, IR, RO, CN JT, 5°, IR, VR, CN JT, 25°, IR, VR, CN JT, 25°, PL, VR, CN JT, 15°, IR, VR, CN JT, 5°, IR, VR, CN
		0	11.0		**NO CORE:** 0.07 m	MW					JT, 5°, PL, RO, CN
					SANDSTONE: fine to coarse grained, layered, red-brown, off-white.			a=0.17 d=0.06			JT, 15°, IR, VR, CN JT, 0°, IR, SO, CN JT, 5°, IR, VR, CN JT, 15°, IR, SO, CN JT, 0°, IR, VR, CN JT, 5°, PL, VR, CN
								a=0.30 d=0.62	76%		JT, 0°, IR, VR, CN CS, 5°, Gravelly Clay CO, 30 mm JT, 5°, IR, VR, CN CS, 5°, Gravelly Clay CO, 30 mm
		-1	12.0								JT, 15°, IR, VR, CN
					NO CORE: 0.10 m	MW		a=0.17 d=0.11			JT, 10°, PL, VR, CN JT, 0°, PL, VR, CN JT, 80°, PL, VR, Clay CO
					SANDSTONE: fine to coarse grained, layered, red-brown, off-white.						JT, 0°, PL, VR, CN JT, 0°, IR, VR, CN JT, 15°, PL, CN
		-2	13.0		**SHALE (60%) INTERBEDDED WITH SANDSTONE (40%)**: grey, distinctly laminated.			a=0.46 d=1.14	73%		JT, 15°, CU, VR, CN JT, 5°, PL, VR, CN JT, 15°, IR, VR, CN JT, 10°, IR, VR, CN JT, 10°, CU, VR, CN
					NO CORE: 0.12 m	MW					JT, 5°, IR, VR, CN
		-3	14.0		**SHALE (90%) INTERLAMINATED WITH SANDSTONE (10%)**: grey, distinctly laminated, fine to medium grained.	MW to SW			0%		recovered as gravel JT, 10°, PL, SO, CN, multiple joints
					NO CORE: 0.15 m						JT, 10°, PL, SO, CN
					SHALE (90%) INTERLAMINATED WITH SANDSTONE (10%): grey, distinctly laminated, fine to medium grained.			a=0.22 d=0.18	67%		JT, 0°, PL, SO, CN JT, 5°, PL, SO, CN JT, 5°, IR, SO, CN JT, 5°, PL, SO, CN JT, 0°, PL, SO, CN JT, 5°, IR, SO, CN JT, 40°, IR, SO, Fe SN JT, 25°, PL, SO, CN
		-4	15.0								JT, 10°, IR, RO, CN JT, 0°, IR, RO, CN
								a=0.37 d=0.28	85%		JT, 5°, IR, SO, CN JT, 5°, PL, SO, CN JT, 5°, IR, SO, CN JT, 5°, IR, SO, CN JT, 40°, IR, SO, CN JT, 10°, IR, RO, CN
		-5									

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method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

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
- DW distinctly 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
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

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

coating
- CN clean
- SN stain
- VN veneer
- CO coating

D&N Geotechnical

Engineering Log - Cored Borehole

Borehole ID.	**BH01**
sheet:	4 of 4
project no.	**C-0861.00**
date started:	**19 May 2021**
date completed:	**20 May 2021**
logged by:	**SM**
checked by:	**LC**

client: ***CHP Fund Pty Ltd***

principal:

project: ***60 & 62-64 Showground Road***

location: ***Gosford NSW***

position: E: 345802; N: 6300757 (MGA94) | surface elevation: 10.83 m (AHD) | angle from horizontal: 90°

drill model: Komatsu, Track mounted | drilling fluid: Water | casing diameter : HW | vane id.:

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		-6	17.0		**SHALE (90%) INTERLAMINATED WITH SANDSTONE (10%)**: grey, distinctly laminated, fine to medium grained. *(continued)*	MW to SW		a=0.27 d=0.23	85%		JT, 15°, PL, SO, Clay CO JT, 10°, PL, SO, CN JT, 5°, PL, SO, CN JT, 40°, CU, SO, CN JT, 40°, CU, SO, CN JT, 10°, PL, SO, CN JT, 40° JT, 10°, IR, SO, CN
						SW		a=2.04 d=1.31	81%		PT, 0°, PL, SO, CN PT, 0°, PL, SO, CN PT, 5°, IR, SO, CN
		-7	18.0					a=3.40 d=5.09			PT, 5°, PL, SO, CN PT, 5°, PL, SO, CN PT, 5°, PL, SO, CN PT, 5°, PL, SO, CN PT, 5°, IR, SO, CN PT, 10°, PL, SO, CN JT, 25°, IR, SO, CN
		-8	19.0						81%		PT, 10°, PL, SO, CN PT, 10°, PL, SO, CN PT, 10°, PL, SO, CN PT, 15°, PL, SO, CN
		-9	20.0					a=3.37 d=2.89	57%		PT, 20°, PL, SO, CN multiple partings
								d=3.35			
		-10	21.0		Borehole BH01 terminated at 20.08 m Target depth						
		-11	22.0								
		-12	23.0								
		-13									

D&N_AU_LIBRARY.GLB rev:AM Log COF BOREHOLE: CORED C-0861.00.GPJ <<DrawingFile>> 09/06/2021 14:21

method & support
- AS auger screwing
- AD auger drilling
- CB claw or blade bit
- W washbore
- NMLC NMLC core (51.9 mm)
- NQ wireline core (47.6mm)
- HQ wireline core (63.5mm)
- PQ wireline core (85.0mm)
- SPT standard penetration test

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
- DW distinctly 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
- SZ shear zone
- SS shear surface
- CO contact
- CS crushed seam
- SM seam

planarity
- PL planar
- CU curved
- UN undulating
- ST stepped
- IR Irregular

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

coating
- CN clean
- SN stain
- VN veneer
- CO coating

D&N Geotechnical

BH01

Core Photograph

Job No: C-0861.00
Office: Canberra

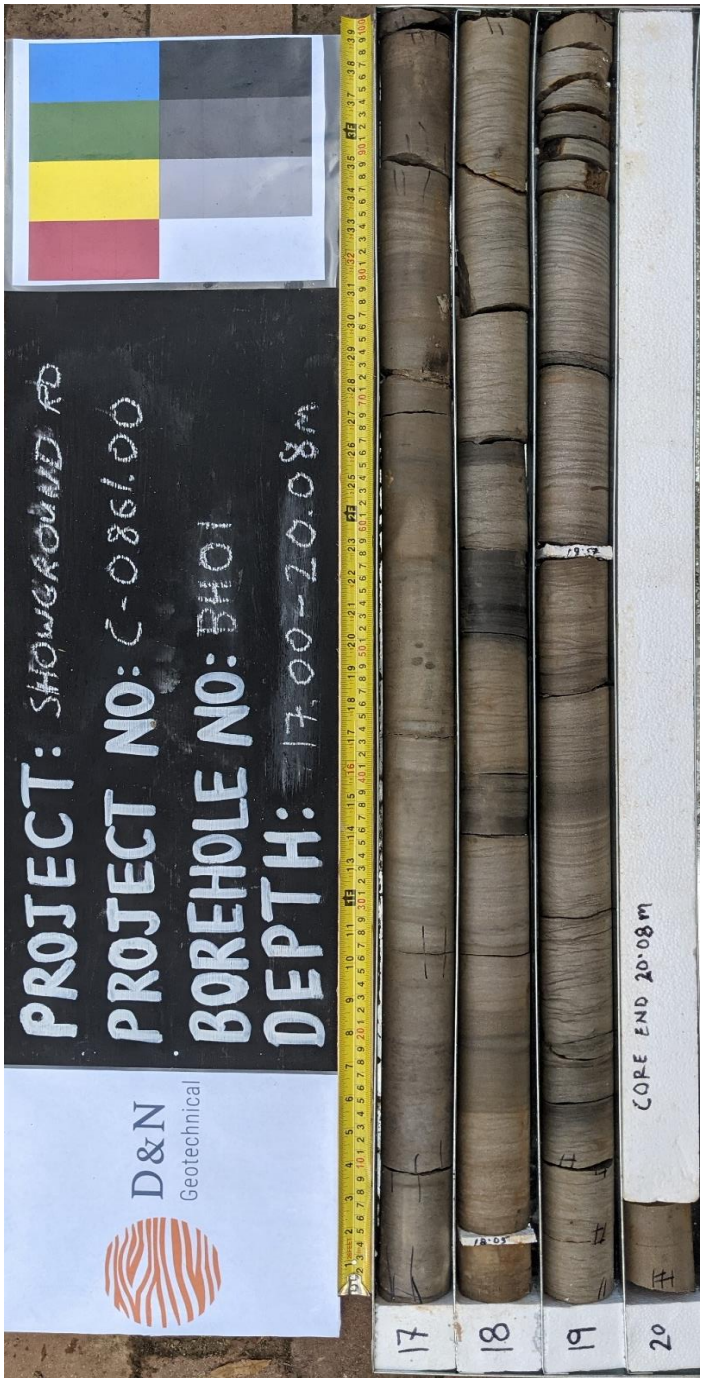
Client: CHP Fund Pty Ltd	Date: 31 May 2021
Principal:	By: SM
Project: 60 & 62-64 Showground Road	Location: Gosford NSW

BH01

Core Photograph

Job No: C-0861.00 Sheet 2 of 2
Office: Canberra

Client: CHP Fund Pty Ltd	Date: 31 May 2021
Principal:	By: SM
Project: 60 & 62-64 Showground Road	Location: Gosford NSW



Appendix B – Laboratory Test Certificates

SYDNEY LABORATORY
Coffey Testing Pty Ltd
ABN 92 114 364 046
31 Hope Street, Melrose Park NSW 2114 Australia
ph: +61 2 8876 0500

Test report - uniaxial compressive strength

client: *D&N GEOTECHNICAL PTY LTD* job no: ***TESTSYDS 00080AA***
Principal:
project: *C-0861.00 60 & 62-64 SHOWGROUND ROAD* report date: *2 June 2021*
location: *GOSFORD NSW* borehole: ***BH01***
test procedure: *AS 4133.1.1.1 and 4133.4.2.1* date received: *28 May 2021*
test apparatus: *Avery with 200 kN CAS load cell 4222* *page 1 of 1*

All samples were tested in an "As Received" condition.

Top platen 228 mm, Bottom platen 120 mm

QESTLab work order ID / depth / QESTLab sample ID	date tested / test duration	height / average diameter / height/dia ratio	uniaxial compressive strength MPa	wet density / moisture content	sample description / bedding/foliation	Client's Sample ID / failure mechanism
SYDS20W00107 *9.00 to 9.24 m* *SYDS20S00971*	*1 Jun 21* *6.72 min*	*149 mm* *51.1 mm* *2.91:1*	***3.13***	***2.3 t/m³*** ***11.2 %***	*Ironstone* *Bedding planes are at an angle of 20° to the axis of loading*	*Conical*

9.00 to 9.24 m

SYDS_001R

NATA Accredited Laboratory
No. 431

Date: *2 Jun 2021*

Authorised Signature:
Alan Cocks
Rock Testing Manager

Central Coast Laboratory

Coffey Testing Pty Ltd
ABN 92 114 364 046
Unit 3, 111 Wisemans Ferry Road
Somersby, NSW 2250

Phone: +61 2 8876 0560

Report No: CCOA21S-01393-1
Issue No: 1

Material Test Report

Client: D&N Geotechnical Pty Ltd
16 Broadsmith Street
Scullin ACT 2614

Principal:
Project No.: TESTCCOA00014AA
Project Name: Construction Materials Testing
Lot No.: - **TRN:** -

Accredited for compliance with ISO/IEC 17025 - Testing. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection and proficiency testing scheme providers reports.

Approved Signatory: Mitchell Taylor (Geotechnician)
NATA Accredited Laboratory Number:431
Date of Issue: 3/06/2021

Sample Details

Sample ID: CCOA21S-01393
Date Sampled: 19/05/2021
Source: Existing
Material: SPT Log
Specification: No Specification
Sampling Method: Submitted by client
Project Location: 60 & 62-64 Showground Road, Gosford NSW
Sample Location: BH01: 2.5 - 2.95 SPT

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	13.5	
Mould Length (mm)		125	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	48	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	18	
Plasticity Index (%)	AS 1289.3.3.1	30	
Date Tested		1/06/2021	

Comments

N/A

Coffey Testing Pty Ltd NSW
31 Hope Street
Melrose Park
NSW 2114

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection and proficiency testing scheme providers reports.

Attention: **Cameron Bik**

Report **798706-S-V2**
Project name 60 & 62-64 SHOWGROUND ROAD
Project ID C-0861.00
Received Date May 27, 2021

Client Sample ID			**BH01 5.5-6.0**
Sample Matrix			**Soil**
Eurofins Sample No.			**S21-My56181**
Date Sampled			**May 19, 2021**
Test/Reference	LOR	Unit	
Chloride	10	mg/kg	< 10
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	28
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	5.4
Resistivity*	0.5	ohm.m	360
Sulphate (as SO4)	10	mg/kg	40
% Moisture	1	%	14

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

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	Sydney	May 31, 2021	28 Days
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Conductivity (1:5 aqueous extract at 25°C as rec.)	Sydney	May 31, 2021	7 Days
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25°C as rec.)	Sydney	May 31, 2021	7 Days
- Method: LTM-GEN-7090 pH in soil by ISE			
Sulphate (as SO4)	Sydney	May 31, 2021	28 Days
- Method: E045 Anions by Ion Chromatography			
% Moisture	Sydney	May 28, 2021	14 Days
- Method: LTM-GEN-7080 Moisture			

eurofins | Environment Testing

ABN: 50 005 085 521 web: www.eurofins.com.au email: EnviroSales@eurofins.com

Australia

Melbourne
6 Monterey Road
Dandenong South VIC 3175
Phone : +61 3 8564 5000
NATA # 1261
Site # 1254 & 14271

Sydney
Unit F3, Building F
16 Mars Road
Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Perth
46-48 Banksia Road
Welshpool WA 6106
Phone : +61 8 9251 9600
NATA # 1261
Site # 23736

Newcastle
4/52 Industrial Drive
Mayfield East NSW 2304
PO Box 60 Wickham 2293
Phone : +61 2 4968 8448
NATA # 1261 Site # 25079

New Zealand

Auckland
35 O'Rorke Road
Penrose, Auckland 1061
Phone : +64 9 526 45 51
IANZ # 1327

Christchurch
43 Detroit Drive
Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

Company Name:	Coffey Testing Pty Ltd NSW	**Order No.:**	**Received:** May 27, 2021 2:00 PM
Address:	31 Hope Street Melrose Park NSW 2114	**Report #:** 798706 **Phone:** 02 8876 0500 **Fax:**	**Due:** Jun 3, 2021 **Priority:** 5 Day **Contact Name:** Cameron Bik
Project Name:	60 & 62-64 SHOWGROUND ROAD		
Project ID:	C-0861.00		

Eurofins Analytical Services Manager : Andrew Black

Sample Detail						Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271							
Sydney Laboratory - NATA Site # 18217						X	X
Brisbane Laboratory - NATA Site # 20794							
Perth Laboratory - NATA Site # 23736							
Mayfield Laboratory - NATA Site # 25079							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH01 5.5-6.0	May 19, 2021		Soil	S21-My56181	X	X
Test Counts						1	1

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid 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. Information identified on this report with blue colour, indicates data provided by customer, that may have an impact on the results.
9. 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	US Department of Defense Quality Systems Manual Version 5.3
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 20-130% Phenols & 50-150% PFASs

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.3 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	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Conductivity (1:5 aqueous extract at 25°C as rec.)	uS/cm	< 10			10	Pass	
LCS - % Recovery							
Conductivity (1:5 aqueous extract at 25°C as rec.)	%	83			70-130	Pass	
Resistivity*	%	83			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Chloride	S21-My56184	NCP	mg/kg	11	< 10	16	30%	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	S21-My56181	CP	uS/cm	28	27	3.0	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	S21-Jn03847	NCP	pH Units	8.3	8.2	<1	30%	Pass	
Resistivity*	S21-My56181	CP	ohm.m	360	370	3.0	30%	Pass	
Sulphate (as SO4)	S21-My56184	NCP	mg/kg	32	26	18	30%	Pass	
% Moisture	S21-My56184	NCP	%	17	16	2.0	30%	Pass	

Comments

V2- new version to amend project ID as per client request.

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	No
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

Authorised by:

Andrew Black	Analytical Services Manager
Charl Du Preez	Senior Analyst-Inorganic (NSW)

Glenn Jackson
General 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.

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

CERTIFICATE OF ANALYSIS 271339

Client Details

Client	Coffey Testing (Central Coast) Pty Ltd
Attention	Cameron Bik
Address	3, 111 Wisemans Ferry Rd, SOMERSBY, NSW, 2250

Sample Details

Your Reference	**TESTCCOA00014AA, Showground Rd, Gosford**
Number of Samples	1 Water
Date samples received	10/06/2021
Date completed instructions received	10/06/2021

Analysis Details

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

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

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

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	11/06/2021
Date of Issue	11/06/2021

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

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

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Miscellaneous Inorganics		
Our Reference		271339-1
Your Reference	UNITS	CT1/A
Date Sampled		04/06/2021
Type of sample		Water
Date prepared	-	10/06/2021
Date analysed	-	10/06/2021
pH	pH Units	6.4
Electrical Conductivity	µS/cm	370
Chloride, Cl	mg/L	37
Sulphate, SO4	mg/L	46

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

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			10/06/2021	[NT]	[NT]	[NT]	[NT]	10/06/2021	[NT]
Date analysed	-			10/06/2021	[NT]	[NT]	[NT]	[NT]	10/06/2021	[NT]
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	101	[NT]
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	91	[NT]
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	[NT]	[NT]	99	[NT]

Result Definitions

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

Quality Control Definitions

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

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

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

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

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

Report Comments

MISC_INORG: pH
Samples were out of the recommended holding time for this analysis.