Site Hydrogeology Report

SITE HYDROGEOLOGY REPORT

4 DELMAR PARADE & 812 PITTWATER ROAD, DEE WHY NSW

Prepared for:

LANDMARK GROUP AUSTRALIA PTY LTD

Reference: P3018_07 rev1

2 May 2024

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Contents

1 INTRODUCTION

1.1 Overview

Morrow Geotechnics Pty Ltd has carried out a Groundwater Study and prepared a Site Hydrogeology Report for the proposed development at 4 Delmar Parade & 812 Pittwater Road, Dee Why NSW (the site) also known as SP 32071 & SP 32072. At the time of producing this report DA2022/0145 was active with a modification 2024/0083 being assessed.

The following geotechnical reports have been prepared for the site:

- AssettGeoEnviro, *Proposed Mixed-use Development, 4 Delmar Parade & 812 Pittwater Road, Dee Why, NSW;* ref 6561-G1 and dated 25 November 2021 (AGE 2021);
- Reditus Consulting Pty Ltd, *Preliminary Site Investigation, 4 Delmar Parade & 812 Pittwater Road, Dee Why;* project number 21181, version 2 and dated 1 December 2021 (RC 2021);
- Geosyntec Consultants Pty Ltd, *Detailed Site Investigation, 4 Delmar Parade & 812 Pittwater Road, Dee Why;* project number 21325 and dated 4 May 2022 (GC 2022); and
- Reditus Consulting Pty Ltd, *Dewatering Management Plan, 4 Delmar Parade & 812 Pittwater Road, Dee Why;* report number 21181RP01, version 1 and dated 7 June 2022 (RC 2022).
- Morrow Geotechnics Pty Ltd, Geotechnical Investigation Report, *4 Delmar Parade & 812 Pittwater Road, Dee Why NSW,* referenced P3018_01 rev3, and dated 2 May 2024 (MG 2024).

The previous geotechnical reports present the results of a site investigation for the proposed development and geotechnical recommendations for design and construction.

1.2 Proposed Development

Architectural drawings for the proposed development have been prepared by Rothe Lowman Property Pty Ltd, Project Number 221054 and dated 16 January 2024. From the drawings provided, Morrow Geotechnics understands that the proposed development involves construction of multi-storey apartment building over a two to three level basement carpark. Morrow understands the development involves excavation to a maximum depth of extends to RL 13.7 to 18.095 mAHD across the eastern half of the site and to RL 21.25 mAHD at the south-western corner of the site.

1.3 Proposed Dewatering Schedule

Given the relatively low permeability of the sandstone profile encountered at depth within the geotechnical investigation it is proposed to construct a secant pile cut-off wall socketed a minimum of 1000 mm into Class III Sandstone to minimise groundwater seepage. Dewatering through spear points and pumping is not proposed for the construction period, rather the minor groundwater seepage around the cut-off wall will be collected by sump pits within the basement.

The excavation program for the proposed basement is expected to take up to 6 months. Temporary construction dewatering is expected to occur for construction seepage inflows during this 6 month period.

1.4 Objectives

The objective of this Site Hydrogeology Report is to provide results on the presence of water at the site and comment on whether or not there is an aquifer present at the site in accordance with the definition of aquifer as laid out in the NSW DPI Office of Water *Aquifer Interference Policy.* Section 1.2 of the policy defines an aquifer as

> "the term 'aquifer' is commonly understood to mean a groundwater system that is sufficiently permeable to allow water to move within it, and which can yield productive volumes of groundwater"

Further, this report provides analysis of the permeability of soils encountered within boreholes at the site and geotechnical advice and recommendations on the management of groundwater in the design and construction of the proposed development.

2 GEOLOGICAL MODEL

2.1 Published Geological Mapping

The Department of Mineral Resources Geological Map Sydney 1:100,000 Geological Series Sydney (DMR 1983) indicates the site to be underlain by Hawkesbury Sandstone, which comprises medium to coarse grained quartz sandstone, very minor shale and laminite lenses.

2.2 Published Soil Landscapes

The Soil Conservation Service of NSW Sydney 1:100,000 Soil Landscapes Series Sheet 9130 indicates that the residual landscape at the site is located on the boundary of the Gymea and Newport Landscapes.

The Gymea landscape type typically includes undulating to rolling rises and low hills on Hawkesbury Sandstone. Soils are generally shallow to moderately deep (0.3 – 1 m) yellow earths and earthy sands. These soils are noted to present localized steep slopes, high soil erosion hazard, rock outcrop and shallow highly permeable soil.

The Newport landscape type typically includes gently undulating plains of Holocene sands to rolling rises over other soils or bedrock. Soils are generally shallow (< 0.5 m) siliceous sands overlaying moderately deep buried sands (< 1.5m) yellow podzolic soil with sandy topsoil on crests and deep (> 2.0m) podzols in depressions earthy sands. These soils are noted present high soil erosion hazards, localized steep slopes, very low soil fertility and non-cohesive topsoil.

2.3 Site Description

At the time of the Geotechnical and Hydrogeological Investigations the site comprises an L-shaped block with a total area of approximately 7,800m^2. The site is bounded to the north by Delmar Parade, to the east by residential dwellings, to the south by Stony Range Regional Botanic Garden, to the west by Pittwater Road and to the north-west by a multi storey residential development. The site dips down towards the northwest with site RLs ranging from RL 37.17 mAHD in the southeast corner of the site to RL 27.85 mAHD in the north corner of the site adjacent to Delmar Parade.

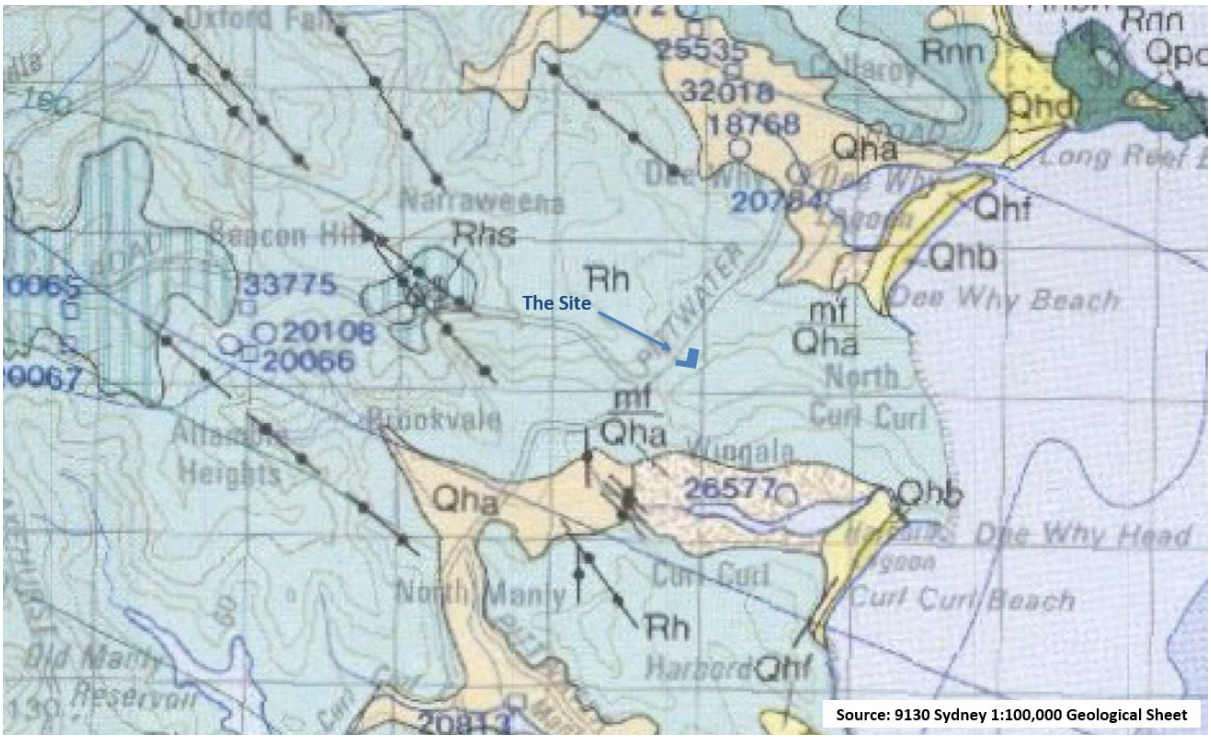


Figure 1: Regional Geology taken from Sydney 1:100,000 Geological Sheet

Figure 2: Soil Landscapes taken from Sydney 1:100,000 Soil Landscape Sheet

2.4 Stratigraphic Model

During the MG2023 investigation BH101, BH102, BH103 and BH105 were drilled by a track mounted drill rig using solid flight augers equipped with a tungsten-carbide bit (TC bit). The boreholes were extended beyond TC bit refusal by NMLC coring techniques to depths of between 12.99 m and 15.00 m below ground level (mBGL). BH104 was drilled using a tight access man portable drilling rig using solid flight augers equipped with a tungsten-carbide bit, it was extended beyond TC bit refusal using NMLC coring techniques to a depth of 22.22 mBGL.

Borehole locations are shown on **Figure 3** below:

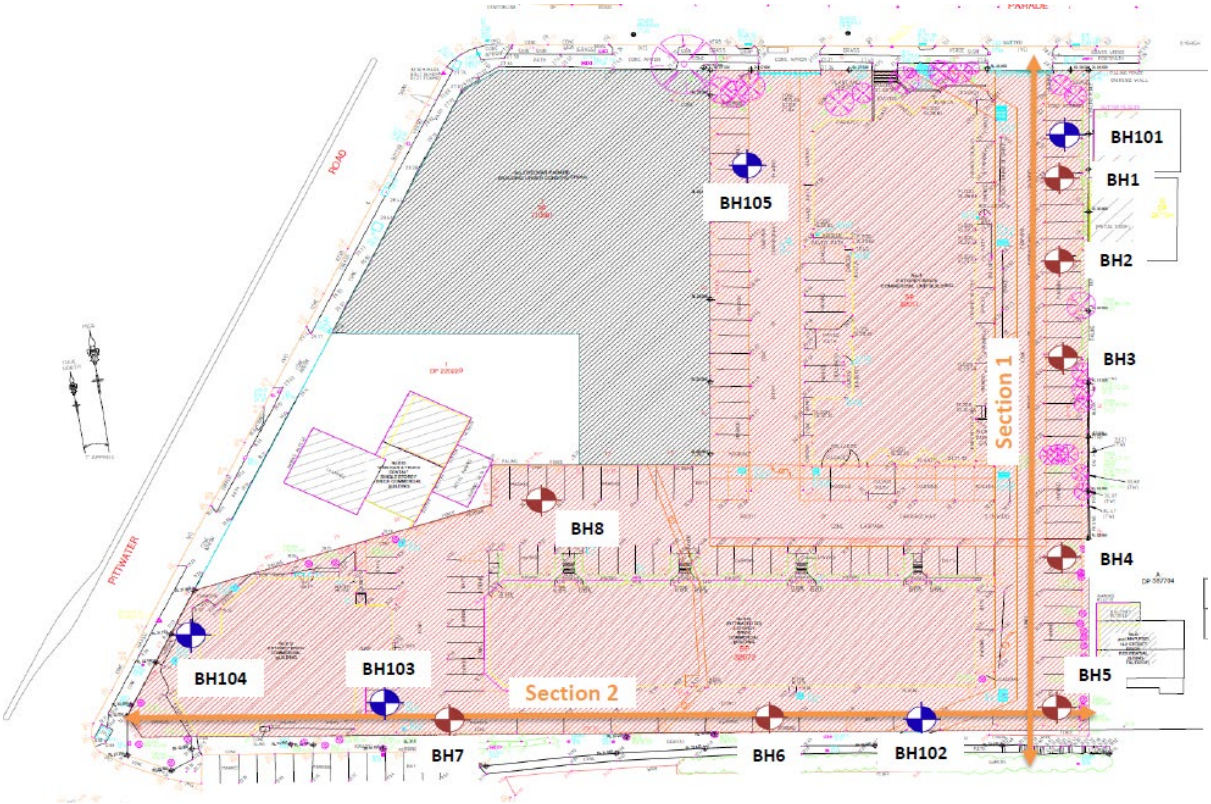


Figure 3: Borehole location plan

The stratigraphy at the site is characterized by topsoil and fill overlying alluvial sands, residual clay, sandstone and shale bedrock.

A summary of the subsurface conditions across the site, interpreted from the investigation results, is presented in **Table 1** and **Table 2**. Borehole Locations are shown on the plan attached to this report.

TABLE 1 SUMMARY OF INFERRED SUBSURFACE CONDITIONS

Unit	Material	Comments
1	Fill	Generally a concrete slab overlying gravely SAND, loose and moist.
2	Alluvial Soil	Alluvial SAND and Sandy CLAY, loose to dense and stiff to very stiff, low to medium plasticity, fine to medium grained with medium sized iron stone and quartz gravels.
3	Residual Soil	Residual sandy to gravelly CLAY, stiff to very stiff grading to hard, medium plasticity, fine to medium grained with medium sized iron stone and sandstone gravels and extremely weathered sandstone bands.
4	Class V and IV Sandstone	Extremely to highly weathered SANDSTONE, very low to low strength, medium grained. Defects within unit 4 are generally horizontally orientated bedding partings with infrequent joints inclined at 10 to 60°.
5	Class III Sandstone	Moderate to slightly weathered SANDSTONE, medium to high strength, medium grained. Defects within unit 5 are generally horizontally orientated bedding partings with infrequent joints inclined at 10 to 60°.
6	Class V Shale	SHALE, SILTSTONE and LAMINITE, extremely to moderately weathered, very low to low strength. Defects within Unit 6 are generally horizontally oriented bedding partings, joints inclined to 45° and clay seams.
7	Class III Shale	SHALE, moderately to slightly weathered, medium to high strength. Defects within Unit 7 are generally horizontally oriented bedding partings, joints inclined to 45°. Defect Spacing >200mm.

TABLE 2 ENCOUNTERED GEOTECHNICAL CONDITIONS

	Approx. Depth Range of Unit [1] mBGL (RL mAHD)						
	Unit 1	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**
	Fill	**Alluvial Soil**	**Residual Soil**	**Class V/IV Sandstone**	**Class III Sandstone**	**Class V Shale**	**Class III Shale**
BH1/CPT1*	0.0 to 1.0	1.0 to 3.5	3.5 to 6.0	6.0 to 8.93	8.93 to 13.9+	-	-
(AGE21)	(28.9 to 27.9)	(27.9 to 25.4)	(25.4 to 23.9)	(23.9 to 20.97)	(20.97 to 4.97+)	-	-
BH2*	0.0 to 1.6	-	1.6 to 3.7	3.7 to 5.63 & 6.6 to 8.4	8.4 to 13.95+	5.63 to 6.6	-
(AGE21)	(29.25 to 27.65)	-	(27.65 to 25.55)	(25.55 to 23.62 & 22.65 to 20.85)	(20.85 to 15.3+)	(23.62 to 22.65)	-
BH3/CPT4*	0.0 to 0.5	-	-	0.5 to 6.36 & 7.09 to 7.7	7.7 to 14.2+	-	6.36 to 7.09
(AGE21)	(30.0 to 29.5)	-	-	(29.5 to 23.64 & 22.91 to 22.3)	(22.3 to 15.8+)	-	(23.64 to 22.91)
BH4*	0.0 to 0.5	-	-	0.5 to 6.0 & 9.12 to 14.55+	6.0 to 7.46	7.46 to 9.12	-
(AGE21)	(31.92 to 31.42)	-	-	(31.42 to 25.92 & 22.8 to 17.37+)	(25.92 to 18.46)	(18.46 to 22.8)	-
BH5*	0.0 to 0.2	-	-	0.2 to 2.95	2.95 to 8.61 & 9.81 to 15.0+	8.61 to 9.81	-
(AGE21)	(32.66 to 32.44)	-	-	(32.44 to 29.71)	(29.71 to 24.05 & 22.85 to 17.66+)	(24.05 to 22.85)	-
BH6/CPT5*	0.0 to 0.2	0.2 to 3.2	-	3.2 to 9.15 & 10.1 to 11.06	11.06 to 14.0+	9.15 to 10.1	-
(AGE21)	(32.08 31.88)	(31.88 to 28.88)	-	(28.88 to 22.93 & 21.98 to 21.02)	(21.02 to 18.08+)	(22.93 to 21.98)	-
BH7/CPT2*	0.0 to 0.9	0.9 to 2.9	2.9 to 9.0	9.0 to 12.78	-	12.78 to 15.06+	-
(AGE21)	(31.8 to 29.9)	(29.9 to 28.9)	(28.9 to 22.8)	(22.8 to 19.02)	-	(19.02 to 16.74+)	-
BH8/CPT3*	0.0 to 2.3	2.3 to 5.2	5.2 to 15.0	15.0 to 16.0+	-	-	-
(AGE21)	(30.51 to 28.21	(28.21 to 25.31)	(25.31 to 15.51)	(15.51 to 14.51+)		-	-
BH101	0.0 to 0.3	0.3 to 6.0	-	-	6.0 to 13.0+	-	-
	(28.8 to 28.5)	(28.5 to 22.8)	-	-	(22.8 to 15.8+)	-	-
BH102	0.0 to 1.3	1.3 to 2.21	2.21 to 2.8	2.8 to 4.8	4.8 to 8.06 & 10.0 to 12.99+	8.06 to 9.0	9.0 to 10.0
	(32.1 to 30.8)	(30.8 to 29.89)	(29.89 to 29.3)	(29.3 to 27.3)	(29.3 to 24.04 & 22.1 to 19.11+)	(24.04 to 23.1)	(23.1 to 22.1)
BH103	0.0 to 0.7	0.7 to 7.1	-	-	7.1 to 13.09	13.09 to 14.0	14.0 to 15.0+
	(31.5 to 30.8)	(30.8 to 24.4)	-	-	(24.4 to 18.41)	(24.4 to 17.5)	(17.5 to 16.5+)
BH104	0.0 to 0.5	0.5 to 1.6+	-	-	-	-	-
	(31.8 to 46.8)	(46.8 to 46.1+)	-	-	-	-	-
BH105	0.0 to 0.4	0.4 to 5.0	5.0 to 7.6	7.6 to 11.15	11.15 to 22.22+	-	-
	(28.5 to 28.1)	(28.1 to 23.5)	(23.5 to 20.9)	(20.9 to 17.35)	(17.35 to 6.28+)	-	-

Notes:

1 Depths shown are based on material observed within test locations and will vary across the site\

2.5 Acid Sulfate Soils

According to the Warringah Local Environmental Plan 2011 mapping the site is not located within a known area of Acid Sulfate soils.

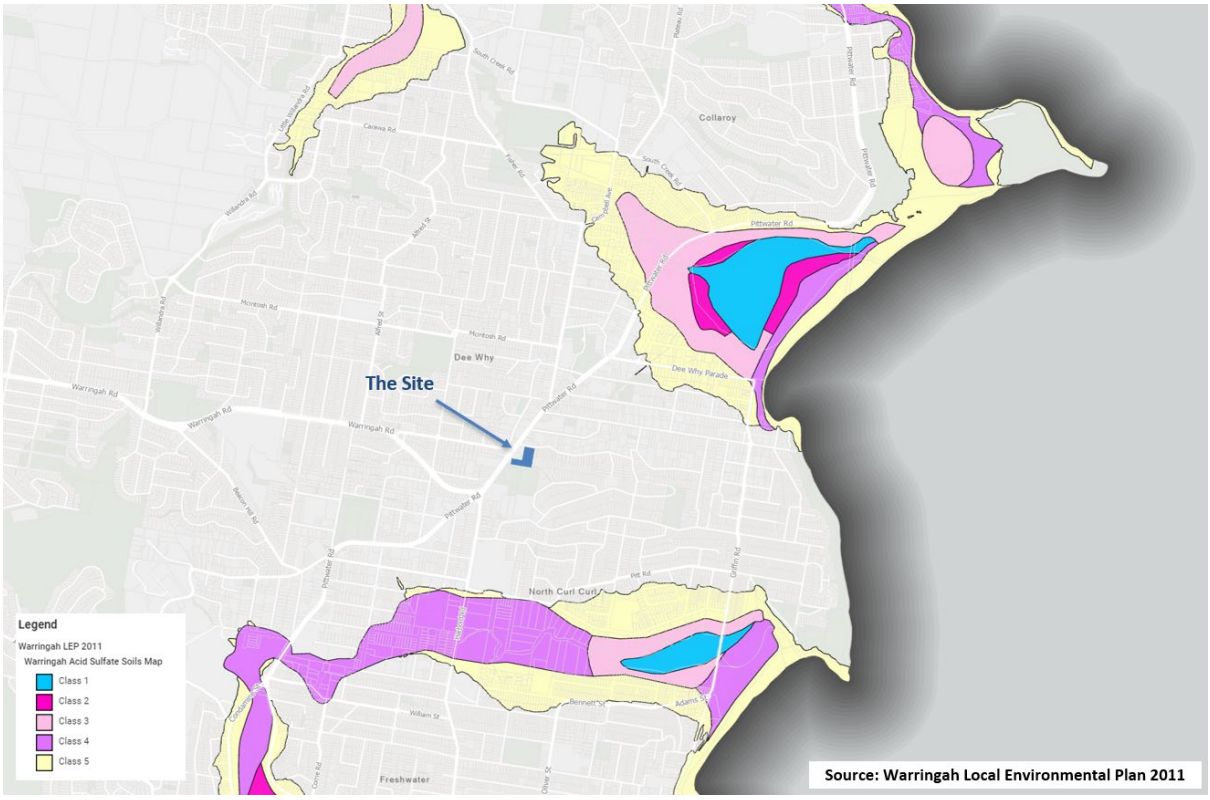


Figure 4: Acid Sulfate Soils Map with site location

The geological profile at the site comprises residual soil over shale and sandstone bedrock. The soils encountered are derived from weathering of the bedrock. No recent alluvial soils were encountered during the investigation. Acid Sulfate Soils are generally linked with alluvial and marine sediments of the Holocene era (<10,000 years ago). The soils encountered on site comprise the Wianamatta Group which ages to the Middle Triassic era (between 247.2 and 237 million years ago). The soils encountered at the site are not consistent in age or origin to produce Acid Sulfate Soils.

3 HYDROGEOLOGICAL MODEL

3.1 Groundwater Observations

Standpipe piezometer wells were installed within four boreholes drilled as part of the MG 2023 geotechnical investigations (BH101, BH102, BH103 and BH104). Monitoring well construction details are found in **Table 3** below. Before the installation of the piezometers, drill cuttings and water in the boreholes was flushed out. The monitoring wells were constructed using 50 mm diameter screw threaded PVC casing, sections of which were machine slotted. The annulus between the casing and boreholes was backfilled using 2 mm filter gravel pack to above the top of the screen. A bentonite plug with a minimum thickness of 0.5 m was then installed above the gravel pack, the remaining annulus was backfilled with drill cuttings. The wells were each finished with a cement plug and a gatic cover.

Groundwater levels within the three piezometer wells have been monitored by Morrow Geotechnics between 29 August 2023 and 25 October 2023.

TABLE 3 PIEZOMETER DETAILS

Piezometer	BH101	BH102	BH103	BH104
Top of Piezometer approx. RL (mAHD)	28.8	32.1	31.5	31.8
Piezometer Depth mBGL	13	12.99	15	20.91
Bentonite Plug Depth mBGL	5.0 to 5.5	2.2 to 2.7	2.5 to 3.25	3.9 to 4.50
Screen Depth mBGL	5.5 to 13.0	3.0 to 12.99	3.0 to 15.0	5.9 to 20.91
Well Development Date	29/8/2023	29/8/2023	29/8/2023	1/11/2023

TABLE 4 WATER LEVELS FROM MANUAL READINGS

Monitoring Date	Piezometer Groundwater Level (RL mAHD)			
	BH101	BH102	BH103	BH104
25/10/2023	23.39	28.15	27.69	-
8/11/2023	23.30	27.00	27.65	26.1

Automatic dataloggers were installed within BH101, BH102, BH103 and BH104 in order to provide long term groundwater measurements. Dataloggers were installed within the piezometers on 29 August 2023, the loggers were set to measure groundwater levels at one hour intervals. Groundwater measurements were recorded between 29 August 2023 and 4 December 2023. Graphs of water level measurements taken by the automatic dataloggers are displayed in **Figure 5** to **Figure 9** below. Daily rainfall totals taken from Bureau of Meteorology Collaroy Long Reef Golf Club {station 66126} for the monitoring period are displayed alongside water level measurements.

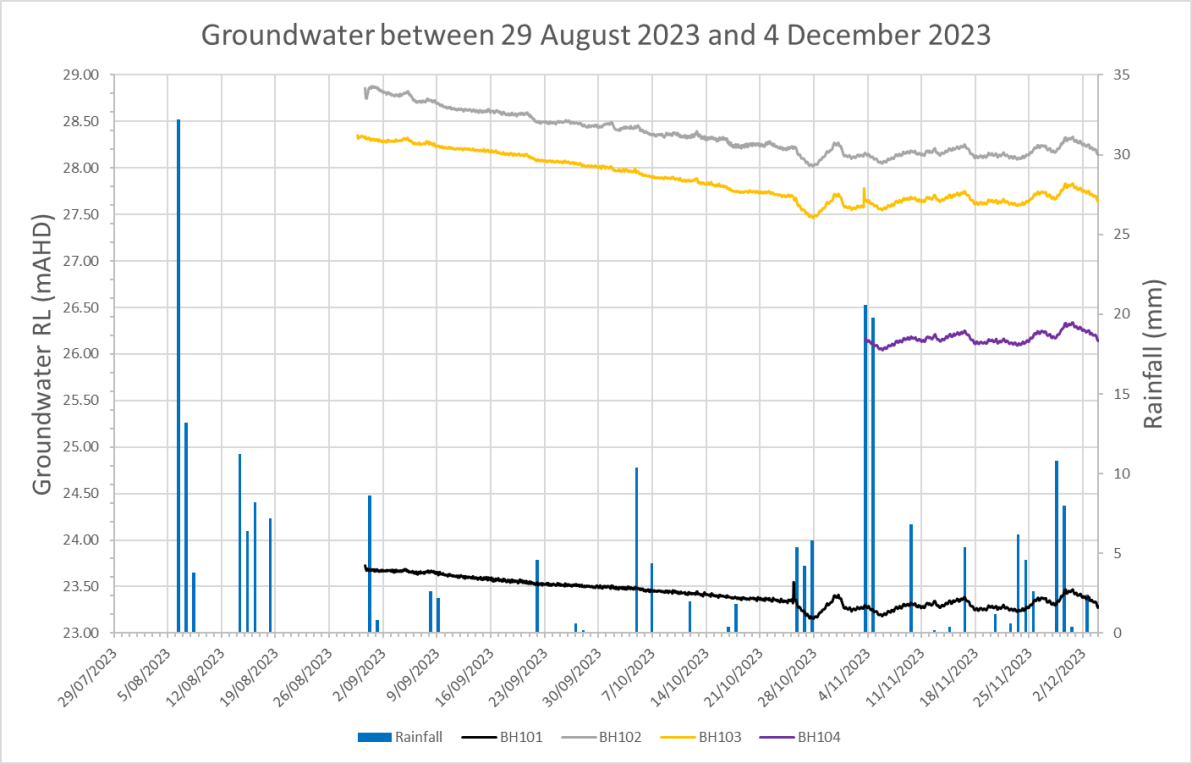


Figure 5: Data Logger Measurements and Daily Rainfall

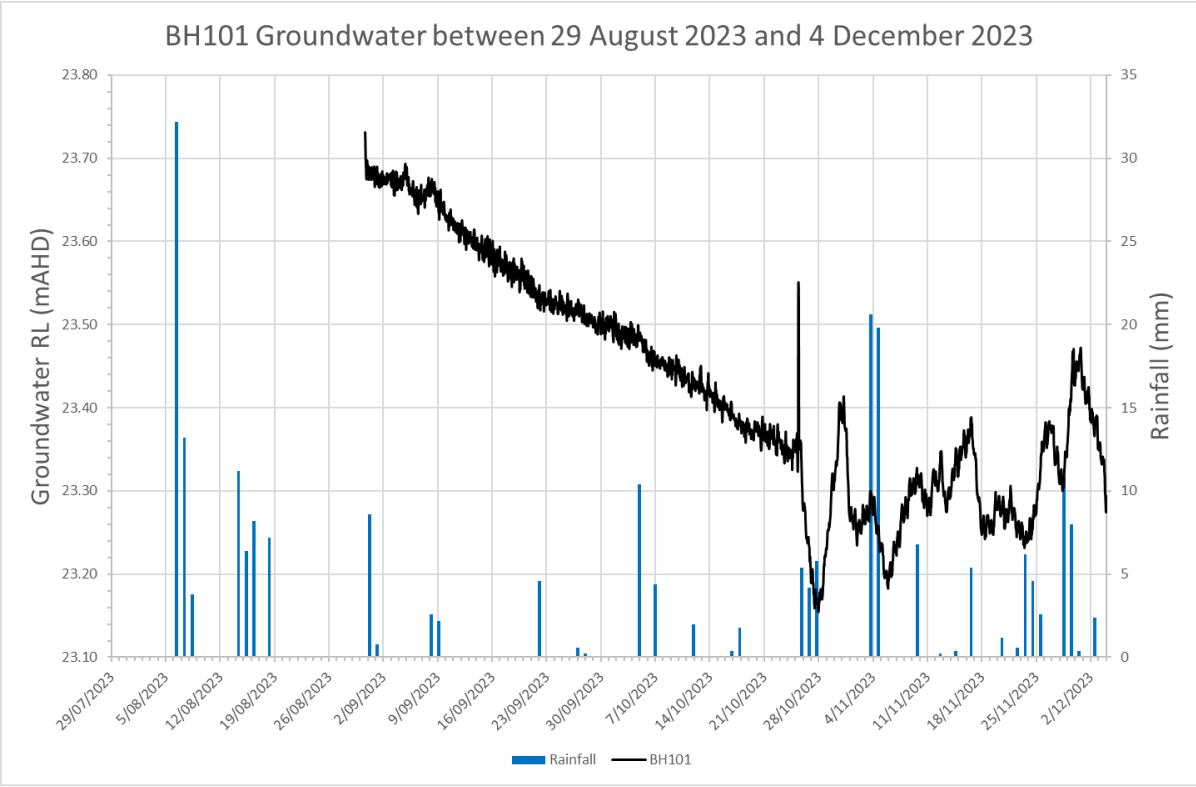


Figure 6: BH101 Data Logger Measurements and Daily Rainfall

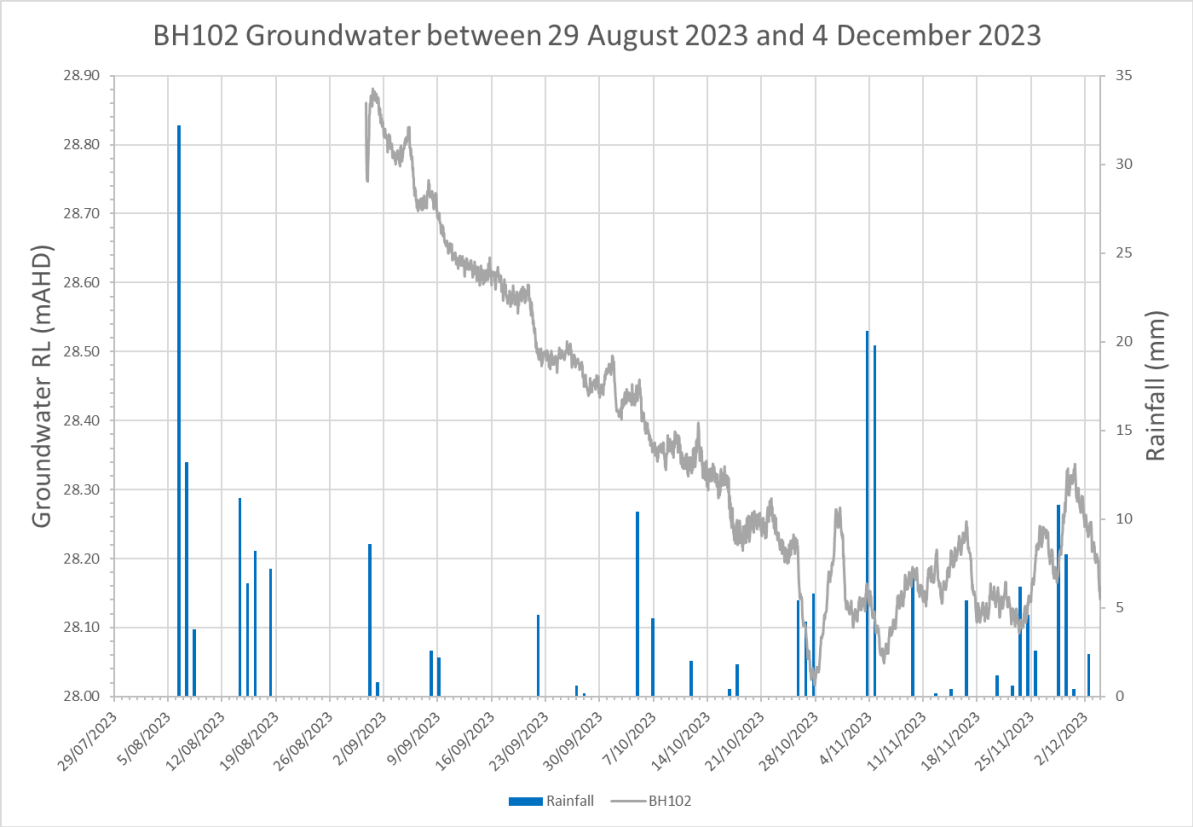


Figure 7: BH102 Data Logger Measurements and Daily Rainfall

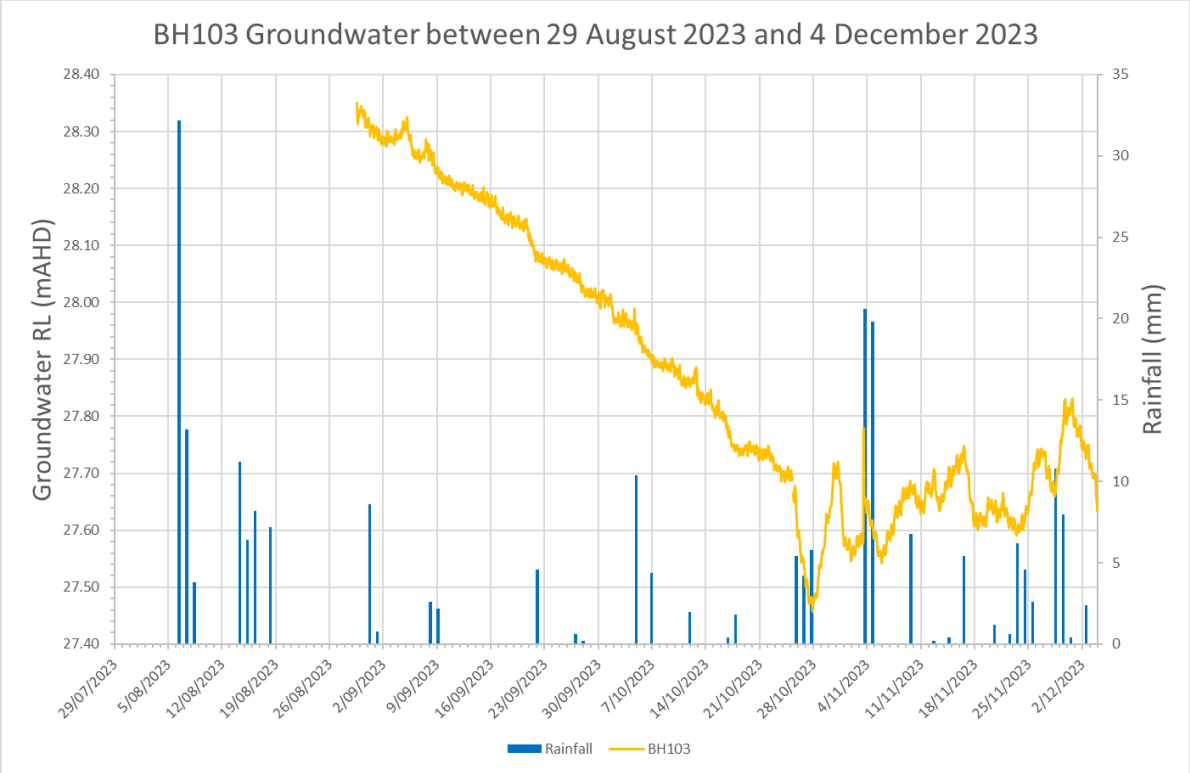


Figure 8: BH103 Data Logger Measurements and Daily Rainfall

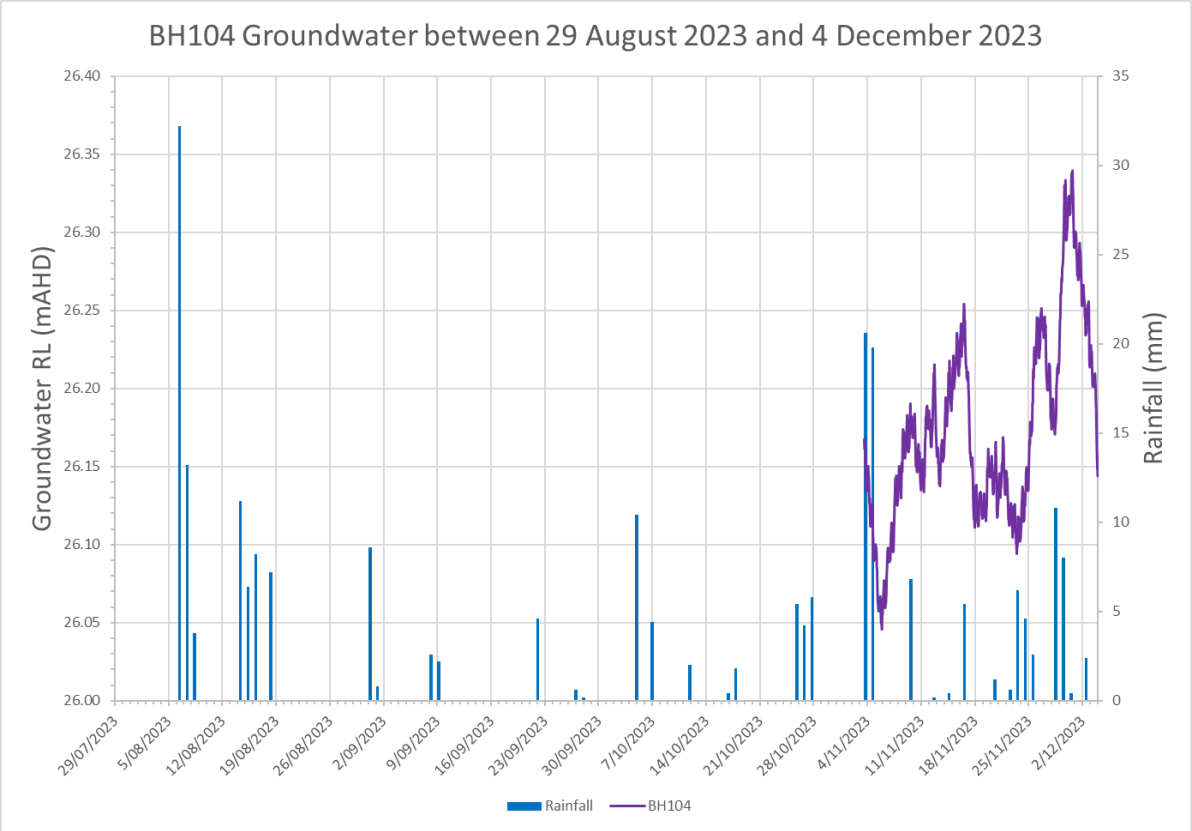


Figure 9: BH104 Data Logger Measurements and Daily Rainfall

A summary of the groundwater observations within the three wells is provided below:

TABLE 5 GROUNDWATER OBSERVATION SUMMARY

Monitoring Date	Piezometer Groundwater Level (RL mAHD)			
	BH101	BH102	BH103	BH104
Maximum Water Level	23.73	28.88	28.35	26.34
Minimum Water Level	23.15	28.02	27.46	26.04
Average Water Level	23.43	28.36	27.97	26.17
Median Water Level	23.41	28.30	27.99	26.16

Measured groundwater levels at the three piezometers are within the following rock strata:

- BH101: Unit 2 – Alluvial Soil;

- BH102: Unit 4 – Class V/IV Sandstone;
- BH103: Unit 2 – Alluvial Soil; and
- BH104: Unit 5 – Class III Sandstone

Groundwater depths observed within BH102 and BH103 were comparable, with average water level RLs of 28.50 and 28.03 mAHD respectively at an average depth of 3.9 mBGL for BH102 and BH103. The average water level within BH101 was measured lower at RL 23.51 mAHD. Groundwater observations within the four wells indicate a phreatic water table which is dipping generally in line with surface topography.

Groundwater within BH104 was observed at a deeper relative depth (i.e. 5.6 mBGL). BH104 water level was within the Class III Sandstone and is inferred to represent a water table which is isolated from the water table within the Alluvial Soil profile.

The monitoring within the boreholes indicated low responsiveness to rainfall events during the three-month monitoring period. This is inferred to be a result of the paved areas in the vicinity of the wells limiting surface water infiltration following rainfall.

On the basis of ongoing groundwater monitoring at the site it is recommended that a design groundwater level for the stable water table within the bedrock is taken at 1.0 m above the consistent water level observed within the boreholes, i.e (2.9 mBGL dipping with topography to the north-west of the site).

3.2 Hydraulic Conductivity Testing

Rising head permeability tests were carried out on BH101, BH102 and BH103 to give an indication of in-situ permeability of the material at the site. Permeability values were calculated on the basis of the testing in accordance with the formulas provided in British Standard BS5930 -1999 Code of Practice for Site Investigations, Section 21.4.6. Calculation sheets for permeability testing are provided as an attachment to this letter as **Appendix C**. Permeability tests were repeated three times to ensure reliability of results.

Permeability values which were adopted from the testing for the assessment of groundwater seepage volumes are shown in **Table 6** below.

TABLE 6 BOREHOLE PERMEABILITY VALUES

	Permeability Based on In-situ Measurement	
	(m/s)	(m/day)
BH101	7.23×10^{-8}	6.24×10^{-3}
BH102	4.57×10^{-8}	3.94×10^{-3}
BH103	1.42×10^{-4}	12.27

Borehole permeability results varied across the test locations by approximately 4 orders of magnitude.

As indicated above, measured groundwater levels at the three piezometers are within the following rock strata:

- BH101: Unit 2 – Alluvial Soil;
- BH102: Unit 4 – Class V/IV Sandstone; and
- BH103: Unit 2 – Alluvial Soil.

BH101 and BH102 results may be taken as indicative of south-eastern half of the site. The south-eastern portion of the site corresponds to soil landscape/geological mapping for the Gymea Landscape which is typical of residual soil slopes over Hawkesbury Sandstone. These soils contain a higher clay content and were observed to be of lower permeability.

BH103 results may be taken as indicative of the generalised permeability of Alluvial soils through the north-western portion of the site, mapped as Newport Landscape soils. The alluvial material contained bands of gravelly sand, and permeabilities up to 1.4 x 10^{-4} m/s are consistent with the soil profile encountered in BH103.

The difference in measured permeabilities across the site footprint can be accounted for in the mapped geological conditions and in the borehole observations.

3.3 Local Groundwater Regime

Based on the water level monitoring results, it is inferred that there is a phreatic water table within alluvial soils and fractured rock at the site. It is recommended that a design groundwater level for the stable water table within the bedrock is taken at 1.0 m above the consistent water level observed within the boreholes, i.e (2.9 mBGL dipping with topography to the north-west of the site).

On the basis of permeability testing at the site it is recommended that the following design permeability values are used for modelling of the sandstone and residual soil strata:

- Alluvial Soils – 1.4 x 10^{-4} m/s
- Bedrock – 7.0 x 10^{-8} m/s

Generalising BH103 permeability to the entirety of the Alluvial profile may be taken as a suitably conservative, worst case model for sensitivity analysis.

3.4 Water Quality Observations

A sample of the water to be discharged was taken on 25 October 2023 and sent to a NATA accredited laboratory for testing against the Australia and New Zealand Environment Conservation Council ANZECC (2000) guidelines for 95% protection of marine ecosystems (in the absence of guidelines the criteria for fresh waters was used) and National Environment Protection (Assessment of Site Contamination) Measure (NEPM, 2013). Relevant water quality results are presented in **Table 7**, lab results are attached in **Appendix B**.

The groundwater samples were taken using an electric powered pump with a length of ¼ inch low-density polyethylene (LDPE) tubing. The groundwater sample was collected from the outflow tube and stored in containers proved by SGS laboratory. The containers were immediately placed in an esky with ice packs to maintain a cool temperature and delivered to SGS laboratory same day. Disposable nitrile gloves were used for sample collection to minimize potential contamination.

TABLE 7 WATER QUALITY RESULTS

Analytes	Measured Concentration in Water Sample (µg/L)			Fresh Water Threshold (µg/L)	Marine Water Threshold (µg/L)
	BH01	BH102	BH103		
pH	5.1	5.2	4.7		
Electrical Conductivity (µS/cm)	350	410	390		
Chloride (mg/L)	74	89	97		
Sulfate, SO4 (mg/L)	40	40	29		
Benzene	<0.5	<0.5	<0.5	950	500
Toluene	2.2	<0.5	<0.5	-	-
Ethylbenzene	<0.5	<0.5	<0.5	-	--
O-Xylene	<0.5	<0.5	<0.5	350	-
M/P-Xylene	<1	<1	<1	200	-
Arsenic	<1	<1	<1	24	-
Cadmium	<0.1	<0.1	<0.1	0.2	0.7
Chromium	<1	**2**	<1	1	4.4
Copper	**3**	<1	**61**	1.4	1.3
Lead	<1	<1	<1	3.4	4.4
Mercury (inorganic) (mg/L)	<0.0001	<0.0001	<0.0001	0.06	0.1
Nickel	5	**18**	**2**	11	7
Zinc	**19**	**25**	**12**	8	15
Total PAH's (18)	<1	<1	1		
Naphthalene	0.2	0.3	0.4	16	50
B(a)P	<0.1	<0.1	<0.1	-	-

Concentrations of Chromium, Copper, Nickel and Zinc are above the ANZECC (2000) and NEPM (2013) freshwater guidelines for the water sample tested at the site.

4 STATEMENT OF LIMITATIONS

The advice and parameters presented in this Groundwater Management Plan are for assessment of the expected groundwater seepage based upon the proposed development and encountered site conditions at the investigation locations.

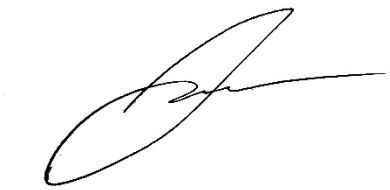
We draw your attention to the document "Important Information", which is attached to this letter. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Morrow Geotechnics, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

Should you have any queries regarding this report, please do not hesitate to contact the undersigned.

5 CLOSURE

Please do not hesitate to contact the undersigned should you have any questions.

For and on behalf of Morrow Geotechnics Pty Ltd,



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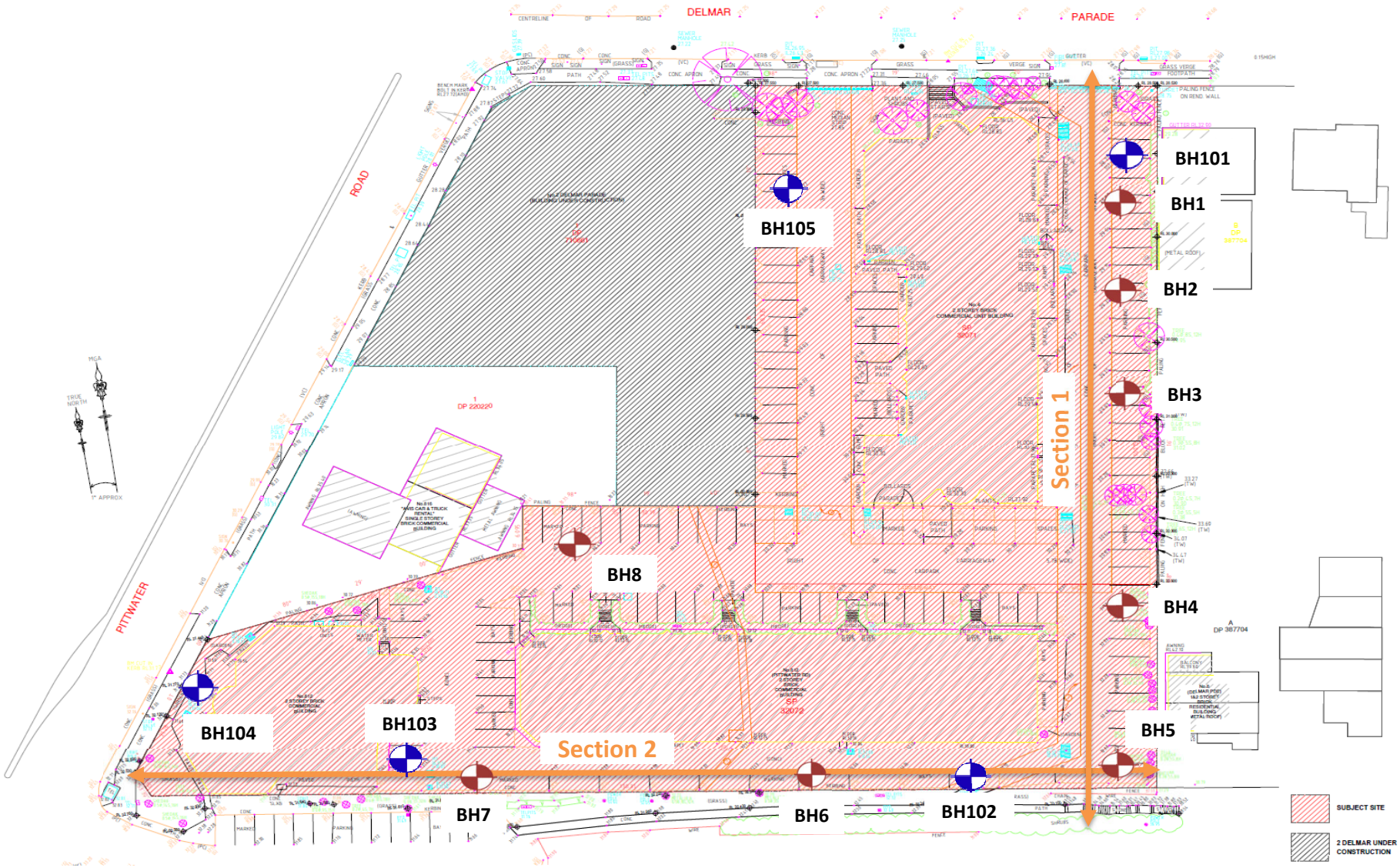

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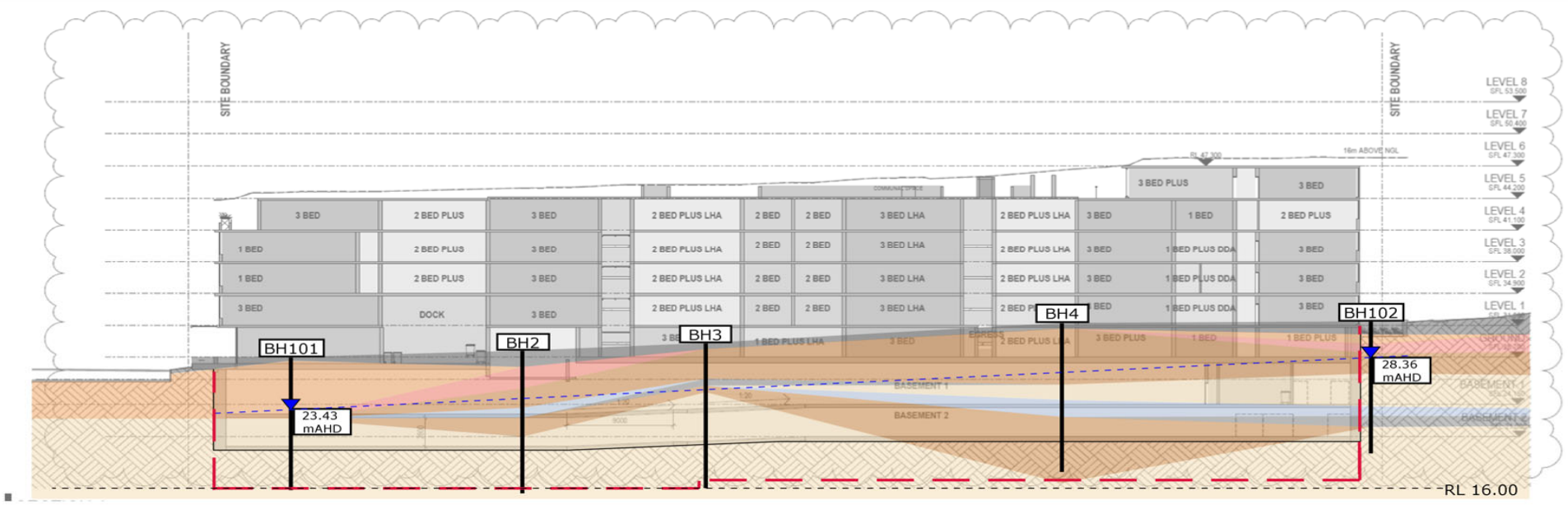
Approved	AM
Date	13/10/2023
Scale	NTS

Landmark Group Construction Australia Pty Ltd
4 Delmar Parade, Dee Why NSW
Geotechnical Investigation
Borehole Location Plan

Figure:
1

Project: P3018



Unit 1 - Fill

Unit 2 - Alluvial

Unit 3 - Residual

Unit 4 - Class V/IV Sandstone

Unit 5 - Class III Sandstone

Unit 6 - Class V Shale

Unit 7 - Class III Shale

Proposed Basement Outline

morrow

79/6 Bellambi Lane, Bellambi NSW 2518

P: 0405 843 933 | E: info@morrowgeo.com.au

Drawn	AB
Approved	AM
Date	21/02/2024
Scale	NTS

Landmark Group Construction Australia Pty Ltd

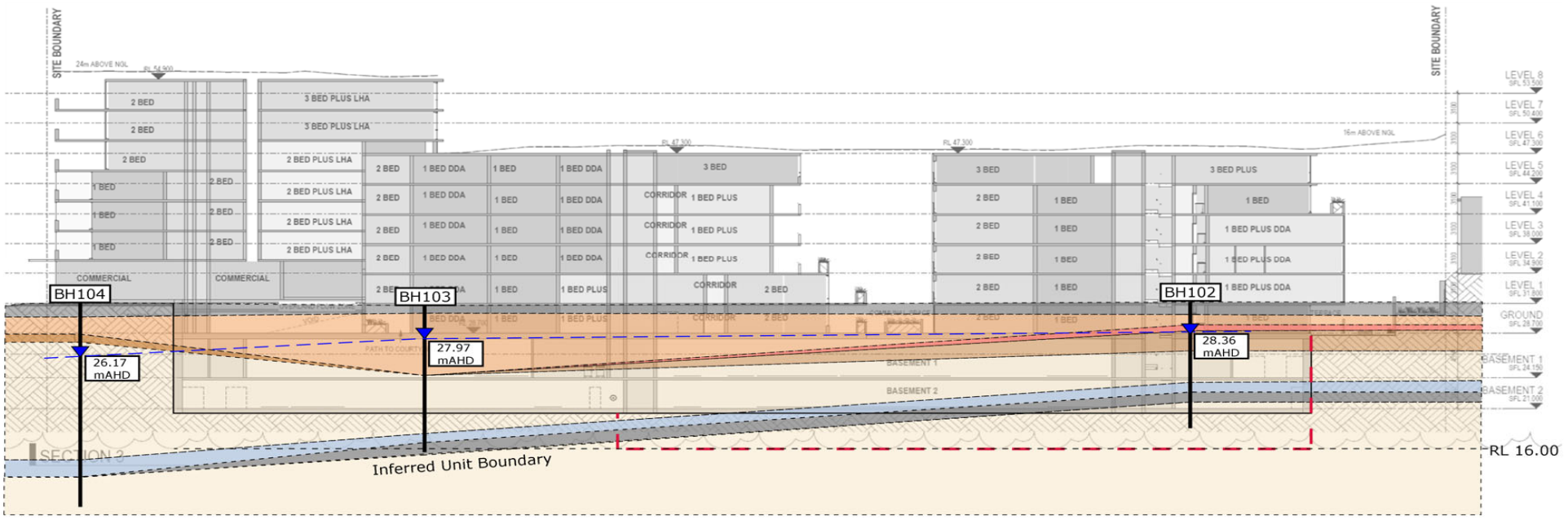
4 Delmar Parade, Dee Why NSW

Geotechnical Investigation

Cross Section 1

Figure: **2**

Project: P3018



Unit 1 - Fill

Unit 2 - Alluvial

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Unit 4 - Class V/IV Sandstone

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Proposed Basement Outline

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79/6 Bellambi Lane, Bellambi NSW 2518
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Drawn	AB
Approved	AM
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Scale	NTS

Landmark Group Construction Australia Pty Ltd
4 Delmar Parade, Dee Why NSW
Geotechnical Investigation
Cross Section 2

Figure: **3**

Project: P3018

Appendix A

BOREHOLE LOGS, EXPLANATORY NOTES AND SITE PHOTOS

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Boring No.: BH101

Easting	**: 341051.1**	**Drill Supplier**	**: MATRIX DRILLING**	**Job Number**	**: P3018**	**Sheet**	**: 1 OF 2**
Northing	**: 6263534.7**	**Driller Company**	**: MATRIX DRILLING**	**Client**	**: Landmark Group Construction Australia Pty Ltd**		
Elevation	**: 28.8(m)**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**		
Total Depth	**: 13 m**	**Date**	**: 30/08/2023**	**Location**	**: 4 Delmar Parade, Dee Why NSW**		

Drilling Method	Water	Well Diagram	Testing: SPT	Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations
Diatube				Non-Soil		CCT	0.15	28.8	Concrete			
				Fill		SC	0.3		Fill Clayey to gravelly SAND (SC) : low plasticity clay, loose, brown grey, fine to medium grained, medium to coarse sized gravel, moist, (low resistance).	L	M	
				Residual		SW	1	27.8	Residual Gravelly SAND (SW) : loose, orange, fine to medium grained, medium to coarse sized gravel, trace low plasticity clay, moist, (low resistance, sandstone gravels).			
				Residual		SC	1.4		Residual Clayey to gravelly SAND (SC) : medium dense, low plasticity clay, low plasticity, orange, fine to medium grained, medium sized gravel, moist, (low resistance, sandstone and quartz gravels).	MD		
ADT			6, 8, 12, (N = 20)				2	26.8				
			8, 12, 11, (N = 23)				3	25.8				
			7, 6, 9, (N = 15)				4	24.8				
				Residual		SC	4.9		As above, but red orange.			
							5	23.8				
				Residual		CI	5.5		Residual Sandy CLAY (CI) : very stiff, medium plasticity, grey red, medium grained sand, with fine sized gravel, w ≈ pl, (low resistance, sandstone gravels).	VSt	w ≈ PL	

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Boring No.: BH101

Easting	**: 341051.1**	**Drill Supplier**	**: MATRIX DRILLING**	**Job Number**	**: P3018**	**Sheet**	**: 2 OF 2**
Northing	**: 6263534.7**	**Driller Company**	**: MATRIX DRILLING**	**Client**	**: Landmark Group Construction Australia Pty Ltd**		
Elevation	**: 28.8(m)**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**		
Total Depth	**: 13 m**	**Date**	**: 30/08/2023**	**Location**	**: 4 Delmar Parade, Dee Why NSW**		

Drilling Method	Water	Well Diagram	Testing: SPT	Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations
ADT	▶		22, (N = 44)	Rock		SST	6	22.8	Extremelyweathered, rock Sandy CLAY (SST) : hard, low plasticity, light grey, medium grained sand, trace fine to medium sized gravel, w ≈ pl, (low to medium resistance).	H		
									6.17m : Commenced NMLC Coring;			
							7	21.8				
							8	20.8				
							9	19.8				
							10	18.8				
							11	17.8				

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Boring No.: BH101

Easting	**: 341051.1**	**Drill Supplier**	**: MATRIX DRILLING**	**Job Number**	**: P3018**	**Sheet**	**: 2 OF 3**
Northing	**: 6263534.7**	**Driller Company**	**: MATRIX DRILLING**	**Client**	**: Landmark Group Construction Australia Pty Ltd**		
Elevation	**: 28.8(m)**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**		
Total Depth	**: 13 m**	**Date**	**: 30/08/2023**	**Location**	**: 4 Delmar Parade, Dee Why NSW**		

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing: Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
							23.8							
							6	22.8					6	
NMLC Coring			RQD = 26% TCR = 100%	d: 0.34, a: 0.38		SW	7	21.8		SST	rock SANDSTONE: slightly weathered, medium strength, grey, fine to medium grained, (massive, subvertical joints).		7	6.24, J, defect bounds 6.20m to 6.28m, 80°, , STP, CL, C 6.35, J, defect bounds 6.34m to 6.37m, 80°, , STP, CL, C 6.8, J, defect bounds 6.65m to 6.93m, 80°, RO, STP, CL, OP 7-7.1, , IR, CL, OP
			RQD = 52% TCR = 100%	d: 0.51, a: 0.44			8	20.8					8	7.34, P, clay coating , 6°, RO, CV, CT, OP 7.38, P, clay coating , , PL, CT, OP 7.46, P, clay coating , 6°, RO, PL, CT, OP 7.64, J, defect bounds 7.59m to 7.68m, 70°, , IR, CL, C 7.87, P, 5°, RO, PL, CT, OP
				d: 0.51, a:0.55			9	19.8					9	8.19-8.39, XWS, infilled clay and extremely weathered sandstone 3°, , IR, CT, 9.33, P, clay coating , 4°, , PL, CT, OP 9.42, P, 5°, , STP, CL, OP 9.5-9.51, IS, infilled clay , 3°, RO, UN, CL, 9.66, P, 4°, RO, PL, CT, C 9.76, P, 3°, , PL, CL, C 9.89, P, 4°, , IR, CL, C 9.92, P, 3°, , PL, CL, C 9.99, P, 5°, , RO, PL, CL, OP
			RQD = 43% TCR = 87%	d: 0.46, a: 0.76										

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Boring No.: BH101

Easting	: 341051.1	**Drill Supplier**	: MATRIX DRILLING	**Job Number**	: P3018	**Sheet**	: 3 OF 3
Northing	: 6263534.7	**Driller Company**	: MATRIX DRILLING	**Client**	: Landmark Group Construction Australia Pty Ltd		
Elevation	: 28.8(m)	**Logged By**	: Mark Peach	**Project**	: Dee Why		
Total Depth	: 13 m	**Date**	: 30/08/2023	**Location**	: 4 Delmar Parade, Dee Why NSW		

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing: Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring			RQD = 43% TCR = 87%	d: 0.71, a: 0.43		SW	11	17.8		SST	rock SANDSTONE: slightly weathered, medium strength, grey, fine to medium grained, (massive, subvertical joints).		11	10.08, P, 3°, , UN, CL, 10.17, P, 6°, , IR, CL, OP 10.21, P, 3°, RO, IR, C C 10.23, J, defect bounds 10.20m to 10.25m, 75°, RO, PL, CL, C 10.27, J, defect bounds 10.24m to 10.28m, sandy clay coating , 75°, , PL, CT, OP 10.38, P, 4°, , PL, CL, 10.5, J, defect bounds 1.40m to 10.59m, infilled extremely weathered sandstone 85°, RO, PL, CL, OP 10.61, P, 3°, , UN, CL, 10.64, P, 4°, , PL, CL,
				d: 0.17, a:0.31			11							
			RQD = 85% TCR = 100%			SW				SST	As above, but (generally massive, minor carbonaceous laminations).			10.98, IS, infilled clay 3°, RO, PL, CT, 11-11.38, CORELOSS Core Loss (notes), 11.39, P, clay coating , 4°, , PL, CT, OP 11.71, P, carbonaceou staining , 3°, RO, PL, STN, OP
				d: 0.39, a: 0.45			12	16.8					12	11.96, P, 3°, RO, PL, CL, OP
							13	15.8			**BH101 Terminated at 13 m (Target Depth Reached)**		13	12.27, P, 2°, RO, PL, CL, OP 12.39, P, 2°, RO, PL, CL, OP 12.56, P, 5°, , UN, CL, OP 12.68, P, 2°, RO, PL, CL, OP 12.75, P, carbonaceou staining , 5°, RO, PL, STN, OP
							14	14.8					14	

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Photo description	BH101 - Tray 1 and 2 of 2		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH101	**BH Depth**	6.17 to 13.00m

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Boring No.: BH102

Easting	**: 341016.1**	**Drill Supplier**	**: MATRIX DRILLING**	**Job Number**	**: P3018**	**Sheet**	**: 1 OF 1**
Northing	**: 6263445.7**	**Driller Company**	**: MATRIX DRILLING**	**Client**	**: Landmark Group Construction Australia Pty Ltd**		
Elevation	**: 32.1(m)**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**		
Total Depth	**: 12.99 m**	**Date**	**: 30/08/2023**	**Location**	**: 4 Delmar Parade, Dee Why NSW**		

Drilling Method	Water	Testing	Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations
							32.1				
Diatube			Non-Soil		CCT			Concrete			
						0.2					
ADT			Fill		SM			Fill Silty to gravelly SAND (SM) : loose, grey dark grey, fine to medium grained, fine to medium sized gravel, trace low plasticity clay, moist, (low resistance).	L	M	
						0.9					
			Rock		SST	1	31.1	Rock SANDSTONE: distinctly weathered, very low strength, grey orange, medium grained, (sandstone floater).	VLS	D	
						1.3					
			Residual		SC			Residual Clayey to gravelly SAND (SC) : loose to medium dense, low plasticity clay, orange grey, medium grained, medium to coarse sized gravel, moist, (low resistance, sandstone floaters).	L-MD	M	
						2	30.1				
								2.21m : Commenced NMLC Coring;			
						3	29.1				
						4	28.1				

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Boring No.: BH102

Easting	: 341016.1	Drill Supplier	: MATRIX DRILLING	Job Number	: P3018	Sheet	: 1 OF 3
Northing	: 6263445.7	Driller Company	: MATRIX DRILLING	Client	: Landmark Group Construction Australia Pty Ltd		
Elevation	: 32.1(m)	Logged By	: Mark Peach	Project	: Dee Why		
Total Depth	: 12.99 m	Date	: 30/08/2023	Location	: 4 Delmar Parade, Dee Why NSW		

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
		B					0	32.1					0	
							1	31.1					1	
							2	30.1					2	
NMLC Coring			RQD = 0% TCR = 100%			XW	2.3			SST	extremelyweathered, rock Sandy to gravelly CLAY (SST) : very stiff, low to medium plasticity, light grey red orange, fine sized gravel, fine to medium grained sand, w < pl, (very low strength).			2.36, P, iron stained , 15°, , PL, STN, OP
						DW	2.4			SST				
						XW	2.5			SST	rock SANDSTONE: distinctly weathered, low strength, purple red, medium grained, (generally massive, iron stained).			
			RQD = 81% TCR = 96%				2.6			PAV				
						XW				SST	extremelyweathered, rock Sandy CLAY (SST) : very stiff, low to medium plasticity, orange red, fine to medium grained sand, with fine to medium sized gravel, w < pl, (very low strength).			2.75-2.79, IS, infilled sandy clay and extremely weathered sandstone , 4°, , PL, STN,
							2.8							
						MW				SST	Core Loss			
							3	29.1			extremelyweathered, rock Sandy CLAY (SST) : hard, low to medium plasticity, orange red, fine to medium grained sand, with fine to medium sized gravel, w < pl, (very low strength, with infilled sandy clay seams).		3	
				d: 0.35, a: 0.43							rock SANDSTONE: moderately weathered, low to medium strength, light grey orange, fine grained, (generally massive, with minor iron staining).			
							4	28.1					4	
				d: 0.22, a: 0.37										
							4.8							4.57, J, iron stained, clay coating, defect bounds 4.46m to 4.67m, 80°, , PL, STN, OP
						SW				SST	rock SANDSTONE: slightly weathered, medium strength, grey, fine grained, (massive, infilled sandy clay seams).			

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Boring No.: BH102

Easting	: 341016.1	**Drill Supplier**	: MATRIX DRILLING	**Job Number**	: P3018	**Sheet**	: 2 OF 3
Northing	: 6263445.7	**Driller Company**	: MATRIX DRILLING	**Client**	: Landmark Group Construction Australia Pty Ltd		
Elevation	: 32.1(m)	**Logged By**	: Mark Peach	**Project**	: Dee Why		
Total Depth	: 12.99 m	**Date**	: 30/08/2023	**Location**	: 4 Delmar Parade, Dee Why NSW		

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing Is(50)	Estimated Strength	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring			RQD = 81% TCR = 96%	d: 0.48, a: 0.60		SW	27.1			SST	rock SANDSTONE: slightly weathered, medium strength, grey, fine grained, (massive, infilled sandy clay seams).			
			RQD = 68% TCR = 86%				6	26.1					6	5.53, IS, clay infilled , 3°, RO, UN, CL, C 5.72-5.78, IS, sandy clay infilled , 3°, RO, PL, CT,
				d: 1.34, a: 1.12			6.6							
						HW				SST	As above, but highly , grey red orange, (generally massive, iron stained with sub horizontal laminations and subvertical joints).			6.61, P, iron stained , 10°, RO, PL, STN, OP 6.66, J, iron stained, defect bounds 6.64m to 6.68m, 75°, , UN, STN, OP
				d: 0.68, a: 0.99			7	25.1					7	7.37, iron stained, defect bounds 7.19m to 7.48m, 85°, , IR, STN, OP 7.42, J, iron stained, infilled extremely weathered sandstone, defect bounds 7.31m to 7.52m, 85°, , IR, STN, C 7.52, P, clay coating , 3°, , PL, CT, OP
							8	24.1					8	
							8.0			PAV	Core Loss			8.06-8.46, CORELOSS Core Loss (notes),
							8.4							
			RQD = 52% TCR = 97%	d: 0.13, a: 0.11		MW	8.5			CI PAV LAM	residual Silty CLAY (CI) : very stiff to hard, medium plasticity, grey, with fine sized gravel, trace fine grained sand, w ≈ pl, (shale fragments and thin shale bands). Core Loss rock LAMINITE: moderately weathered, low strength, grey light grey, fine grained, (massive in parts, interbedded with sub-horizontal shale laminations and infilled clay seams).			8.51-8.57, CORELOSS Core Loss (notes), 8.65, P, clay veneer , 3°, RO, UN, VN, OP 8.7, P, clay coating , 3°, RO, PL, CT, OP 8.72-8.75, IS, clay infilled with extremely weathered shale laminations , 4°, , UN, CL,
						MW-SW	9	23.1		SHA	rock SHALE: moderately to slightly weathered, low to medium strength, grey, fine grained, (minor sandstone bands).		9	8.8-8.83, XWS, infilled extremely weathered shale , 4°, RO, IR, CL,
				d: 0.26, a: 0.23										8.87-8.89, IS, infilled clay , 3°, RO, IR, CL, OP 8.91-9, IS, infilled clay seam with 1mm to 2mm shale laminations , 3°, RO, PL, CL, 9.06, P, 2°, RO, PL, CL, OP 9.25, P, 3°, RO, PL, CL, OP

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Boring No.: BH102

Easting	**: 341016.1**	**Drill Supplier**	**: MATRIX DRILLING**	**Job Number**	**: P3018**	**Sheet**	**: 3 OF 3**
Northing	**: 6263445.7**	**Driller Company**	**: MATRIX DRILLING**	**Client**	**: Landmark Group Construction Australia Pty Ltd**		
Elevation	**: 32.1(m)**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**		
Total Depth	**: 12.99 m**	**Date**	**: 30/08/2023**	**Location**	**: 4 Delmar Parade, Dee Why NSW**		

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring			RQD = 52% TCR = 97%	d: 0.72, a: 1.07		MW-S	10	22.1		SHA	rock SHALE: moderately to slightly weathered, low to medium strength, grey, fine grained, (minor sandstone bands).			10, P, 2°, SO, PL, CL, OP 10.08, P, 2°, RO, PL, CL, OP 10.21-10.22, IS, infilled extremely weathered shale , 3°, RO, PL, CL
						F				SST	rock SANDSTONE: fresh weathered, medium to high strength, light grey, fine grained, (generally massive, minor carbonaceous laminations).			
				d: 0.72, a: 0.91			11	21.1					11	
			RQD = 99% TCR = 100%				12	20.1					12	12.52, P, 8°, RO, CL, OP
				d: 0.62, a: 1.36			13	19.1			**BH102 Terminated at 12.99 m (Target Depth Reached)**		13	
							14	18.1					14	

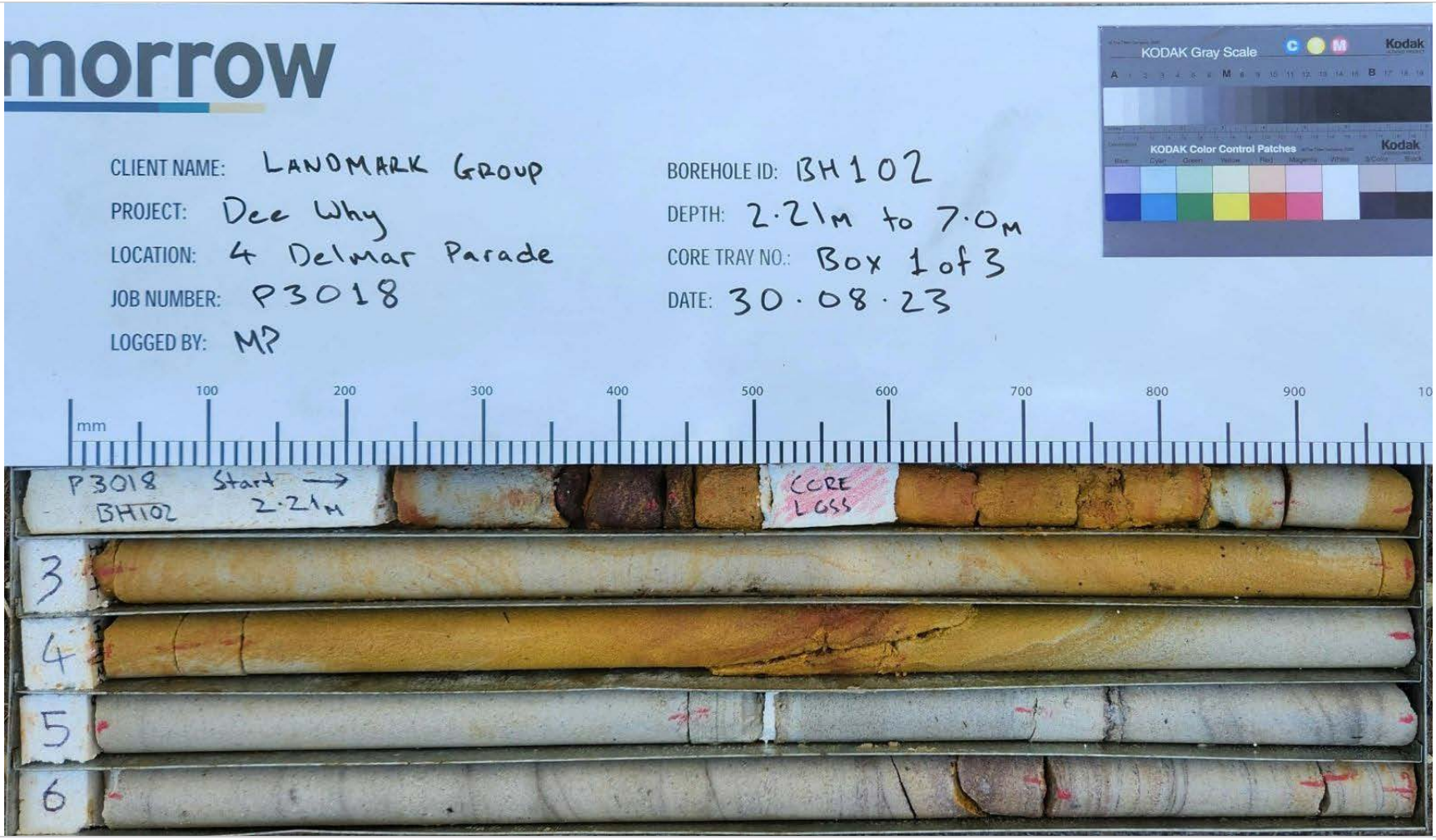

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Photo description	BH102 - Tray 1 of 3		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH102	**BH Depth**	2.21 to 7.00m

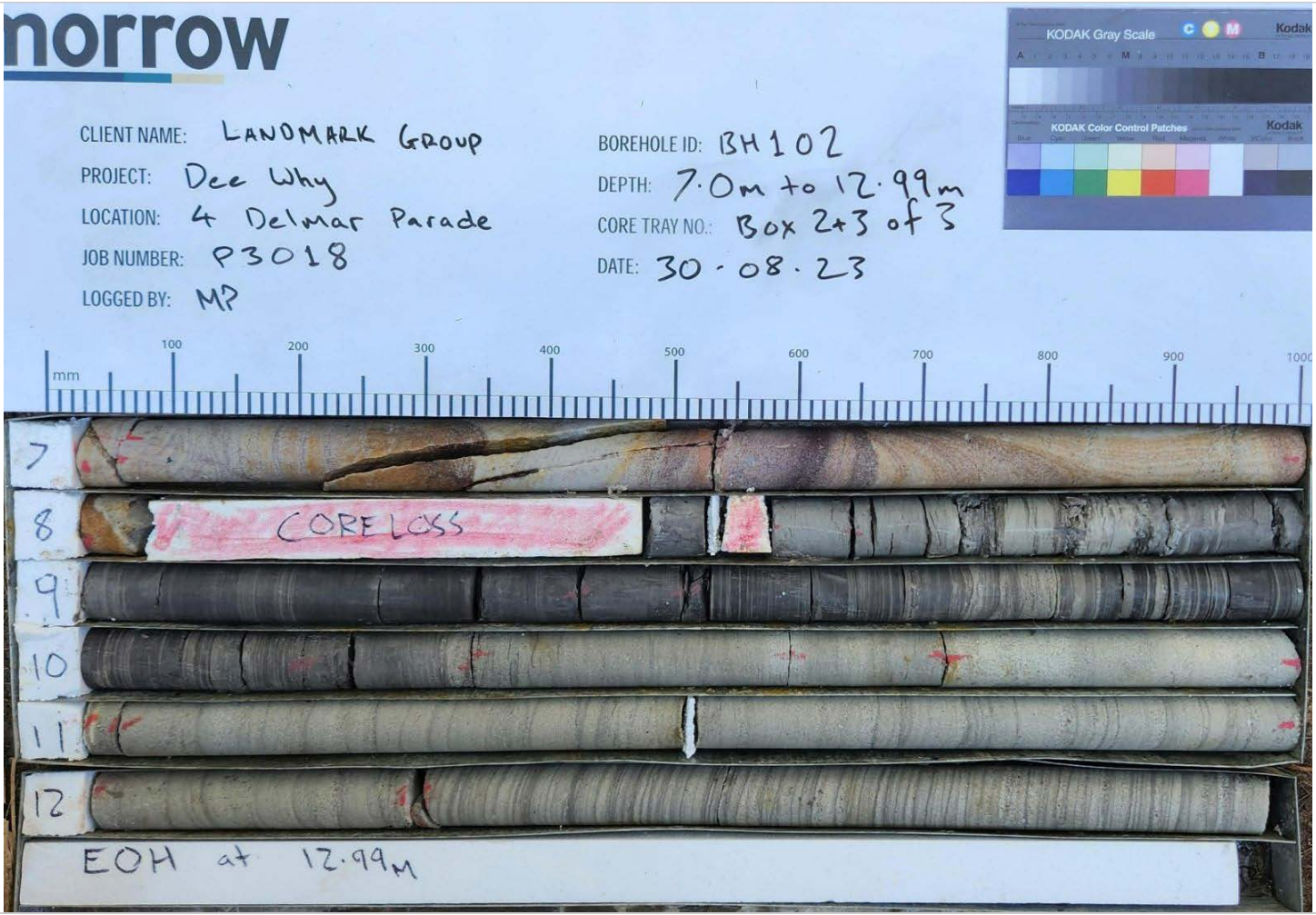

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Photo description	BH102 - Tray 2 and 3 of 3		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH102	**BH Depth**	7.00 to 12.99m

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Boring No.: BH103

Easting	**: 340947.7**	**Drill Supplier**	**: MATRIX DRILLING**	**Job Number**	**: P3018**	**Sheet**	**: 1 OF 2**
Northing	**: 6263458.9**	**Driller Company**	**: MATRIX DRILLING**	**Client**	**: Landmark Group Construction Australia Pty Ltd**		
Elevation	**: 31.5(m)**	**Logged By**	**: Andrew Butel**	**Project**	**: Dee Why**		
Total Depth	**: 15 m**	**Date**	**: 03/09/2023**	**Location**	**: 4 Delmar Parade, Dee Why NSW**		

Drilling Method	Water	Well Diagram	Testing: SPT	Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations
Diatube				Non-Soil		CCT		31.5	Concrete			
				Fill		SW	0.22		Fill Gravelly SAND (SW) : loose, orange grey, fine to medium grained, medium sized gravel, moist, (poorly graded).	L	M	
			4, 5, 4, (N = 9)	Alluvial		SW	0.7		Alluvial Gravelly SAND (SW) : loose, orange grey, fine to medium grained, medium sized gravel, moist, (poorly graded).			
			2, 4, 7, (N = 11)				1	30.5				
ADT				Alluvial		CI	2	29.5	Alluvial Sandy CLAY (CI) : stiff, medium plasticity, orange light grey, medium grained sand, with medium to coarse sized gravel, inorganic, w ≈ pl, (quartz gravels).	St	w ≈ PL	
			2, 6, 3, (N = 9)	Alluvial		CI	3	28.5	As above, but red orange.			
			6, 7, 5, (N = 12)	Alluvial		SP	4	27.5	Alluvial Gravelly SAND (SP) : medium dense to dense, grey orange, medium grained, medium sized gravel, wet, (quartz gravels).	MD-D	W	

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Phone: 0405 843 933

Boring No.: BH103

Easting	**: 340947.7**	**Drill Supplier**	**: MATRIX DRILLING**	**Job Number**	**: P3018**	**Sheet**	**: 2 OF 2**
Northing	**: 6263458.9**	**Driller Company**	**: MATRIX DRILLING**	**Client**	**: Landmark Group Construction Australia Pty Ltd**		
Elevation	**: 31.5(m)**	**Logged By**	**: Andrew Butel**	**Project**	**: Dee Why**		
Total Depth	**: 15 m**	**Date**	**: 03/09/2023**	**Location**	**: 4 Delmar Parade, Dee Why NSW**		

Drilling Method	Water	Well Diagram	Testing: SPT	Soil Origin	Graphic Log	Classification Code	Depth (m)	Elevation (m)	Material Description	Consistency/Density	Moisture	Observations
ADT				Alluvial		SP		26.5	Alluvial Gravelly SAND (SP) : medium dense to dense, grey orange, medium grained, medium sized gravel, wet, (quartz gravels).	MD-D	W	
150mm Washbore			4, 10, 11, (N = 21)				6	25.5				
							7	24.5				
							7.1					
				Rock		SST			Rock SANDSTONE: distinctly weathered, very low strength, very light grey, medium grained, (generally massive with minor carbaceous lamintions).	VLS	D	
			12, (N = 24) , Hard Bounce									
									7.83m : Commenced NMLC Coring;			
							8	23.5				
							9	22.5				

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Phone: 0405 843 933

Boring No.: BH103

Easting	: 340947.7	Drill Supplier	: MATRIX DRILLING	Job Number	: P3018	Sheet	: 2 OF 3
Northing	: 6263458.9	Driller Company	: MATRIX DRILLING	Client	: Landmark Group Construction Australia Pty Ltd		
Elevation	: 31.5(m)	Logged By	: Andrew Butel	Project	: Dee Why		
Total Depth	: 15 m	Date	: 03/09/2023	Location	: 4 Delmar Parade, Dee Why NSW		

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
							6	25.5					6	
							7	24.5					7	
NMLC Coring			RQD = 84% TCR = 100%	d: 0.70, a: 0.40		SW	8	23.5		SST	rock SANDSTONE: slightly weathered, medium strength, very light grey, medium grained, (generally massive with minor carbaceous lamintions).		8	8.05, P, 3°, RO, UN, C OP 8.17, P, 6°, VR, UN, C OP 8.21, P, 1°, VR, UN, C OP 8.26, P, 1°, VR, UN, C OP 8.29, P, 1°, VR, UN, C OP 8.31-8.37, J, 40°, VR, UN, CL, OP
				d: 0.58, a: 0.48		MW	8.2			SST	rock SANDSTONE: moderately weathered, medium strength, orange red, medium grained, (20° to 40° bedding).			
			RQD = 100% TCR = 100%			MW	9	22.5		SST	rock SANDSTONE: moderately weathered, medium strength, red orange mottled, medium grained, (generally massive).		9	
						MW	9.2			SST	rock SANDSTONE: moderately weathered, medium strength, orange red, medium grained, (10° to 20° bedding).			
				d: 0.77, a: 1.11		SW	9.5			SST	rock SANDSTONE: slightly weathered, medium to high strength, very light grey pink, medium grained, (generally massive).			

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Boring No.: BH103

Easting	**: 340947.7**	**Drill Supplier**	**: MATRIX DRILLING**	**Job Number**	**: P3018**	**Sheet**	**: 3 OF 3**
Northing	**: 6263458.9**	**Driller Company**	**: MATRIX DRILLING**	**Client**	**: Landmark Group Construction Australia Pty Ltd**		
Elevation	**: 31.5(m)**	**Logged By**	**: Andrew Butel**	**Project**	**: Dee Why**		
Total Depth	**: 15 m**	**Date**	**: 03/09/2023**	**Location**	**: 4 Delmar Parade, Dee Why NSW**		

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing: Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Elevation (m)	Graphic Log	Classification Code	Material Description	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring			RQD = 100% TCR = 100%			SW	10.0	21.5		SST	rock SANDSTONE: slightly weathered, medium to high strength, very light grey pink, medium grained, (generally massive).			
						MW				SST	rock SANDSTONE: moderately weathered, medium to high strength, light orange very light grey, medium grained, (2° to 8° bedding).			
				d: 1.08, a: 1.28		SW	10.			SST	rock SANDSTONE: slightly weathered, medium to high strength, very light grey pink, medium grained, (generally massive).			
				d: 0.83, a: 1.26			11	20.5					11	
						HW-MW	11.4			SST	rock SANDSTONE: highly to moderately weathered, medium to high strength, red-purple, medium grained, (generally massive).			
			RQD = 98% TCR = 100%			SW	11.8			SST	rock SANDSTONE: slightly weathered, medium to high strength, very light grey, medium grained, (generally massive).			
				d: 1.16, a: 0.92			12	19.5					12	12.56, P, 5°, VR, UN, CL, OP 12.78, P, 2°, VR, UN, CL, OP
							13	18.5					13	13.1, P, ironstained, 2° VR, UN, CT,
				d: 0.03, a: 0.04		HW	13.0 13.1			SST CL	rock SANDSTONE: highly weathered, medium to high strength, red-purple, medium grained, (ironstone). residual Sandy CLAY (CL) : soft, low plasticity, very light grey, medium grained sand, inorganic, w ≈ pl.			
						SW				SHA	rock SHALE: slightly weathered, very low to low strength, very light grey, fine grained, (5° laminations at 1-5mm spacing).			13.47, P, 3°, SO, CV, CL, OP
				d: 0.14, a: 0.43		MW	13.7			SST	rock SANDSTONE: moderately weathered, low strength, very light grey, medium grained, (generally massive with some carbonaceous layers).			
							14	17.5					14	
						SW	14.0			SHA	rock SHALE: slightly weathered, medium strength, grey very dark grey, fine grained, (sub-horizontal laminations at 1-2mm spacing).			14.14, P, 3°, SO, CV, CL, OP
				d: 0.30, a: 0.35										14.5, P, 3°, SO, CV, CL, OP 14.52, P, 3°, SO, CV, CL, OP

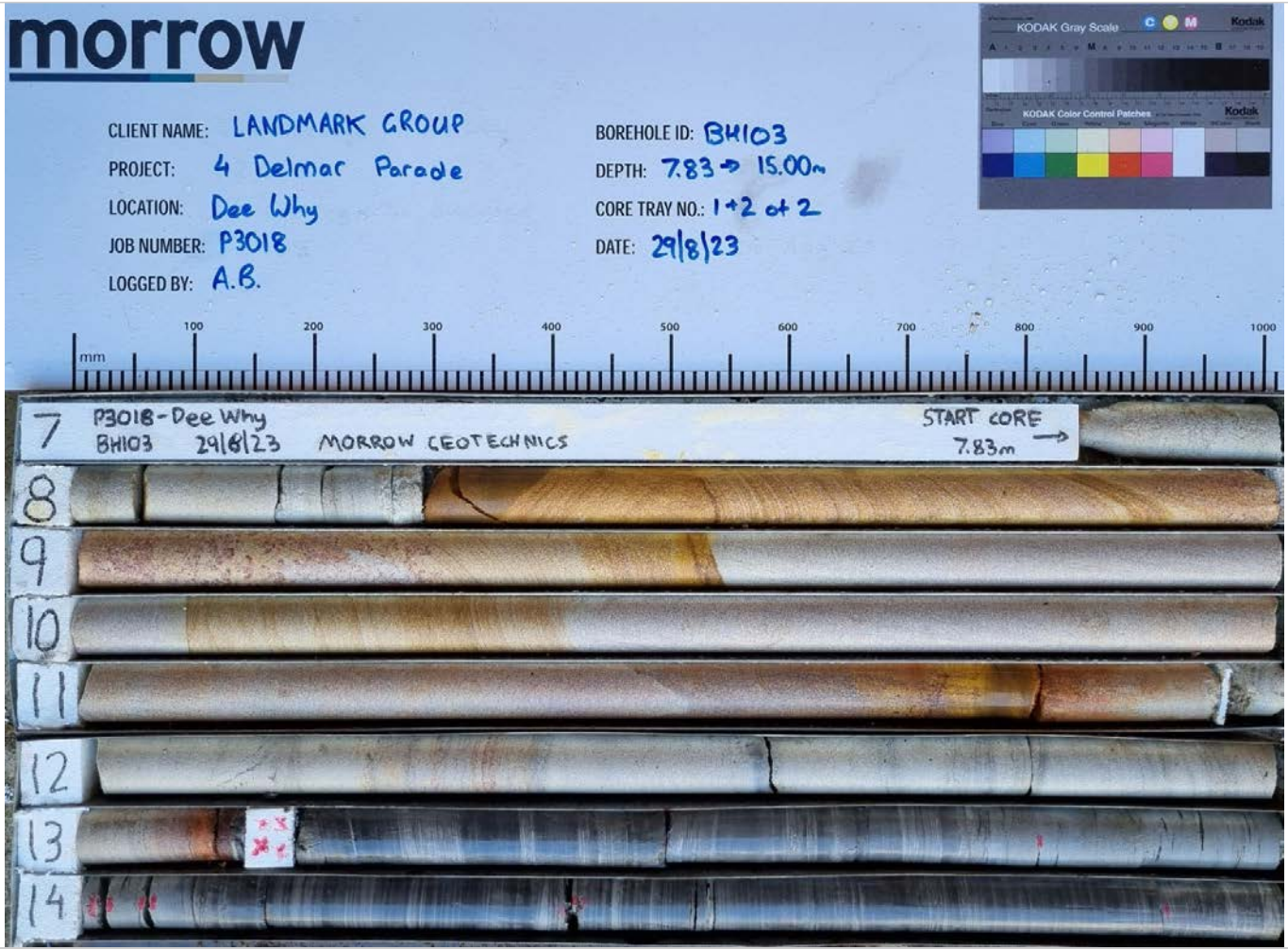

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Photo description	BH103 - Tray 1 and 2 of 2		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH103	**BH Depth**	7.83 to 15.00m

Morrow Geotechnics
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Geotechnical Log - Borehole

BH104

UTM	**: 56H**	**Drill Rig**	**: Hand Auger**	**Job Number**	**: P3018**
Easting (m)	**: 340914.1**	**Driller Supplier**	**: MG**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263462.4**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**
Ground Elevation	**: 31.8 (m)**	**Reviewed By**	**: Rhiannon McKeon**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 20.91 m BGL**	**Date**	**: 30/08/2023**	**Loc Comment**	**:**

Drilling Method	Water	Well Diagram	Soil Origin	Graphic Log	Classification Code	Depth (m)	Material Description	Elevation (m)	Consistency/Density	Moisture
Hand Auger	GWNE	Backfill; 50mm PVC Solid	Fill; Soil		PAR	0.1	Pavers	31.8		
					SW		Fill Gravelly SAND (SW) : very loose to loose, grey, fine to medium grained, fine to medium sized gravel, moist, low resistance, concrete gravels .	30.8	VL-L	M
			Alluvial		SW	1.4	Alluvial SAND (SW) : loose, grey, fine to medium grained, trace fine sized gravel, moist, low resistance .		L	
			Alluvial		SC	1.8	Alluvial Clayey SAND (SC) : loose to medium dense, low plasticity clay, orange light grey grey, medium grained, trace medium sized gravel, moist, low resistance .	29.8	L-MD	
			Alluvial		CL-CI	2.7	Alluvial Sandy CLAY (CL-CI) : firm, low to medium plasticity, grey orange light grey, fine to medium grained sand, with fine to medium sized gravel, w ≈ pl, low to medium resistance, ironstone and extremely weathered sandstone gravels .	28.8	F	w ≈ PL
			Rock		SST	3.1	Extremelyweathered, rock Sandy CLAY (SST) : very stiff to hard, low to medium plasticity, light grey red orange, medium grained sand, with fine sized gravel, w < pl, high resistance, with sandy clay bands.		VSt-H	w < PL
							3.3m : Commenced NMLC Coring;	27.8		

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Geotechnical Log - Borehole

BH104

UTM	**: 56H**	**Drill Rig**	**: Hand Auger**	**Job Number**	**: P3018**
Easting (m)	**: 340914.1**	**Driller Supplier**	**: MG**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263462.4**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**
Ground Elevation	**: 31.8 (m)**	**Reviewed By**	**: Rhiannon McKeon**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 20.91 m BGL**	**Date**	**: 30/08/2023**	**Loc Comment**	**:**

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
		Backfill					1				31.8		1	
											30.8			
		50mm PVC Solid					2				29.8		2	
											28.8			
							3						3	
NMLC Coring	0% Water Loss	Bentonite	RQD = 92% TCR = 100%	d: 0.65, a: 0.53		HW			SST	Rock SANDSTONE: highly weathered, low strength, light grey red orange, fine grained, massive, iron stained .				
							3.9							
						F	4		SST	Rock SANDSTONE: fresh weathered, medium strength, grey, fine grained, massive, minor carbonaceous laminations .	27.8		4	
				d: 0.27, a: 0.30										4.16, P, 5°, RO, PL, CL, OP
		5mm Graded Sand	RQD = 99% TCR = 100%											4.35, P, 3°, RO, PL, CL, OP
														4.81, P, 5°, , PL, CL OP

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Geotechnical Log - Borehole

BH104

UTM	**: 56H**	**Drill Rig**	**: Hand Auger**	**Job Number**	**: P3018**
Easting (m)	**: 340914.1**	**Driller Supplier**	**: MG**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263462.4**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**
Ground Elevation	**: 31.8 (m)**	**Reviewed By**	**: Rhiannon McKeon**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 20.91 m BGL**	**Date**	**: 30/08/2023**	**Loc Comment**	**:**

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring	0% Water Loss	50mm PVC Solid	RQD = 99% TCR = 100%	d: 0.79, a: 0.83		F	6		SST	Rock SANDSTONE: fresh weathered, medium strength, grey, fine grained, massive, minor carbonaceous laminations .	26.8		6	5.07, P, 5°, RO, PL, CL, OP
														5.59, P, 3°, RO, PL, CL, OP
						F			SST	Rock SANDSTONE: fresh weathered, medium to high strength, grey, fine grained, massive, minor carbonaceous laminations .	25.8			
		-5mm Graded Sand	RQD = 100% TCR = 100%	d: 0.79, a: 1.32			7				24.8		7	
			RQD = 100% TCR = 100%	d: 1.07, a: 1.25			8				23.8		8	8.14, P, 5°, , PL, CL OP
		50mm PVC Slotted		d: 1.17, a: 0.78										
			RQD = 100% TCR = 100%				9				22.8		9	9.71, P, 5°, , PL, CL OP

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Geotechnical Log - Borehole

BH104

UTM	**: 56H**	**Drill Rig**	**: Hand Auger**	**Job Number**	**: P3018**
Easting (m)	**: 340914.1**	**Driller Supplier**	**: MG**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263462.4**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**
Ground Elevation	**: 31.8 (m)**	**Reviewed By**	**: Rhiannon McKeon**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 20.91 m BGL**	**Date**	**: 30/08/2023**	**Loc Comment**	**:**

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring	0% Water Loss	-5mm Graded Sand 50mm PVC Slotted	RQD = 100% TCR = 100% RQD = 99% TCR = 100% RQD = 100% TCR = 100% RQD = 92% TCR = 100% RQD =	d: 1.05, a: 1.36 d: 0.44, a: 0.58 d: 1.39, a: 1.64 d: 1.23, a: 1.00 d: 1.37, a: 1.46		F F HW	11 12 12.8 13 14 14.72		SST SST SST	Rock SANDSTONE: fresh weathered, medium to high strength, grey, fine grained, massive, minor carbonaceous laminations . Rock SANDSTONE: fresh weathered, high strength, grey, fine grained, massive, minor carbonaceous laminations . As above, but highly weathered, grey orange light grey, massive, iron stained with trace quartz nodules (2mm x 3mm).	21.8 20.8 19.8 18.8 17.8		11 12 13 14	10.49, SZ, 3°, RO, PL, CL, OP 10.78, P, 4°, RO, PL CL, OP 11.12, P, 2°, RO, PL CL, OP 13.39, P, clay coating , 20°, , PL, CT, OP 14.45-14.47, IS, infilled clay and sandstone with quartz gravels , 5°, , CV, CT, OP 14.5, P, 4°, , PL, CL OP 14.74, P, iron stained , 9°, , PL, STP, OP

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Geotechnical Log - Borehole

BH104

UTM	**: 56H**	**Drill Rig**	**: Hand Auger**	**Job Number**	**: P3018**
Easting (m)	**: 340914.1**	**Driller Supplier**	**: MG**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263462.4**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**
Ground Elevation	**: 31.8 (m)**	**Reviewed By**	**: Rhiannon McKeon**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 20.91 m BGL**	**Date**	**: 30/08/2023**	**Loc Comment**	**:**

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring	0% Water Loss	-5mm Graded Sand 50mm PVC Slotted	RQD = 98% TCR = 100%	d: 1.23, a: 1.00		HW			SST	As above, but highly weathered, grey orange light grey, massive, iron stained with trace quartz nodules (2mm x 3mm).	16.8			
							15.95							
				d: 0.16, a: 0.15		F	16		SHA	Rock SHALE: fresh weathered, low strength, grey light grey, fine to medium grained, 1mm to 5mm laminations, with some massive sandstone bands.	15.8		16	15.95-15.97, XWS, clay coating , 2°, RO, PL, CT, OP 16.16, P, 2°, RO, PL CL, OP
			RQD = 80% TCR = 100%											
				d: 0.32, a: 0.43			17				14.8		17	16.93, P, 3°, , IR, CL OP 17, J, defect bounds 16.95m to 17.05m, 80°, RO, PL, CL, OP 17.42, P, 3°, RO, PL CL, OP 17.47, P, 6°, RO, CY CL, OP
							17.7							
						HW			SST	Rock SANDSTONE: highly weathered, medium to high strength, red orange, fine to medium grained, generally massive, heavily iron stained, minor 1mm to 2mm quartz nodules.				17.62, P, 3°, RO, UI CL, OP
			RQD = 99% TCR = 100%	d: 1.52, a: 2.65			18				13.8		18	17.72, P, iron stained , 6°, , IR, STN, OP 17.73, P, iron stained , 3°, , IR, STN, C
							18.57							
						SW			SST	As above, but slightly weathered, high strength, light grey orange, massive.				18.72, P, 9°, , PL, CL, OP
							18.97							
				d: 1.55, a: 2.65		F	19		SST	Rock SANDSTONE: fresh weathered, high strength, light grey, fine to medium grained, massive.	12.8		19	19.03, P, 6°, , PL, CL, OP
			RQD = 100% TCR = 100%											

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Geotechnical Log - Borehole

BH104

UTM	**: 56H**	**Drill Rig**	**: Hand Auger**	**Job Number**	**: P3018**
Easting (m)	**: 340914.1**	**Driller Supplier**	**: MG**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263462.4**	**Logged By**	**: Mark Peach**	**Project**	**: Dee Why**
Ground Elevation	**: 31.8 (m)**	**Reviewed By**	**: Rhiannon McKeon**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 20.91 m BGL**	**Date**	**: 30/08/2023**	**Loc Comment**	**:**

Drilling Method	Water	Well Diagram	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring	0% Water Loss	5mm Graded Sand; 50mm PVC Slotted	RQD = 100% TCR = 100%	d: 1.59, a: 2.61		F			SST	Rock SANDSTONE: fresh weathered, high strength, light grey, fine to medium grained, massive.	11.8			
							21			**BH104 Terminated at 20.91m (Target Depth Reached)**	10.8		21	
							22				9.8		22	
							23				8.8		23	
							24				7.8		24	

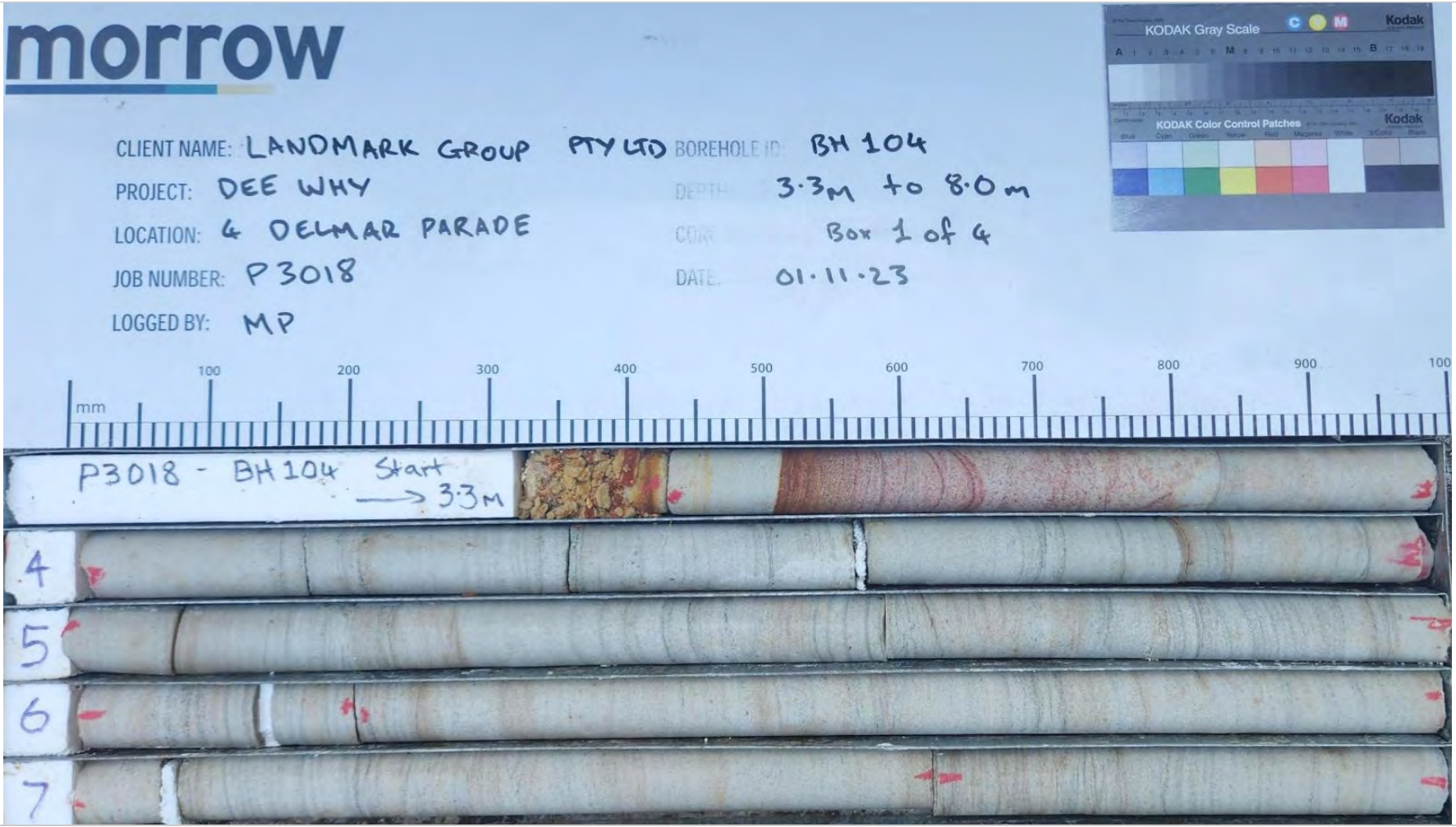

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Photo description	Box 1 of 4		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH104	**BH Depth**	3.3m to 8.0m

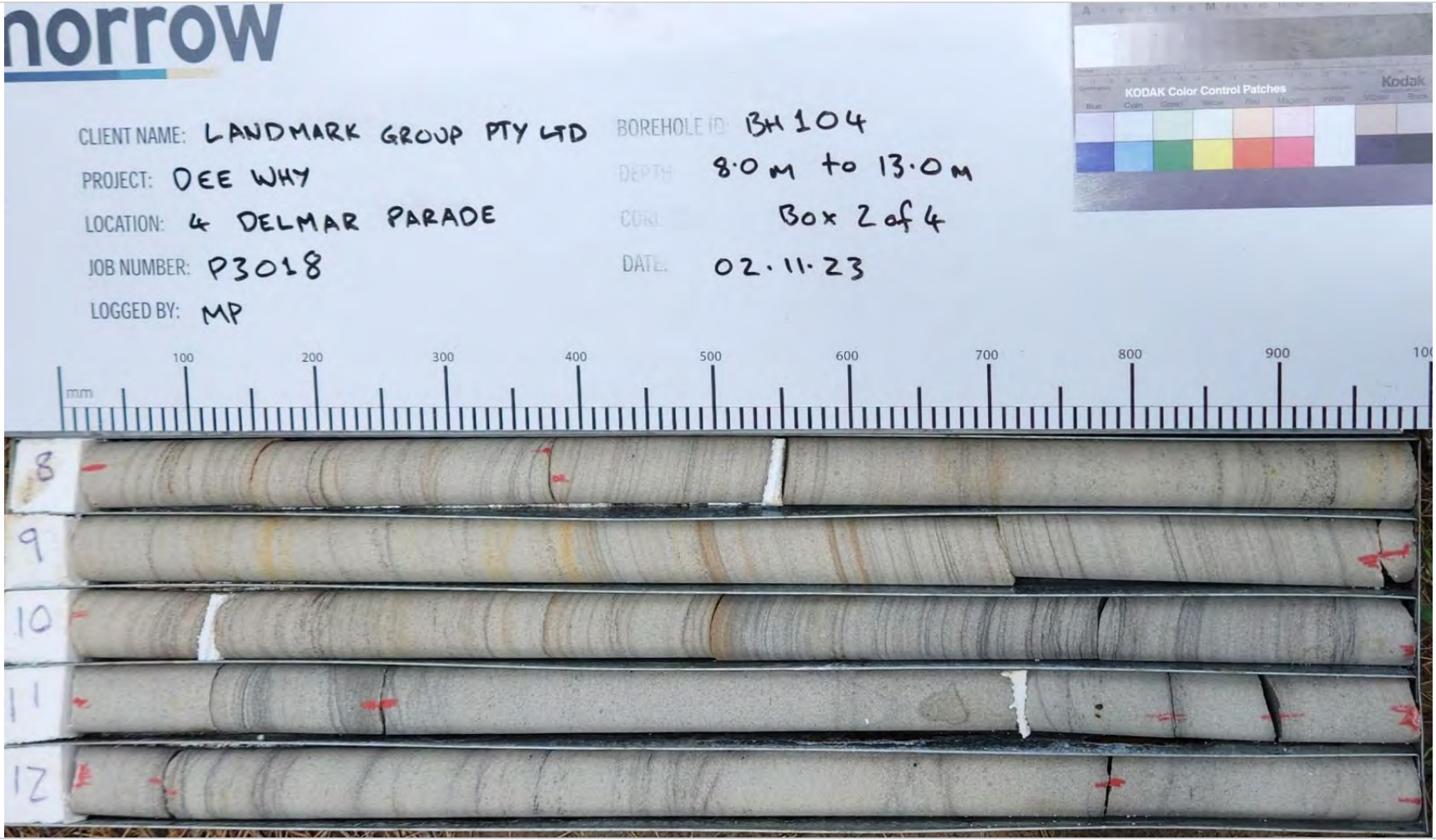

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Photo description	Box 2 of 4		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH104	**BH Depth**	8.0m to 13.0m

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Photo description	Box 3 of 4		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH104	**BH Depth**	13.0m to 18.0m

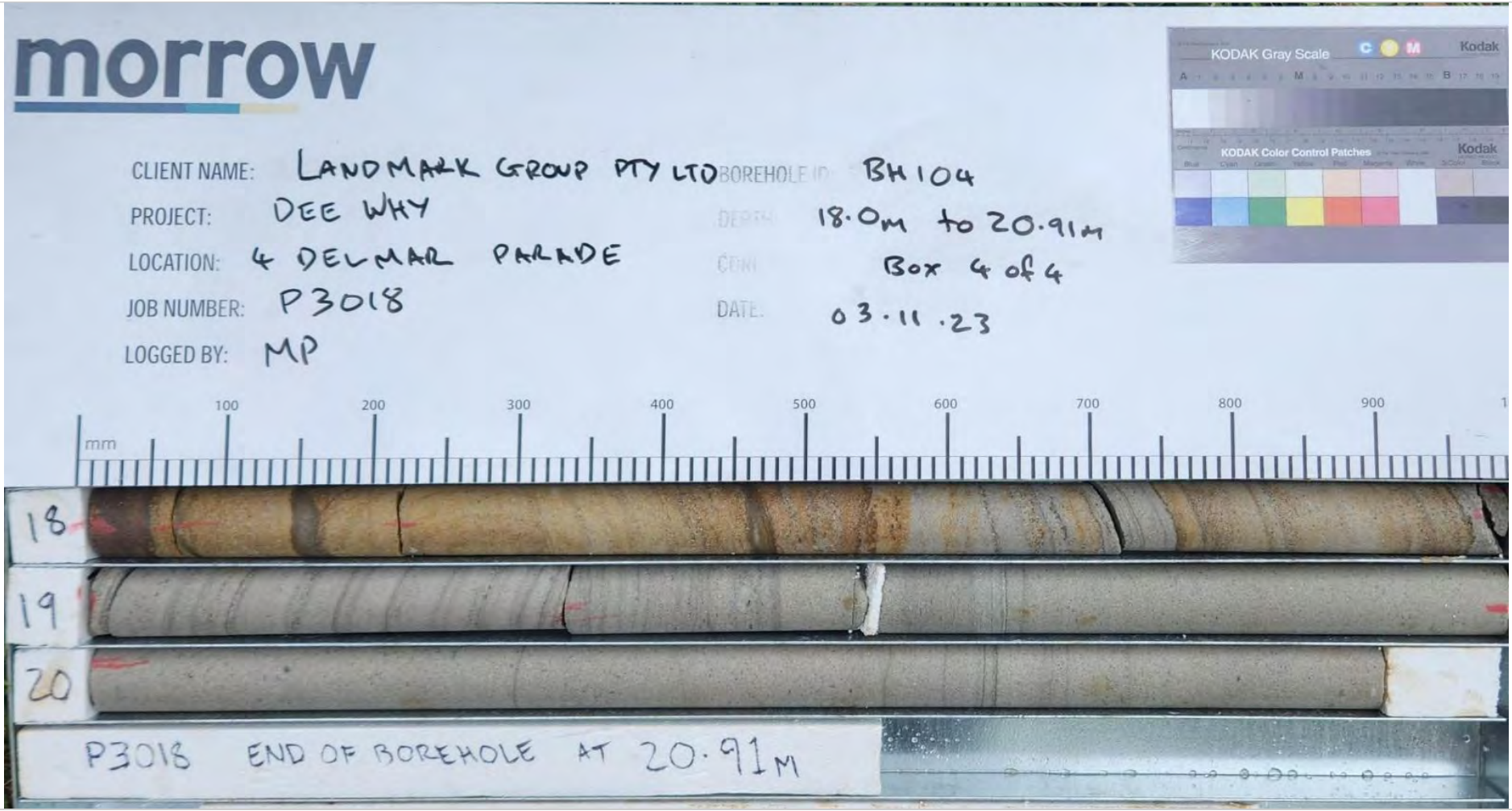

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Photo description	Box 4 of 4		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH104	**BH Depth**	18.0m to 20.91m

Morrow Geotechnics

Bellambi, NSW

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Geotechnical Log - Borehole

BH105

UTM	**: 56H**	**Drill Rig**	**: Christie Rig**	**Job Number**	**: P3018**
Easting (m)	**: 341010.2**	**Driller Supplier**	**: Tracess**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263530.0**	**Logged By**	**: Mahmoud Jangidaryan**	**Project**	**: Dee Why**
Ground Elevation	**: 28.5 (m)**	**Reviewed By**	**: Mark Peach**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 22.22 m BGL**	**Date**	**: 08/11/2023**	**Loc Comment**	**:**

Drilling Method	Water	DCP graph	Soil Origin	Graphic Log	Classification Code	Depth (m)	Material Description	Elevation (m)	Consistency/Density	Moisture
Diatube			Non-Soil		CCT	0.15	Concrete	28.5		
			Fill		SC	0.4	Fill Clayey to gravelly SAND (SC) : low plasticity clay, medium dense, brown, fine grained, fine sized gravel, moist.		MD	M
			Alluvial		SC	1.5	Alluvial Clayey SAND (SC) : medium dense, low plasticity clay, brown, fine grained, trace fine sized gravel, moist.	27.5		
ADT	GWNE		Alluvial		CI	3	Alluvial Sandy CLAY (CI) : stiff to very stiff, medium plasticity, brown yellow, fine grained sand, w < pl.	26.5	St-VSt	w < PL
			Alluvial		CL		Alluvial Sandy CLAY (CL) : very stiff, low plasticity, yellow brown orange brown yellow, fine grained sand, w < pl.	25.5	VSt	
						1				
						2				
						3				
						4		24.5		

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Geotechnical Log - Borehole

BH105

UTM	: 56H	**Drill Rig**	: Christie Rig	**Job Number**	: P3018
Easting (m)	: 341010.2	**Driller Supplier**	: Tracess	**Client**	: Landmark Group Construction Australia Pty Ltd
Northing (m)	: 6263530.0	**Logged By**	: Mahmoud Jangidaryan	**Project**	: Dee Why
Ground Elevation	: 28.5 (m)	**Reviewed By**	: Mark Peach	**Location**	: 4 Delmar Parade, Dee Why NSW
Total Depth	: 22.22 m BGL	**Date**	: 08/11/2023	**Loc Comment**	:

Drilling Method	Water	DCP graph	Soil Origin	Graphic Log	Classification Code	Depth (m)	Material Description	Elevation (m)	Consistency/Density	Moisture
ADT			Residual		CL	5	Residual Sandy CLAY (CL) : very stiff, low plasticity, grey light grey orange, fine to medium grained sand, w ≈ pl.	23.5		w ≈ PL
			Residual		CL	6	As above, but grey orange brown yellow, fine grained sand, trace fine sized gravel, w ≈ ll.	22.5		w ≈ LL
						7		21.5		
			Rock		SST	7.6	Extremelyweathered, rock Clayey SAND (SST) : very dense, low plasticity clay, brown brown yellow, fine grained, trace fine sized gravel, wet.		VD	W
						8		20.5		
							8.72m : Commenced NMLC Coring;			
						9		19.5		

Morrow Geotechnics

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Geotechnical Log - Borehole

BH105

UTM	**: 56H**	**Drill Rig**	**: Christie Rig**	**Job Number**	**: P3018**
Easting (m)	**: 341010.2**	**Driller Supplier**	**: Tracess**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263530.0**	**Logged By**	**: Mahmoud Jangidaryan**	**Project**	**: Dee Why**
Ground Elevation	**: 28.5 (m)**	**Reviewed By**	**: Mark Peach**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 22.22 m BGL**	**Date**	**: 08/11/2023**	**Loc Comment**	**:**

Drilling Method	Water	RQD% and TCR%	Testing: Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
						6				23.5 22.5		6	
						7				21.5		7	
						8				20.5		8	
NMLC Coring	0% Water Loss	RQD = 100% TCR = 100%	d: 0.17, a: 0.13 d: 0.05, a: 0.03 d: 0.06, a: 0.03		HW	9		SST	Rock SANDSTONE: highly weathered, very low strength, orange, fine grained, generally massive, wiith minor xw and dw sandstone bands, iron stained.	19.5		9	

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Geotechnical Log - Borehole

BH105

UTM	: 56H	**Drill Rig**	: Christie Rig	**Job Number**	: P3018
Easting (m)	: 341010.2	**Driller Supplier**	: Tracess	**Client**	: Landmark Group Construction Australia Pty Ltd
Northing (m)	: 6263530.0	**Logged By**	: Mahmoud Jangidaryan	**Project**	: Dee Why
Ground Elevation	: 28.5 (m)	**Reviewed By**	: Mark Peach	**Location**	: 4 Delmar Parade, Dee Why NSW
Total Depth	: 22.22 m BGL	**Date**	: 08/11/2023	**Loc Comment**	:

Drilling Method	Water	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring	0% Water Loss	RQD = 100% TCR = 100%	d: 0.07, a: 0.01		HW			SST	Rock SANDSTONE: highly weathered, very low strength, orange, fine grained, generally massive, wiith minor xw and dw sandstone bands, iron stained.	18.5			
						10.3							
					HW-M			SST	Rock SANDSTONE: highly to moderately weathered, low strength, grey light grey, fine to medium grained, medium grained.				
		RQD = 90% TCR = 100%	d: 0.20, a: 0.21										
						11				17.5		11	
						11.15							11.06, P, RO, PL, CL, OP
													11.14, P, RO, PL, CL, OP
					SW-F			SST	Rock SANDSTONE: slightly to fresh weathered, medium strength, light grey mottled yellow white, fine grained, 10-15 degree 2mm beddings at 10-20mm spacing.				
			d: 1.01, a: 1.30										11.57, J, 30°, SO, PL, CL, OP
						12				16.5		12	
													12.68, J, 20°, SO, PL, CL, OP
			d: 0.63, a: 1.17										12.82, J, RO, PL, CL, OP
						13				15.5		13	
						13.32							13.32, P, 10°, RO, PL, CL, OP
					SW-F			SST	Rock SANDSTONE: slightly to fresh weathered, medium to high strength, very light grey with grey, medium to coarse grained, generally massive, medium to coarse grained with sub rounded gravels.				
		RQD = 88% TCR = 100%											
						14				14.5		14	
			d:0.81, a: 0.50										14.17, P, 20°, , CV, CL, OP
													14.23, P, 30°, , PL, CL, OP
													14.39, P, 20°, , PL, CL, OP
						14.45							
					F			SST	Rock SANDSTONE: fresh weathered, medium to high strength, light grey, fine grained, generally massive, 10° laminations at 1-5mm spacing.				14.53, P, 10°, SO, PL, CL, OP
													14.62, P, 10°, SO, PL, CL, OP
			d: 1.30, a: 1.17										

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Geotechnical Log - Borehole

BH105

UTM	**: 56H**	**Drill Rig**	**: Christie Rig**	**Job Number**	**: P3018**
Easting (m)	**: 341010.2**	**Driller Supplier**	**: Tracess**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263530.0**	**Logged By**	**: Mahmoud Jangidaryan**	**Project**	**: Dee Why**
Ground Elevation	**: 28.5 (m)**	**Reviewed By**	**: Mark Peach**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 22.22 m BGL**	**Date**	**: 08/11/2023**	**Loc Comment**	**:**

Drilling Method	Water	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring	70% Water Loss	RQD = 88% TCR = 100%	d: 1.58, a: 1.52		F	16		SST	Rock SANDSTONE: fresh weathered, medium to high strength, light grey, fine grained, generally massive, 10° laminations at 1-5mm spacing.	13.5		16	15.34, J, 75°, RO, PL, CL, OP 15.37, P, 10°, RO, PL, CL, OP
			d: 0.87, a: 0.90							12.5			16.3, P, 5°, SO, PL, CL, OP 16.59, P, 5°, SO, PL, CL, OP
		RQD = 91% TCR = 100%				17				11.5		17	16.73, J, 60°, RO, PL, CL, OP 16.77, P, RO, PL, CL, OP 17.09, P, RO, PL, CL, OP
			d: 0.89, a: 1.08										17.6, P, 5°, SO, PL, CL, OP 17.7, P, 5°, RO, PL, CL, OP
			d: 0.92, a:1.07			18				10.5		18	18.3, P, 5°, SO, PL, CL, OP 18.37, P, 10°, RO, PL, CL, OP 18.46, P, 10°, RO, PL, CL, OP 18.57, P, 15°, RO, PL, CL, OP
			d: 0.91, a: 0.77			19				9.5		19	19.32, P, 5°, RO, PL, CL, OP
		RQD = 71% TCR = 100%											19.66, J, 80°, RO, PL, CL, OP 19.9, J, 75°, RO, PL, CL, OP

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Geotechnical Log - Borehole

BH105

UTM	**: 56H**	**Drill Rig**	**: Christie Rig**	**Job Number**	**: P3018**
Easting (m)	**: 341010.2**	**Driller Supplier**	**: Tracess**	**Client**	**: Landmark Group Construction Australia Pty Ltd**
Northing (m)	**: 6263530.0**	**Logged By**	**: Mahmoud Jangidaryan**	**Project**	**: Dee Why**
Ground Elevation	**: 28.5 (m)**	**Reviewed By**	**: Mark Peach**	**Location**	**: 4 Delmar Parade, Dee Why NSW**
Total Depth	**: 22.22 m BGL**	**Date**	**: 08/11/2023**	**Loc Comment**	**:**

Drilling Method	Water	RQD% and TCR%	Testing Is(50)	Estimated Strength (VLS, LS, MS, HS, VHS, EHS)	Weathering	Depth (m)	Graphic Log	Classification Code	Material Description	Elevation (m)	Defect Spacing (mm) (30, 100, 300, 1000, 3000)	Defect Depth	Defect Description (type, inclination, planarity, roughness, coating, thickness)
NMLC Coring	70% Water Loss	RQD = 71% TCR = 100%	d: 1.00, a: 0.98		F	20.3		SST	Rock SANDSTONE: fresh weathered, medium to high strength, light grey, fine grained, generally massive, 10° laminations at 1-5mm spacing.	8.5			20.07, P, 5°, RO, PL, CL, OP 20.28, P, 5°, SO, PL, CL, OP 20.45, P, 5°, RO, CV, CL, OP
					F			SST	As above, but high strength, generally massive with some carbonaceous layers.				
			d: 1.71, a: 2.02			21				7.5		21	21.08, J, 75°, RO, PL, CL, OP
			d: 2.13, a: 2.27			22				6.5		22	21.58, P, 5°, SO, PL, CL, OP 21.62, J, 85°, , PL, CL, OP 21.84, P, 5°, RO, PL, CL, OP 21.88-22.22, J, 85°, RO, PL, CL, OP
									BH105 Terminated at 22.22m (Target Depth Reached)				
						23				5.5		23	
						24				4.5		24	

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Photo description	Box 1 of 3		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH105	**BH Depth**	8.72m to 13.0m

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Photo description	Box 2 of 3		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH105	**BH Depth**	13.0m to 18.0m

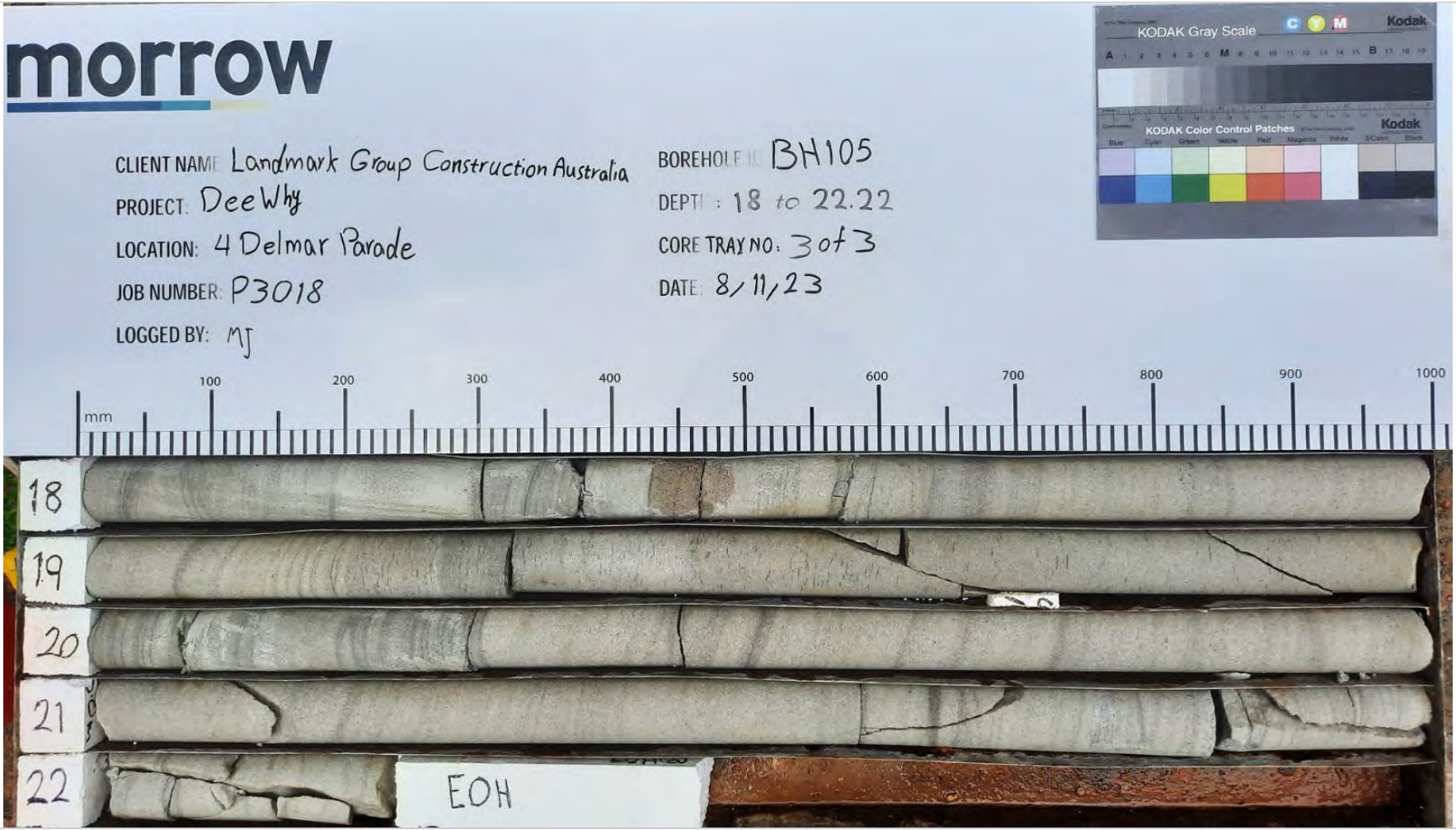

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Photo description	Box 3 of 3		
Client	Landmark Group Construction Australia Pty Ltd		
Location	4 Delmar Parade, Dee Why NSW		
Project name	Dee Why		
Project No	P3018	**Scale**	Not to Scale
BH No	BH105	**BH Depth**	18.0m to 22.22m

Soil and Rock Logging Explanatory Notes

GENERAL

Information obtained from site investigations is recorded on log sheets. The "Cored Drill Hole Log" presents data from an operation where a core barrel has been used to recover material - commonly rock. The "Non-Core Drill Hole - Geological Log" presents data from an operation where coring has not been used and information is based on a combination of regular sampling and insitu testing. The material penetrated in non-core drilling is commonly soil but may include rock. The "Excavation - Geological Log" presents data and drawings from exposures of soil and rock resulting from excavation of pits, trenches, etc.

The heading of the log sheets contains information on Project Identification, Hole or Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material substance description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The common depth scale is 8m per drill log sheet and about 3-5m for excavation logs sheets.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is inevitable in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures. Material description and classifications are based on SAA Site Investigation Code AS 1726 - 1993 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

DRILLING

Drilling & Casing

ADV	Auger Drilling with V-Bit
ADT	Auger Drilling with TC Bit
WB	Wash-bore drilling
RR	Rock Roller
NMLC	NMLC core barrel
NQ	NQ core barrel
HMLC	HMLC core barrel
HQ	HQ core barrel

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

VE	Very Easy
E	Easy
M	Medium
H	High
VH	Very High

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

D	Disturbed
B	Bulk
U	Undisturbed
SPT	Standard Penetration Test
N	Result of SPT (sample taken)
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer Test

EXCAVATION LOGS

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the "Structure and other Observations" column. The depth of the base of excavation (for the logged section) at the appropriate depth in the "Material Description" column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added.

MATERIAL DESCRIPTION - SOIL

Classification Symbol - In accordance with the Unified Classification System (AS 1726-1993, Appendix A, Table A1)

Material Description - In accordance with AS 1726-1993, Appendix A2.3

Moisture Condition

D	Dry, looks and feels dry
M	Moist, No free water on remoulding
W	Wet, free water on remoulding

Consistency - In accordance with AS 1726-1993, Appendix A2.5

VS	Very Soft	< 12.5 kPa
S	Soft	12.5 – 25 kPa
F	Firm	25 – 50 kPa
St	Stiff	50 – 100 kPa
VSt	Very Stiff	100 – 200 kPa
H	Hard	> 200 kPa

Strength figures quoted are the approximate range of undrained shear strength for each class.

Density Index. (%) is estimated or is based on SPT results.

VL	Very Loose	< 15 %
L	Loose	15 – 35 %
MD	Medium Dense	35 – 65 %
D	Dense	65 – 85 %
VD	Very Dense	> 85 %

MATERIAL DESCRIPTION -ROCK

Material Description

Identification of rock type, composition and texture based on visual features in accordance with AS 1726-1993, Appendix A3.1-A3.3 and Tables A6a, A6b and A7.

Core Loss

Is shown at the bottom of the run unless otherwise indicated.

Bedding

Thinly Laminated	< 6 mm
Laminated	6 - 20
Very Thinly Bedded	20 - 60
Thinly Bedded	60 - 200
Medium Bedded	200 – 600
Thickly Bedded	600 – 2000
Very Thickly Bedded	> 2000

Weathering - No distinction is made between weathering and alteration. Weathering classification assists in identification but does not imply engineering properties.

Fresh (F)	Rock substance unaffected by weathering
Slightly Weathered (SW)	Rock substance partly stained or discoloured. Colour and texture of fresh rock recognisable.
Moderately Weathered (MW)	Staining or discolouration extends throughout rock substance. Fresh rock colour not recognisable.
Highly Weathered (HW)	Stained or discoloured throughout. Signs of chemical or physical alteration. Rock texture retained.
Extremely Weathered (EW)	Rock texture evident but material has soil properties and can be remoulded.

Strength - The following terms are used to described rock strength:

Rock Strength Class	Abbreviation	Point Load Strength Index, Is(50) (MPa)
Extremely Low	EL	< 0.03
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	H	1 to 3
Very High	VH	3 to 10
Extremely High	EH	≥ 10

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical estimated strength by using:

° Diametral Point Load Test

Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown.

MATERIALS STRUCTURE/FRACTURES

ROCK

Natural Fracture Spacing - A plot of average fracture spacing excluding defects known or suspected to be due to drilling, core boxing or testing. Closed or cemented joints, drilling breaks and handling breaks are not included in the Natural Fracture Spacing.

Visual Log - A diagrammatic plot of defects showing type, spacing and orientation in relation to core axis.

Defects	———	Defects open in-situu or clay sealed
	– – – – –	Defects closed in-situ
	.....	Breaks through rock substance

Additional Data - Description of individual defects by type, orientation, in-filling, shape and roughness in accordance with AS 1726-1993, Appendix A Table A10, notes and Figure A2.

Orientation - angle relative to the plane normal to the core axis.

Type	BP	Bedding Parting
	JT	Joint
	SM	Seam
	FZ	Fracture Zone
	SZ	Shear Zone
	VN	Vein
	FL	Foliation
	CL	Cleavage
	DL	Drill Lift
	HB	Handling Break
	DB	Drilling Break
Infilling	CN	Clean
	X	Carbonaceous
	Clay	Clay
	KT	Chlorite
	CA	Calcite
	Fe	Iron Oxide
	Qz	Quartz
	MS	Secondary Mineral
	MU	Unidentified Mineral
Shape	PR	Planar
	CU	Curved
	UN	Undulose
	ST	Stepped
	IR	Irregular
	DIS	Discontinuous
Rougness	POL	Polished
	SL	Slickensided
	S	Smooth
	RF	Rough
	VR	Very Rough

SOIL

Structures - Fissuring and other defects are described in accordance with AS 1726-1993, Appendix A2.6, using the terminology for rock defects.

Origin - Where practicable an assessment is provided of the probable origin of the soil, eg fill, topsoil, alluvium, colluvium, residual soil.

Appendix B

WATER QUALITY LABORATORY TESTING CERTIFICATES

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Andrew Butel
Client	MORROW GEOTECHNICS PTY LTD
Address	PO BOX 4069 NSW 2218
Telephone	(Not specified)
Facsimile	(Not specified)
Email	andy@morrowgeo.com.au
Project	**P3018 - Dee Why**
Order Number	**P3018**
Samples	3

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE255664 R0**
Date Received	25/10/2023
Date Reported	1/11/2023

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Dong LIANG
Metals/Inorganics Team Leader

Kamrul AHSAN
Senior Chemist

Ly Kim HA
Organic Section Head

Ying Ying ZHANG
Laboratory Technician

VOCs in Water [AN433] Tested: 30/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
Benzene	µg/L	0.5	<0.5	<0.5	<0.5
Toluene	µg/L	0.5	**2.2**	<0.5	<0.5
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5
m/p-xylene	µg/L	1	<1	<1	<1
o-xylene	µg/L	0.5	<0.5	<0.5	<0.5
Total Xylenes	µg/L	1.5	<1.5	<1.5	<1.5
Total BTEX	µg/L	3	<3	<3	<3
Naphthalene (VOC)*	µg/L	0.5	<0.5	<0.5	<0.5

Volatile Petroleum Hydrocarbons in Water [AN433] Tested: 30/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
TRH C6-C9	µg/L	40	<40	<40	<40
Benzene (F0)	µg/L	0.5	<0.5	<0.5	<0.5
TRH C6-C10	µg/L	50	<50	<50	<50
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50	<50

TRH (Total Recoverable Hydrocarbons) in Water [AN403] Tested: 30/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
TRH C10-C14	µg/L	50	**87**	**240**	<50
TRH C15-C28	µg/L	200	**280**	**330**	<200
TRH C29-C36	µg/L	200	<200	<200	<200
TRH C37-C40	µg/L	200	<200	<200	<200
TRH >C10-C16	µg/L	60	**110**	**300**	<60
TRH >C10-C16 - Naphthalene (F2)	µg/L	60	**110**	**300**	<60
TRH >C16-C34 (F3)	µg/L	500	<500	<500	<500
TRH >C34-C40 (F4)	µg/L	500	<500	<500	<500
TRH C10-C40	µg/L	320	**450**	**650**	<320

PAH (Polynuclear Aromatic Hydrocarbons) in Water [AN420] Tested: 30/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
Naphthalene	µg/L	0.1	**0.2**	**0.3**	**0.4**
2-methylnaphthalene	µg/L	0.1	<0.1	<0.1	**0.4**
1-methylnaphthalene	µg/L	0.1	<0.1	<0.1	**0.3**
Acenaphthylene	µg/L	0.1	<0.1	<0.1	<0.1
Acenaphthene	µg/L	0.1	<0.1	<0.1	<0.1
Fluorene	µg/L	0.1	<0.1	<0.1	<0.1
Phenanthrene	µg/L	0.1	<0.1	<0.1	**0.1**
Anthracene	µg/L	0.1	<0.1	<0.1	<0.1
Fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1
Pyrene	µg/L	0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	µg/L	0.1	<0.1	<0.1	<0.1
Chrysene	µg/L	0.1	<0.1	<0.1	<0.1
Benzo(b&j)fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	µg/L	0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	µg/L	0.1	<0.1	<0.1	<0.1
Dibenzo(ah)anthracene	µg/L	0.1	<0.1	<0.1	<0.1
Benzo(ghi)perylene	µg/L	0.1	<0.1	<0.1	<0.1
Total PAH (18)	µg/L	1	<1	<1	**1**

Anions by Ion Chromatography in Water [AN245] Tested: 27/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
Chloride	mg/L	1	**74**	**89**	**97**
Sulfate, SO4	mg/L	1	**40**	**40**	**29**

Alkalinity [AN135] Tested: 27/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
Bicarbonate Alkalinity as CaCO3	mg/L	5	**14**	**16**	**6**
Carbonate Alkalinity as CaCO3	mg/L	1	<1	<1	<1
Hydroxide Alkalinity as CaCO3	mg/L	5	<5	<5	<5
Phenolphthalein Alkalinity as CaCO3*	mg/L	5	<5	<5	<5
Total Alkalinity as CaCO3	mg/L	5	**14**	**16**	**6**

Acidity and Free CO2 [AN140] Tested: 27/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
Acidity to pH 8.3	mg CaCO3/L	5	110	130	110

pH in water [AN101] Tested: 25/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
pH**	No unit	-	**5.1**	**5.2**	**4.7**

Conductivity and TDS by Calculation - Water [AN106] Tested: 25/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
Conductivity @ 25 C	µS/cm	2	350	410	390
Total Dissolved Solids (by calculation)	mg/L	2	210	240	240

Metals in Water (Dissolved) by ICPOES [AN320] Tested: 27/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
Calcium, Ca	mg/L	0.1	**1.5**	**4.5**	**2.4**
Magnesium, Mg	mg/L	0.1	**6.1**	**9.5**	**9.4**
Sodium, Na	mg/L	0.1	**43**	**64**	**49**
Potassium, K	mg/L	0.2	**1.1**	**1.1**	**0.8**

Trace Metals (Dissolved) in Water by ICPMS [AN318] Tested: 26/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
Arsenic	µg/L	1	<1	<1	<1
Cadmium	µg/L	0.1	<0.1	<0.1	<0.1
Chromium	µg/L	1	<1	**2**	<1
Copper	µg/L	1	**3**	<1	**61**
Lead	µg/L	1	<1	<1	<1
Nickel	µg/L	1	**5**	**18**	**2**
Zinc	µg/L	5	**19**	**25**	**12**

Mercury (dissolved) in Water [AN311(Perth)/AN312] Tested: 26/10/2023

PARAMETER	UOM	LOR	BH101 WATER - 25/10/2023 SE255664.001	BH102 WATER - 25/10/2023 SE255664.002	BH103 WATER - 25/10/2023 SE255664.003
Mercury	mg/L	0.0001	<0.0001	<0.0001	<0.0001

METHOD	METHODOLOGY SUMMARY
AN020	Unpreserved water sample is filtered through a 0.45µm membrane filter and acidified with nitric acid similar to APHA3030B.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B.
AN106	Salinity may be calculated in terms of NaCl from the sample conductivity. This assumes all soluble salts present , measured by the conductivity, are present as NaCl.
AN135	Alkalinity (and forms of) by Titration: The sample is titrated with standard acid to pH 8.3 (P titre) and pH 4.5 (T titre) and permanent and/or total alkalinity calculated. The results are expressed as equivalents of calcium carbonate or recalculated as bicarbonate, carbonate and hydroxide. Reference APHA 2320. Internal Reference AN135
AN140	Acidity by Titration: The water sample is titrated with sodium hydroxide to designated pH end point. In a sample containing only carbon dioxide, bicarbonates and carbonates, titration to pH 8.3 at 25°C corresponds to stoichiometric neutralisation of carbonic acid to bicarbonate. Method reference APHA 2310 B.
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B
AN311(Perth)/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN318	Determination of elements at trace level in waters by ICP-MS technique,, referenced to USEPA 6020B and USEPA 200.8 (5.4).
AN320	Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components .
AN320	Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements . Reference APHA 3120 B.
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). Where F2 is corrected for Naphthalene, the VOC data for Naphthalene is used.
AN403	Additionally, the volatile C6-C9/C6-C10 fractions may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Recoveerable Hydrocarbons - Silica (TRH-Silica) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents.
AN403	The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.
AN420	(SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D). Total PAH calculated from individual analyte detections at or above the limit of reporting .
AN433	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

Calculation	Free and Total Carbon Dioxide may be calculated using alkalinity forms only when the samples TDS is <500mg/L. If TDS is >500mg/L free or total carbon dioxide cannot be reported. APHA4500CO2 D.

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
***	Indicates that both * and ** apply.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

Appendix C

RISING HEAD PERMEABILITY SHEETS

Rising Head Permeability Results

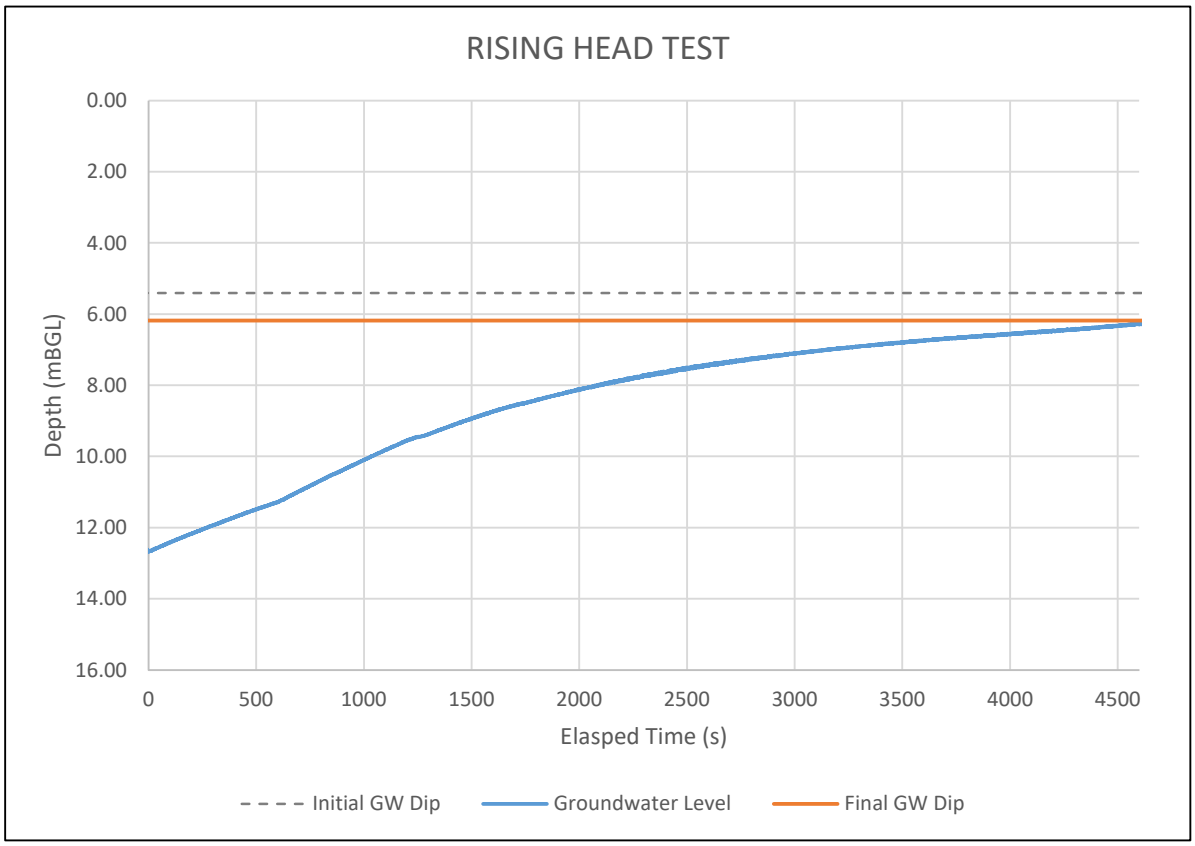
79/6 Bellambi Lane, Bellambi NSW 2518
P: 0405 843 933 | E: info@morrowgeo.com.au

Project Number	P3018
Address	4 Delmar Parade, Dee Why
Borehole	BH101
Monitoring Date	25/10/2023

Static water level (mBGL)	5.41
Internal Diameter (D) (m)	0.07
Length of Standpipe below Ground Level (m)	12.95
Height of Water above Ground Level (m)	0.00
Length of Standpipe above Ground Level (m)	0.00
Water level at start of test (mBGL)	5.41
Top of Response Zone (mBGL)	6.18
Bottom of Response Zone (mBGL)	12.95

Time (t1) (s)	38.401
Time (t2) (s)	4641.4
Initial Head (H1) at (t1)	12.57
Final Head (H2) at (t2)	6.25
Length of Response Zone *(L)*	6.77
Cross Sectional Area *(A)*	0.0038

Stratigraphy Description: Fill and Alluvial Sand over Sandstone Bedrock



Intake Factor (F) Case D $\dfrac{2\pi L}{\log_e[(L/D)+\sqrt{(1+(L/D)^2)}]}$ = $\dfrac{42.54}{5.26}$ = 8.08

Permeability (k) $\dfrac{A}{F\,(t2-t1)}\log_e\dfrac{H1}{H2}$ = 7.23E-08 m/s

Rising Head Test Method 1 (after Hvorslev)
Formulae for borehole permeability tests(21.4.6) BS5930 : 1981

Calculation by:	AB	Checked by:	AM	Date:	27/10/2023

Rising Head Permeability Results

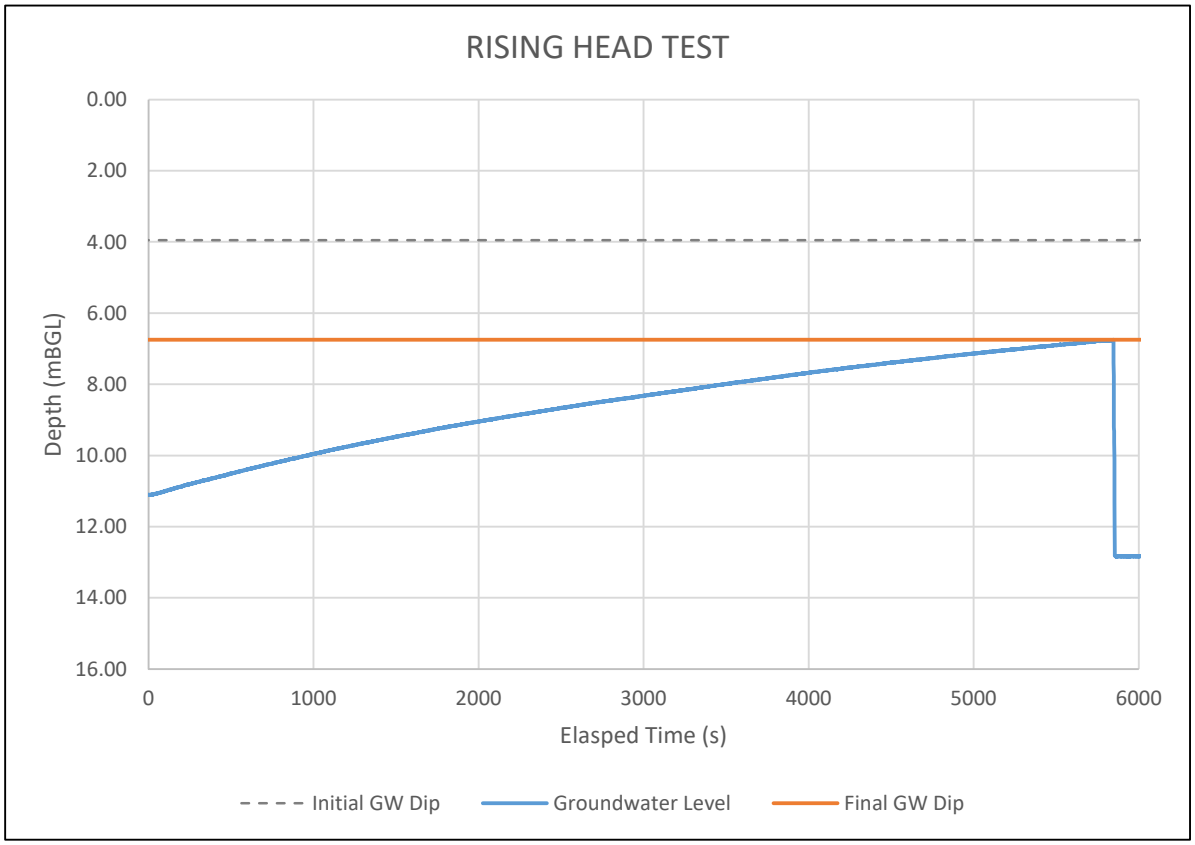
79/6 Bellambi Lane, Bellambi NSW 2518
P: 0405 843 933 | E: info@morrowgeo.com.au

Project Number	P3018
Address	4 Delmar Parade, Dee Why
Borehole	BH102
Monitoring Date	25/10/2023

Static water level (mBGL)	3.95
Internal Diameter (D) (m)	0.07
Length of Standpipe below Ground Level (m)	12.72
Height of Water above Ground Level (m)	0.00
Length of Standpipe above Ground Level (m)	0.00
Water level at start of test (mBGL)	3.95
Top of Response Zone (mBGL)	6.74
Bottom of Response Zone (mBGL)	12.72

Time (t1) (s)	51
Time (t2) (s)	5485
Initial Head (H1) at (t1)	11.06
Final Head (H2) at (t2)	6.90
Length of Response Zone *(L)*	5.98
Cross Sectional Area *(A)*	0.0038

Stratigraphy Description: Fill,Alluvial and Residual Soil over Sandstone/Shale bedrock



Intake Factor (F) Case D $\dfrac{2\pi L}{\log_e[(L/D)+\sqrt{(1+(L/D)^2)}]}$ = $\dfrac{37.57}{5.14}$ = 7.31

Permeability (k) $\dfrac{A}{F\,(t2-t1)}\log_e\dfrac{H1}{H2}$ = 4.57E-08 m/s

Rising Head Test Method 1 (after Hvorslev)
Formulae for borehole permeability tests(21.4.6) BS5930 : 1981

Calculation by:	AB	Checked by:	AM	Date:	27/10/2023

Rising Head Permeability Results

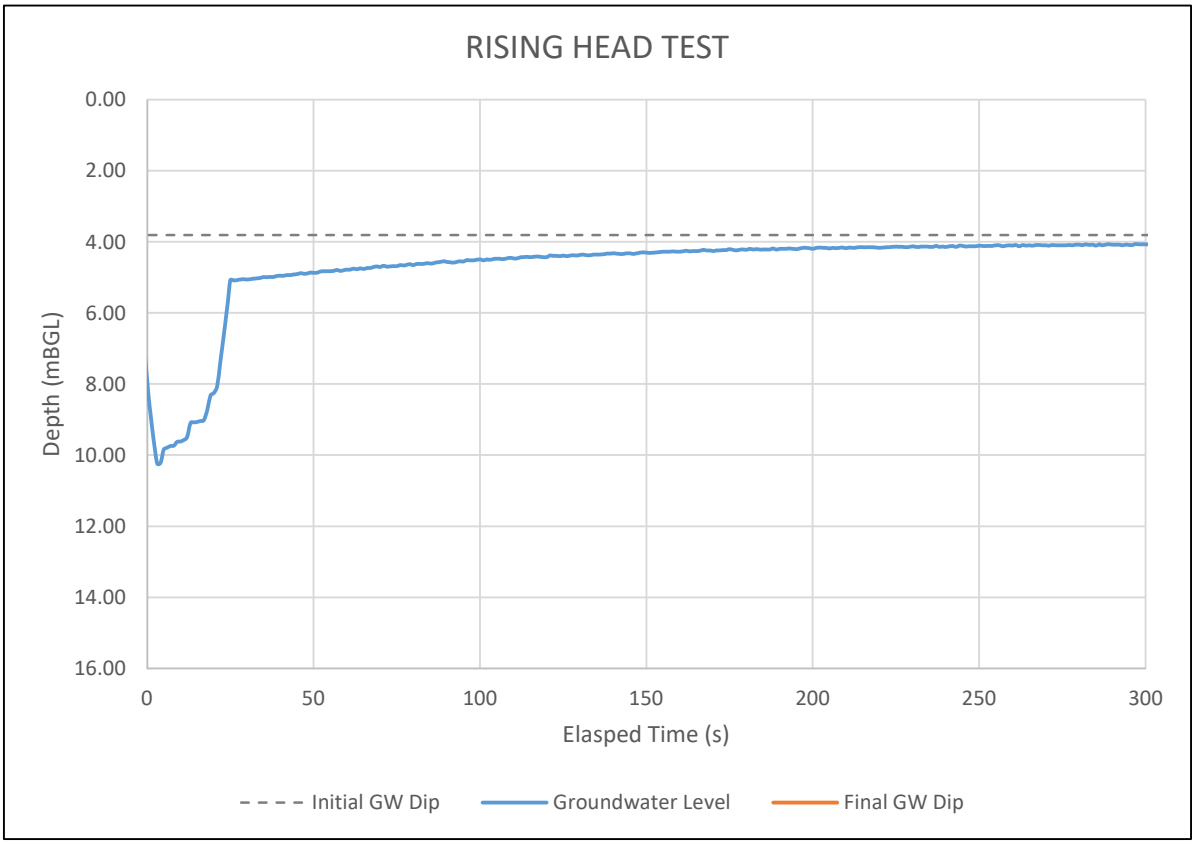
79/6 Bellambi Lane, Bellambi NSW 2518
P: 0405 843 933 | E: info@morrowgeo.com.au

Project Number	P3018
Address	4 Delmar Parade, Dee Why
Borehole	BH103
Monitoring Date	25/10/2023

Static water level (mBGL)	3.81
Internal Diameter (D) (m)	0.07
Length of Standpipe below Ground Level (m)	0.00
Height of Water above Ground Level (m)	0.00
Length of Standpipe above Ground Level (m)	0.00
Water level at start of test (mBGL)	3.81
Top of Response Zone (mBGL)	3.81
Bottom of Response Zone (mBGL)	5.06

Time (t1) (s)	20
Time (t2) (s)	26
Initial Head (H1) at (t1)	8.26
Final Head (H2) at (t2)	5.08
Length of Response Zone *(L)*	1.25
Cross Sectional Area *(A)*	0.0038

Stratigraphy Description: Fill and Alluvial Soil over Sandstone and Shale bedrock



Intake Factor (F) Case D $\dfrac{2\pi L}{\log_e[(L/D)+\sqrt{(1+(L/D)^2)}]}$ = $\dfrac{7.85}{3.58}$ = 2.20

Permeability (k) $\dfrac{A}{F\,(t2-t1)}\log_e\dfrac{H1}{H2}$ = 1.42E-04 m/s

Rising Head Test Method 1 (after Hvorslev)
Formulae for borehole permeability tests(21.4.6) BS5930 : 1981

Calculation by:	AB	Checked by:	AM	Date:	27/10/2023

Appendix D

IMPORTANT INFORMATION

Important Information

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