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Berry Road Development Pty Ltd

St Leonards South Development

Groundwater Impact Assessment

JUNE 2023

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St Leonards South Development
Groundwater Impact Assessment

Berry Road Development Pty Ltd

WSP
Level 27, 680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
wsp.com

REV	DATE	DETAILS
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	NAME	DATE	SIGNATURE
Prepared by:	Craig Wicenciak	7 June 2023	
Reviewed by:	Ray Hatley Andrea Madden	5 June 2023 6 June 2023	
Approved by:	Craig Wicenciak	7 June 2023	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Table of contents

1 Introduction 1
1.1 Overview 1
1.2 Objective 1
1.3 Scope of work 1
1.4 Terminology 1
1.5 Abbreviations 2
2 Basement configuration 4
3 Legislative considerations 5
4 Licencing requirements 6
5 Hydrogeological investigations 7
5.1 Overview 7
5.2 Drilling 8
5.3 In-situ borehole ‘packer’ testing 9
5.4 Groundwater monitoring well installation 10
5.5 Well development 12
5.6 Groundwater level monitoring 12
6 Site Setting and Characterisation 13
6.1 Information sources 13
6.2 Topography 13
6.3 Surrounding land use and infrastructure 14
6.4 Rainfall and evaporation 14
6.5 Geological setting 16
6.5.1 Background 16
6.5.2 Site Information 17
6.6 Acid sulfate soils 20
6.7 Regulated groundwater resources 20
6.8 Regional hydrogeology 20
6.9 Groundwater elevations 22
6.10 Aquifer hydraulic conductivity 24
6.10.1 Lugeon water-pressure (packer) tests 24

6.10.2 Slug tests 26
6.10.3 Other information sources 27
6.11 Groundwater quality 29
6.12 Groundwater abstraction and drainage 31
6.13 Nearby registered groundwater bores 31
6.14 Groundwater-dependent ecosystems 31
6.15 Springs 32
6.16 Culturally-significant groundwater sites 32
6.17 Nearby contaminated sites 32
7 Numerical modelling – groundwater inflow and drawdown assessment 34
7.1 Objective 34
7.2 Conceptual model 34
7.3 Groundwater model 37
7.3.1 Modelling code 37
7.3.2 Model class 37
7.3.3 Model geometry 37
7.3.4 Model calibration 42
7.3.5 Model limitations 43
7.4 Groundwater inflow and drawdown assessment outcomes 44
7.4.1 Groundwater inflows 44
7.4.2 Drawdown 46
7.4.3 Settlement 48
7.4.4 Groundwater drainage quality 49
8 Groundwater impact assessment 50
8.1 Minimal impact considerations 50
8.2 Water sharing plan rules for water access approval 51
9 Monitoring and reporting 54
9.1 Requirements 54
9.2 Threshold criteria 55
9.3 Stakeholders 55

10 Other considerations 56

11 Conclusions 57

12 Limitations 58

12.1 Permitted purpose 58

12.2 Qualifications and assumptions 58

12.3 Use and reliance 58

12.4 Disclaimer 59

13 References 60

List of tables

Table 5.1 WSP Borehole location rationale 9

Table 5.2 Groundwater monitoring well construction summary – WSP wells 11

Table 5.3 Groundwater monitoring well construction summary – Coffey wells 12

Table 6.1 Groundwater monitoring well construction summary 14

Table 6.2 Average rainfall (mm) across the monitoring period (excluding incomplete data sets) 14

Table 6.3 Mean monthly evaporation rates (mm) between 2009 and 2022 15

Table 6.4 Groundwater depths and elevation 22

Table 6.5 Summary of packer hydraulic conductivity test results 25

Table 6.6 Summary of Coffey slug test results (Coffey, 2023) 27

Table 6.7 Summary of Pells class hydraulic properties of the Hawkesbury Sandstone (Pells et. al. 2019) and WSP's site observations 27

Table 6.8 WCX M4-M5 Link Hawkesbury Sandstone core porosity and hydraulic conductivity testing results 29

Table 6.9 Summary of groundwater analytical results and exceedances of DGVs 30

Table 6.10 Summary of groundwater field parameters from WSP groundwater monitoring wells 31

Table 7.1 Hydraulic properties of model layers 40

Table 7.2 Mass balance in steady state model 43

Table 7.3 Mass balance in transient model 43

Table 7.4 Estimated construction-phase groundwater inflows 44

Table 7.5 Estimates of operational-phase groundwater inflows 45

Table 8.1 Minimal impact consideration under the Aquifer Interference Policy 50
Table 8.2 Water Sharing Plan rules and groundwater impact assessment considerations 51
Table 9.1 Summary of monitoring and reporting requirements 54
Table 9.2 Proposed inflow threshold and actions for temporary dewatering 55

List of figures

Figure 6.1: Annual residual rainfall and cumulative deviation from average for BOM Station 66062 (Observatory Hill) 15
Figure 6.2 Typical Class I / II Hawkesbury Sandstone outcrop north of Sydney 16
Figure 6.3 Typical high-strength Pells Class I/II Hawkesbury Sandstone in the northern portion of the site. 18
Figure 6.4 Geological cross section oriented north – south through the centre of the northern portion of the site. 19
Figure 6.5 Groundwater elevation and flow direction in the southern portion of the site as estimated by Coffey (2023) 23
Figure 6.6 Site and selected WHT packer test Lugeon value estimates versus test midpoint elevation 26
Figure 6.7 Tammetta and Hawkes (2009) hydraulic conductivity estimates from packer testing in the Sydney Basin 28
Figure 7.1 Class III/IV/V Hawkesbury Sandstone from borehole BH10A 34
Figure 7.2 Class I/II Hawkesbury Sandstone from boreholes BH10A (left) and BH11 (right) both above and below proposed BEL 35
Figure 7.3 Horizontal shear zone in the Hawkesbury Sandstone between 33.0 and 36.4 m depth in BH10A, about 12 m below the planned basement (between about RL 41.5 m AHD and RL 38.1 m AHD) 36
Figure 7.4 Horizontal shear zone in the Hawkesbury Sandstone between about 34.5 and 36.8 m depth in borehole BH5 at the '88' development in St Leonards 36
Figure 7.5 Model domain, no-flow cells, constant head boundary 38
Figure 7.6 Model domain, no-flow cells, constant head boundaries and model topography 39
Figure 7.7 Numerical groundwater flow model layering oriented north – south (right to left) through the model and site 41
Figure 7.8: Initial pre-development modelled groundwater levels (left) and groundwater levels estimated by Coffey from groundwater monitoring wells in the southern portion of the site (right) 42

Figure 7.9 Modelled groundwater level drawdown at the end of construction (24 months) 47
Figure 7.10 Modelled steady-state groundwater level drawdown (after 100 years of operation) 48

List of appendices

Appendix A Geotechnical Factual Report
Appendix B Proposed Development Drawings
Appendix C Tetra Tech Coffey Report
Appendix D Survey Plans
Appendix E Well Development Records
Appendix F Hydraulic Conductivity Testing

1 Introduction

1.1 Overview

This Groundwater Impact Assessment has been prepared by WSP Australia Ltd (WSP) for Berry Road Development Pty Ltd (BRD) for its planned residential development fronting Park Road, St Leonards, New South Wales. It was commissioned by Mr David Zhao of BRD on 17 March 2023 and prepared in accordance with:

(i) proposed scope of work and terms and conditions of WSP proposal No. PP201997-WSP-SYD-WAT-PRP-00001 Rev1 dated 17 March 2023, and

(ii) WSP project fee variations 01 (dated 16 May 2023) and 02 (dated 30 May 2023).

1.2 Objective

The objective of this Groundwater Impact Assessment is to estimate the likely long-term groundwater impacts that may eventuate at the planned development. This information will allow consideration of the effects of a drained basement.

1.3 Scope of work

The scope of works undertaken as part of the Groundwater Impact Assessment included the following.

- Inspection of the site and surrounds to collect information relevant to the planned scope of work.
- Drilling of five hydrogeological investigation boreholes (identified as BH9, BH10A, BH10B, BH11 and BH12) at selected locations in the northern portion of the site (refer to Appendix A).
- Performance of in situ hydraulic ('packer') tests in each of the 'deep' boreholes (i.e., those drilled to depths below the basement floor elevation) drilled at the site by WSP, namely BH9, BH10A, BH11 and BH12.
- Installation of five groundwater monitoring wells surrounding the existing basement excavation at the site as detailed in Section 5; these wells are in addition to those installed by Coffey in the southern portion of the site.
- Development of each of the monitoring wells installed at the site by WSP.
- Monitoring of groundwater levels in selected groundwater monitoring wells at the site.
- Collation and consideration of all geological and hydrogeological information from the southern portion of the site as documented by Coffey.
- Development of a three-dimensional (3D) groundwater flow model as detailed in Section 0.
- Preparation of this Groundwater Impact Assessment.

1.4 Terminology

Throughout this GIA, reference has been made to those rock descriptions presented in Pells et al. (2019) when describing ground conditions – in particular that of the Hawkesbury Sandstone – at the site. These descriptions, which are often referred to as the 'Pells system' in this GIA, were developed for foundation assessments within Sydney and is based on unconfined compression test strength of a saturated substance (i.e., intact sandstone or shale), defect spacing and percentage of seams within a defined vertical interval of the near-horizontal bedded rock. Whilst this system does not focus on groundwater characteristics and their variations within the Hawkesbury Sandstone, it does focus on rock

substance properties and defects (namely joints and bedding), such that it is not unreasonable to allocate mass hydraulic conductivity values into the respective classes. It is also reasonable to make assessments of total porosity and residual water content, hence giving drainable storage. The classification system also provides guidelines for mass Young's Modulus for each Class. As such, experience applying this system at work sites in Sydney indicates there is often a good relationship between Pells classes and the broad hydraulic characteristics of the Hawkesbury Sandstone (and accompanying Ashfield Shale) and that adopting this system can be useful in describing rock types and likely geological and hydrogeological conditions at a site.

1.5 Abbreviations

Abbreviations used within this GIA are summarised below.

ABBREVIATION	DEFINITION
2D / 3D	2/3 dimensional
AHD	Australian Height Datum
AIP	(New South Wales) Aquifer Interference Policy
ASS	Acid-sulfate soil
BEL	Basement excavation level
BoM	Bureau of Meteorology
BRD	Berry Road Developments Pty Ltd
cm	Centimetre
CDFM	Cumulative rainfall deficit from mean
DPE	Department of Primary Industries – Environment
EPA	(NSW) Environment Protection Authority
GDE	Groundwater Dependent Ecosystems
g/L	Grams per litre
GIA	Groundwater Impact Assessment
GWL	Groundwater level
K_h	Horizontal hydraulic conductivity
K_v	Vertical hydraulic conductivity
Km	Kilometre
L	Litre
LCMC	Lane Cove Municipal Council
LOP	Level of protection

ABBREVIATION	DEFINITION
Lugeon	Unit of permeability; 1 Lugeon is approximately equivalent to 1 x 10^{-7} m/sec.
M	Mega (i.e. 10^6)
m	Metre
MGA	Map grid Australia
m AHD	Metres above Australian height datum
m bgl	Metres below ground level
mg/L	Milligram per litre
mm	Millimetres
NSW	New South Wales
pH	Hydrogen potential (negative 10-base logarithm of the positive hydrogen ion concentration)
ppm	Parts per million
RL	Reduced level
SCBGS	Sydney Central Basin Groundwater Source
TfNSW	Transport for New South Wales
TDS	Total dissolved solids
TRH	Total recoverable hydrocarbons
µg	Micrograms
µS	Micro-Siemens
WCX	WestConnex project in Sydney
WHT	Western Harbour Tunnel project in Sydney
WSP	Water Sharing Plan
WSP	WSP Australia Pty Ltd

2 Basement configuration

The proposed development consists of the demolition of the existing site structures and construction of four separate residential structures between 7 and 12 storeys in height. A combined basement structure will be constructed beneath the towers which will vary between 2 (at the south part of the site) to 5stories below ground level (at the north). This will include excavations up to about 20m below ground level (55m AHD) in the northern part of the site.

Based on the estimated low groundwater inflow to the planned basement (detailed in Section 8 of this GIA), it is proposed to develop the sub-surface car park as a drained basement. The basement is currently planned as a split-level basement with a bulk excavation level of 55.10 m AHD on the northern side (known as Area 22) and 53.95 m AHD on the southern side (Area 23) of the development.

No active dewatering will be carried out during project construction or occupancy. Rather dewatering and depressurisation of the Hawkesbury Sandstone aquifer will occur via the passive seepage of groundwater into the drained basement during both construction and operation, with this groundwater collected in drainage systems and pumped from the excavation. Discharge of any collected seepage will be disposed of in an appropriate manner.

BRD has informed WSP that the shoring pile design is generally based on piles with toe levels above the excavation level; this is conditional on the depth of the self-supporting sandstone. Piles in the southern portion of the site will likely need to found 2 to 3 m below the bulk level given rock is expected to drop off at this end of the site as detailed in Appendix B.

Construction of the development is planned for between 20 and 24 months. Excavation of the basement will occur in the first two to three months of construction.

Drawings showing the planned development are shown in Appendix B

3 Legislative considerations

The following NSW state legislation, policies, and guidelines are applicable to the planned development and have been considered during the preparation of this Groundwater Impact Assessment.

- Water Management Act (2000) and Water Act (1912).
- Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources.
- NSW Aquifer Interference Policy (NOW, 2012).
- Risk Assessment Guidelines for Groundwater Dependent Ecosystems (NOW, 2012).
- NSW Wetlands Policy (2010).
- NSW State Groundwater Policy Framework Document (1997).
- NSW State Groundwater Quality Protection Policy (1998).
- NSW State Groundwater Dependent Ecosystems Policy (2002).
- NSW Water Extraction Monitoring Policy (2007).

4 Licencing requirements

Dewatering during construction will require a water access licence to account for the groundwater inflow to the basement, since it is greater than 3 ML/year. As such BRD will need to purchase groundwater entitlement from the Sydney Basin Central Groundwater Source.

The water access licence must be obtained prior to the commencement of dewatering. Predicted maximum long-term groundwater inflows to the planned drained basement during construction since such estimates are more than 3 ML/year.

Predicted maximum long term groundwater inflows to the planned drained basement during operation of the development are expected to be less than 3 ML/year. As such this development could be considered as a 'minor aquifer interference activity' which are generally exempt from the full extent of the Water Management Act and therefore may not require a licence, as presented in WaterNSW's Fact Sheet titled "Water access licence exemption for aquifer interference activities taking 3 ML or less of groundwater per year". This fact sheet includes a list of common aquifer interference activities to which the exemption may apply, one of which is the 'ongoing dewatering of basements'. Ultimately the decision as to whether a licence will be required for the long-term passive collection of groundwater seepage in the planned basement will be at the discretion of WaterNSW.

5 Hydrogeological investigations

5.1 Overview

Two rounds of groundwater investigations have been carried out at the site. The first was carried out by Coffey in 2018. This included the drilling of ten boreholes (identified as BH1 to BH9 inclusive and BH7A) across the southern portion of proposed development to characterise the site's geotechnical and hydrogeological conditions. The work included installation of five groundwater monitoring wells in boreholes BH1, BH3, BH5, BH7A and BH9 to manually measure and monitor groundwater levels, the performance of rising-head ('slug') tests in three wells (BH1, BH7A and BH9), and the collection of groundwater quality samples from wells BH1 and BH9. It should be noted that Coffey's investigations were carried out in the southern portion of the site only, with no investigations in the northern half of the site.

The second round of groundwater investigations at the site was carried out by WSP in May and June of 2023. These investigations were carried out to collect additional data (above that collected by Coffey) required to comply with most data requirements presented DPE's publication titled *minimum requirements for groundwater investigations and reporting for building and construction sites*, and were focused on the northern portion of the site where the planned basement will be deepest. These investigations comprised the following:

- Drilling of five hydrogeological investigation boreholes (identified as BH9, BH10A, BH10B, BH10, BH11 and BH12) at selected locations at the site (**Error! Reference source not found.**). This is considered a sufficient number of addition geotechnical and hydrogeological investigation locations to supplement those boreholes drilled by Coffey in the southern portion of the site to allow a reassessment of likely groundwater inflows to and groundwater impacts surrounding the planned development.
- Performance of in situ hydraulic ('packer') tests in the boreholes BH9, BH10A, BH11, and BH12 at, across and below the planned basement excavation level (BEL).

  These tests were carried out to assess the hydraulic conductivity (K) of the Hawkesbury Sandstone at the site, including expectations of generally lower hydraulic conductivities with depth (as observed on numerous infrastructure and development projects in Sydney) and – where appropriate – support the use of lower hydraulic conductivity values in the revised numerical groundwater inflow and impact assessments presented in this GIA.
- Geophysical imaging of boreholes BH9 and BH10A using both the optical televiewer (OTV) and acoustic televiewer methods (ATV) for geological and geotechnical ground characterisation purposes.
- Installation of groundwater monitoring wells in each of those boreholes drilled by WSP at the site.
- Development (i.e., cleaning) of the newly installed groundwater monitoring wells.
- Manual measurement of groundwater levels in all wells at the site during a single monitoring event.
- Installation of automated water pressure transducers and data loggers ('water level loggers') in three groundwater monitoring wells at the site and the monitoring and the recording of groundwater levels in these wells using these loggers; water level loggers were installed in BH10A, BH11 and BH9, the latter installed by Coffey and located at the southern end of Park Road.

Further description of each of the above tasks comprising WSP's site investigations are discussed in the following sections of this GIA. A copy of Coffey's report detailing its scope of work and all data collected during these investigations is presented in Appendix C.

5.2 Drilling

Boreholes BH9, BH10A, BH11 and BH12 were drilled under WSP's supervision using the HQ^3 rotary diamond drilling ('coring') technique. Each of these boreholes were drilled to depths below the planned BEL, with BH10A drilled 16 m beneath the planned BEL to assess deep foundation geotechnical and hydrogeological conditions.

Core recovered from each of these boreholes logged in accordance with Australian Standard *AS 1726 2017 Geotechnical Site Investigations.* All drilling activities were also supervised by a Geotechnical Engineer and/or Hydrogeologist from WSP to ensure appropriate classification of geological units for hydrostratigraphic differentiation as required by DPE.

The borehole for BH10B was drilled using the wash-boring technique. The geological information from the adjacent borehole BH10A, which was drilled about 2 m from BH10B, was used to inform both:

- the depth of this borehole, which was designed to assess and characterise the presence of any 'shallow' groundwater in the residual soil and weathered zone of the underlying Hawkesbury Sandstone, and
- design of the well in this borehole.

Boreholes were located to allow appropriate assessment of geological, geotechnical, and hydrogeological conditions at the site in light of:

- the dimensions of the planned basement, with an emphasis on its northern wall which will be up to 20 m deep
- location of former geotechnical boreholes drilled and groundwater monitoring wells installed in the southern portion of the site by Coffey
- location of existing public and private infrastructure at, and surrounding, the site, and
- current and expected future land use (so as to best avoid damage to these wells, thereby allowing them to be used for any ongoing monitoring post completion of this Groundwater Impact Assessment).

Drill cuttings and drilling fluid were stored on site during the investigation and subsequently disposed of upon completion of the site works.

Borehole locations are summarised in Table 5.1. Copies of the borehole logs for each of those boreholes drilled at the site by WSP are attached in the Geotechnical Investigation report included in Appendix A borehole locations are also shown in Appendix A. Survey plans showing these borehole locations and those drilled by Coffey are shown in Appendix D.

Table 5.1 WSP Borehole location rationale

BOREHOLE	LOCATION	DEPTH	TARGETED GEOLOGICAL FORMATION	BOREHOLE GEOPHYSICAL IMAGING
BH9	Western portion of northern boundary of the site where the planned basement will be 20 m deep.	26.2 m	Hawkesbury Sandstone – predominantly Class I/II	Yes
BH10A	Eastern portion of the northern boundary of the site where the planned basement will be 20 m deep.	36.5 m [Complies with maximum investigation depth required by DPE, 2022.]	Hawkesbury Sandstone – predominantly Class I/II	Yes
BH10B		5.5 m	Residual soils and weathered zone of the underlying Hawkesbury Sandstone	--
BH11	Western portion of the northern half of the site.	26.4 m	Hawkesbury Sandstone – predominantly Class I/II	--
BH12	Eastern portion of the northern half of the site.	25.2 m	Hawkesbury Sandstone – predominantly Class I/II	--

Notes: † metres Australian height datum
‡ metres below ground level

5.3 In-situ borehole ‘packer’ testing

In-situ water pressure (‘packer’) tests were carried out in boreholes BH9, BH10A, BH11 and BH12 (i.e., in each of those deep boreholes drilled under the supervision of WSP and screened across and below the planned BEL in the northern, and ‘deepest’, portion of the site) in line with the procedure described in ISO 22282 3 (2012) (*Geotechnical investigation and testing – Geohydraulic testing – Part 3: Water pressure tests in rock*). Tests were conducted across test intervals specified by a Principal Hydrogeologist. Locations were selected based on a review of core photographs to target:

(i) geological features such as joints and shears observed in drill core recovered from the geotechnical boreholes, and

(ii) those elevations immediately above, across and below the planned BEL.

Prior to undertaking the water pressure tests, each borehole was flushed with clean water and the test interval isolated with either a ‘single’ gas-inflated packer or ‘straddle’ gas inflated packers. The packer(s) and the gas line were connected to the system setup at the surface and lowered through the drill stem to the designated depth and inflated to a pre-determined pressure (based on the depth of the test and the static water level of the formation). The packers were then inflated to pressures nominated by WSP’s Geotechnical Engineer.

Groundwater levels were measured in each borehole immediately prior to testing using an electric ‘dipper’ tape. It is recognised, however, that in some instances, groundwater levels observed and used for estimating water injection pressures may not be representative of actual groundwater levels and pressures in the test formation.

Testing involved pumping water into the designated test section at three ascending pressures, followed by two decreasing water pressures. Field engineers recorded readings of water flow at regular time intervals, each typically two-minutes in duration. The maximum water pressure used during each test was typically about 75% of the vertical rock pressure

(identified as 'Pmax') at the selected test depth (so as not to fracture the formation), with test water injection pressures starting at 25% of Pmax, and stepping up to 50% and 75%, then back down. All test pressures were estimated using an assumed rock density of 22 kN/m^3 and water density of 10 kN/m^3.

Water injection rates and pressures were regulated using an adjustable bypass valve on the surface. The rate of water flow into each test section was measured using an analogue flow meter connected to the water supply line and cross checked with volume changes from a calibrated drum. Water injection pressures were monitored using a water pressure gauge also fitted to the water supply line.

During testing, all equipment and the borehole collar were regularly checked for leakage. No leakage was observed during testing. All equipment for the water pressure tests was supplied by Legion (Numac) Drilling Pty Ltd.

Test results were interpreted using the methods presented by Houlsby (1976). During interpretation, the geological log and core photographs of each test interval were reviewed to assess whether interpreted Lugeon values (which are an estimate of the average – i.e. bulk – hydraulic conductivity of a rock mass based on Darcy's law and where 1 Lugeon is equivalent to 1 x 10^{-7} m/sec) are consistent with values expected for the test interval (based on professional judgement and past experience), particularly for those test intervals where low or negligible flow was observed..

Where rock hydraulic conductivity values are less than 1 Lu (i.e. less than 10^{-7} m/sec), adopted Lugeon values are based on the averages of values obtained from the flow meter readings and drum measurements to overcome potential inaccuracy associated with solely relying on the flow meters.

For all tests, friction losses in the hoses and drill pipe were assumed to be negligible given flows during testing were similarly negligible.

5.4 Groundwater monitoring well installation

Groundwater monitoring wells were installed in those boreholes drilled at the site under WSP's supervision to allow assessment of hydrogeological conditions at the site as required in DPIE (2021). Each of these wells will also form part of the preferred groundwater investigation and monitoring system for the development moving forward.

Groundwater monitoring wells were designed considering:

- ground conditions encountered at the location of all geotechnical boreholes drilled at the site, albeit with a focus on any observed fracture zones encountered during drilling and results of the packer tests carried out in these boreholes
- proposed basement excavation depth of the planned development, and
- expected depths and intervals of groundwater inflows to the planned excavation and basement.

Before installation of the monitoring wells, any drilling cuttings and water in the boreholes were flushed out using clean water. Groundwater monitoring wells were constructed using:

- 60 mm external diameter (50 mm internal diameter) Class 18 screw threaded unplasticised polyvinyl chloride (uPVC) casing
- 60 mm external diameter (50 mm internal diameter) Class 18 screw threaded uPVC well screen with 0.4 mm aperture machine cut slots
- 50 mm internal diameter Class 18 uPVC end caps
- 1 – 2 mm washed and clean quartzose sands for the gravel pack
- ¼ inch sodium coated *Pel Plug™ TR30* pellets comprising compressed and coated bentonite for seals, and
- cement bentonite powder grout seal to backfill the remaining portion of the boreholes.

uPVC solvent cement was *not* used in the construction of any wells.

All wells were also completed with gatic covers flush with ground level.

Copies of the construction diagrams for these wells are included in Appendix A whilst key features are summarised in Table 5.2.

Table 5.2 Groundwater monitoring well construction summary – WSP wells

WELL FEATURE	GROUNDWATER MONITORING WELL				
	BH9	BH10A	BH10B	BH11	BH12
Easting (metres east)[#]	332,667.2	332,651.1	322,650.5	322,327.6	332,639.8
Northing (metres north)[#]	6,255,665.9	6,255,657.9	6,255,657.0	6,255.622.3	6,255,620.8
Top of well casing elevation (m AHD[†])	71.7	74.2	74.2	69.9	69.8
Well head recess (m)	0.1	0.1	0.1	0.1	0.1
Well cover type	Gatic cover	Gatic cover	Gatic cover	Gatic cover	Gatic cover
Borehole depth (m bgl[‡])	26.2	36.5	5.5	26.4	25.2
Well depth (m bgl)	22.0	25.5	5.5	16.6	23.7
Screen interval (m bgl)	16.0 – 22.0	19.5 – 25.5	1.5 – 5.5	10.6 – 16.6	17.7 – 23.7
Screened lithology	Hawkesbury Sandstone – fresh with only minor fracturing	Hawkesbury Sandstone – fresh with horizontal shear zone in lower 3.4 m	Residual soils + weathered Hawkesbury Sandstone	Hawkesbury Sandstone – fresh with only minor fracturing	Hawkesbury Sandstone – fresh with only minor fracturing
Upper bentonite seal (m bgl)	12.0 – 15.0	16.0 – 19.0	0.8 – 1.4	9.5 – 6.5	12.5 – 16.7
Lower bentonite seal (m bgl)	--	26.0 – 29.5	--	19.5 – 17.1	--

Notes: # information provided by Berry Road Developments Pty Ltd
[†] metres Australian height datum
[‡] metres below ground level

In addition to the above, five groundwater monitoring wells, installed by Coffey, are located in the southern portion of the site (Section 5.1). With the exception of Coffey well BH9, all are located within the proposed excavation footprint of the development, whilst all were screened over 'long' sections comprising both weathered and fresh Hawkesbury Sandstone. Details of these wells are summarised in Table 5.3 whilst additional details including copies of the geological logs, corebox photographs and construction diagrams for these wells are presented in Appendix C.

Table 5.3 Groundwater monitoring well construction summary – Coffey wells

WELL ID	EASTING (METRES EAST)	NORTHING (METRES NORTH)	TOP OF WELL CASING ELEVATION (M AHD)	TOP OF SCREEN (M BELOW GROUND LEVEL)	BASE OF SCREEN (M BELOW GROUND LEVEL)
BH1	332,594	6,255,594	66.20	4.02	10.02
BH3	332,664	6,255,581	66.20	4.08	10.08
BH5	332,632	6,255,546	60.15	1.00	10.00
BH7A	332,585	6,255,514	56.85	4.26	10.26
BH9	332,667	6,255,518	60.16	4.48	10.48

5.5 Well development

Development of those groundwater monitoring wells installed as part of WSP's site investigation scope is currently being carried out in accordance with the recommendations outlined in AS/NZS 5667.11:1998 "*Water Quality – Sampling" and "Minimum construction requirements for water bores in Australia*" (NUDLC, 2012). Development involves the purging of water and water entrained sediment (if present) and drilling mud from individual wells using the 'hand bailing' technique; individual single-use high density polyethylene (HDPE) bailers were used for each well.

Development is continuing at the time of the preparation of this GIA. Groundwater level recovery in all wells has been observed to be very slow, typically less than 5 m of head recovery after 4 days of complete water removal, providing an insight to the hydraulic properties of the Hawkesbury Sandstone at this site and possible groundwater inflow rates to the planned basement.

Copy of the well development field records to date are provided in Table 5.2. Measurements of groundwater physio-chemical parameters (namely fluid pH, electrical conductivity, oxidation – reduction potential and temperature) at the time of development are shown on these forms.

5.6 Groundwater level monitoring

Groundwater levels were measured by both Coffey and WSP in those groundwater monitoring wells installed in the southern portion of the site using an electric water 'dipper' meter. Four monitoring events have been carried out at the site, one in 2018 following the installation of those Coffey wells in southern portion of the site, and three events in 2023 in the same wells.

Water-pressure transducers and data loggers (colloquially known as 'water level loggers') have also been installed in the following groundwater monitoring wells by WSP:

- BH10A in the north-eastern corner of the site
- BH11 in the western portion of the site, and
- BH9 (installed by Coffey) at the southern end of Berry Road and adjacent to River Road.

Water level loggers were installed in the above wells in May 2023, with non-vented level loggers used in all wells; a barometric logger was installed in groundwater monitoring well BH10A to allow barometric compensation of pressure data when estimating groundwater levels from this data.

All data loggers were set to record water pressure (in kilopascals or metres head of water above the reference point of the instrument) and temperature (as degrees Celsius) at 1-hour intervals.

6 Site Setting and Characterisation

6.1 Information sources

Information used to develop the conceptual hydrogeological model was obtained primarily from the geotechnical and hydrogeological investigations carried out surrounding the site by WSP and detailed in this Groundwater Impact Assessment. Additional information was also obtained from the following sources:

- A preliminary Dewatering Management Plan (DMP) prepared by Tetra Tech Coffey (Coffey, 2023) for the development. This DMP was based on geotechnical and hydrogeological investigations carried out in the southern portion of the site in 2018 with salient points (according to Coffey) of the DMP included the following.
  - The (southern portion of the) site is underlain by Hawkesbury Sandstone which is variably weathered, although with the degree of weathering and fracturing decreasing with depth.
  - Groundwater in the southern portion of the site is typically encountered at depths of 3 to 5 m below ground level (noting no groundwater wells were installed in the northern portion of the site, including in either the Ashfield Shale or Mittagong Formation).
  - Groundwater flow is generally from north to south across the site (i.e., from the Pacific Highway in the north towards Berrys Creek to the south) in line with the local topographic setting.
  - Estimates of hydraulic conductivity of the uppermost 10 m of the Hawkesbury Sandstone, as measured from falling head slug tests carried out in wells BH1, BH7A and BH9 at the site, ranged between about 6.0×10^{-8} m/sec and 1.5×10^{-7} m/sec. No hydraulic testing was carried out in the Hawkesbury Sandstone below this depth.
- Geological maps published by the Geological Survey of New South Wales (which was part of the then NSW Department of Minerals and Energy).
- Acid sulphate soil maps published by the (now former) NSW Land and Water Conservation [now the NSW Department of Planning and Environment].
- Aerial photographs / satellite imagery hosted on the NSW Government *SIX Maps™* spatial services website and *Google Earth™*.
- Information from the NSW Government SEED (sharing and enabling environmental data in NSW) online system.
- An inspection of the site and surrounding area by a Principal Hydrogeologist from WSP.
- WSP 'internal' reports documenting geological, geotechnical, and hydrogeological conditions at a number of sites at and around St Leonards, including the '88' development fronting the Pacific Highway at St Leonards about 350 m east of the site.
- Discussions with BRD.

6.2 Topography

The site is located on the lower slopes of a southerly sloping hill situated between the Pacific Highway in the north and River Road in the south. The northern boundary of the site is situated at an elevation of about 74 m AHD and the southern boundary between about 57 and 54 m AHD, with higher elevations in the southwestern corner of this boundary.

The highest topographic feature in the area is an east-west oriented ridgeline defined by the Pacific Highway. This is situated at an elevation of about 85 m AHD with elevation increasing to the west.

Berrys Creek, the most notable surface waterway in the area, is located about 200 m southeast of the site. This waterway is largely undeveloped to the south of the site (although has been reengineered and aligned along its upper reaches in the catchment) and flows into the Gore Cove reserve wetland and Berrys Bay (Sydney Harbour) about 750 m south of the site.

6.3 Surrounding land use and infrastructure

The site is situated in a primarily residential area. Known land-uses and infrastructural features surrounding the area are summarised below:

To the north – the site is immediately bound to the north by single and multi-storey residential dwellings fronting Park and Berry Roads. The Pacific Highway is located about 150 m north of the site.

To the east – the site is immediate bound to the east by Berry Street. Single and multi-storey residential dwellings fronting Berry Road and Holdsworth Avenue are located further to the east.

To the south – the site is immediately bound to the south by River Road. Single and multi-storey residential dwellings fronting River Road and Wilona Avenue are located further to the south.

To the west – the site is immediate bound to the west by Park Road. Single and multi-storey residential dwellings fronting Park Road and Portview Road are located further to the west.

6.4 Rainfall and evaporation

Rainfall data has been obtained from the closest BOM weather stations at Sydney Botanic Gardens (BOM Station 66006), Observatory Hill (BOM Station 66062) and Mosman Council (BOM Station 66184). The rainfall record and reliability of data for each of these stations are provided in Table 6.1, with average monthly rainfall provided in Table 6.2

Table 6.1 Groundwater monitoring well construction summary

STATION	RAINFALL RECORD	NUMBER OF INCOMPLETE YEARS OF DATA (EXCLUDING 2022)
66006 (Botanic Gardens)	137 years (1885 to present)	14 (10%)
66062 (Observatory Hill)	163 (1858 to 2023)	4 (2%)
66184 (Mosman Council)	22 years (1984 to 2007)	12 (55%)

Table 6.2 Average rainfall (mm) across the monitoring period (excluding incomplete data sets)

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
66006	102.8	117.5	138.1	120	119.1	135.6	96.8	85.3	67.9	75.5	85.6	82.4	1230
66062	101.2	119.3	131.6	126.5	117.4	133.1	96.3	80.2	68.1	76.7	83.8	77.1	1213
66184	110.3	139.4	95.7	147.6	123.3	122.8	77.4	76.1	63.0	79.6	111.0	91.8	1232

Long-term cumulative residual rainfall plots provide an indication of the broad scale trends in rainfall patterns. Periods of below average rainfall are represented as downward trending slopes while periods of above average rainfall are represented as upwards trending slopes. Rainfall can act as a primary recharge component for groundwater sources and downward trending slopes identified in climate graphs may be considered as ‘drying’ trends with associated potentially

lower groundwater levels. In comparison, upward trending slopes can be considered as 'wetting' trends with potentially associated higher groundwater levels.

Observatory Hill (BOM Station 66062) has the longest and most complete rainfall record with completed data for 159 years out of 163 years of observation and therefore has been selected to show large scale climatic trends over the length of its monitoring as a cumulative departure from mean (CDFM) plot (Figure 6.1). The CDFM rainfall chart suggests above average rainfall has occurred in Sydney since 2021, with this exemplified by the highest annual aggregate rainfall of 2,530 mm occurring in 2022, suggesting groundwater levels will be at or close to their highest elevation at the time of this assessment.

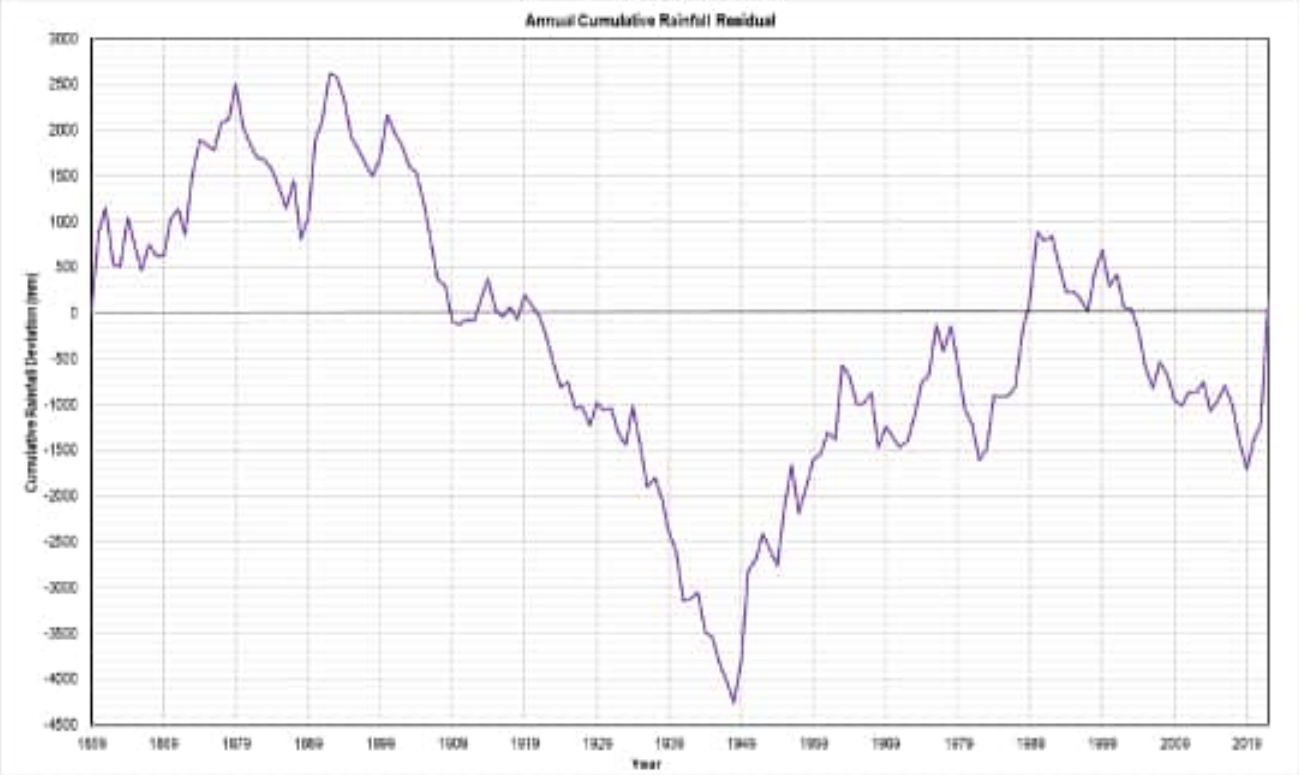


Figure 6.1: Annual residual rainfall and cumulative deviation from average for BOM Station 66062 (Observatory Hill)

Long-term changes in daily rainfall across NSW were modelled by Ji et al. (2016) on behalf of the NSW Department of Primary Industries – Water. Projected changes in rainfall were an increase of up to 5% of mean annual rainfall along the alignment of the Project by 2030, and an increase of up to 10% by 2070.

Evapotranspiration data for Observatory Hill (BOM Station 66062) are provided in Table 6.3. Evapotranspiration data is only available from 2009 to present, noting that no data was recorded or made available between April 2018 – July 2020, inclusive. Incomplete data was not included in the climatic statistics discussed below. Average annual evapotranspiration for the monitoring period is 879.1 millimetres per annum.

Table 6.3 Mean monthly evaporation rates (mm) between 2009 and 2022

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
66062	132.7	99.7	83.2	55.6	33.6	20.5	24.0	41.1	69.6	100.8	115.3	130.4

Long-term changes (up to 2080) in daily areal potential evapotranspiration (APET) across NSW were also modelled by Ji et al. (2016). Model projections suggest an increase of APET between 1.5 and 2% may occur at the site by 2030, and an increase between 5.0 and 5.5% may occur by 2070.

6.5 Geological setting

6.5.1 Background

A review of the 1:100,000 scale Sydney Geological Series Sheet 9130 (DMR 1983) indicates that the site is primarily mapped with Hawkesbury Sandstone as the underlying formation. This map suggests the Ashfield Shale and possibly the Mittagong Formation may occur in the northern portion of the site, possibly extending to distances of about 25 m from the northern wall of the planned basement, however neither was encountered in any of the boreholes drilled in the northern portion of the site. Both though are expected to be located to the north (upgradient) of the site.

Hawkesbury Sandstone is a medium to coarse-grained sandstone which consists of three main units, namely: massive sandstone facies; cross-bedded or sheet facies; and shale/siltstone interbedded facies. The sheet facies make up about 70 per cent of the unit with primary beds that range in thickness from less than 0.5 m to greater than 5 m but generally occur between one to 2 m.

Secondary structural features such as joints, fractures and faults are also present. The overall dip of sandstone bedding in the project area is generally horizontal to 5°, with cross-beds dipping 20°. Jointing is ubiquitous throughout the Hawkesbury Sandstone (as well as the Ashfield Shale). Published data indicates regional jointing in the Sydney area occurs as an orthogonal pair of sub-vertical sets trending approximately north-northeast and east-southeast (Bertuzzi and Pells, 2002), ranging from individual joints to closely spaced swarms. Somewhat typical fracture sets observed in the Hawkesbury Sandstone are shown in Figure 6.2.



Figure 6.2 Typical Class I / II Hawkesbury Sandstone outcrop north of Sydney

The sandstone weathers to a clayey sandy soil, typically up to 1 to 2 m in depth. Within the upper 10 m of the profile a duricrust may be present where iron cementation has caused the development of ferricrete or coffee rock, or similarly silica cementation may cause the development of silcrete. Deep orange, red and ‘rust’ brown iron staining is characteristic of the Hawkesbury Sandstone that can be concentrated along water bearing fractures and discontinuities.

Pells (1993) lists the following significant geological structures in Hawkesbury Sandstone:

- Near horizontal and undulating bedding planes, often comprising sandy clay seams
- Undulating erosional bedding surfaces often contain shale breccia
- Cross (current) bedding

- High angle faults and low angle thrust faults which typically step along bedding
- Near vertical joints, and
- Volcanic dykes.

With the exception of volcanic dykes and high-angled faults, all of those features listed in the above bullet points are evident in the core samples recovered from the boreholes drilled at the site; reference to the 1:100,000 scale Sydney Geological Series Map Sheet and published references for the nearby Western Harbour Tunnel project, suggest there are no regionally significant vertical fracture zones – such as faults or joint swarms – passing through or in the vicinity of the site.

Bedding surfaces in the Hawkesbury Sandstone in this part of the Sydney Basin typically dip gently towards the south at up to five degrees. Locally, dips may increase, and where present, are generally associated with depositional channel structures. Minor siltstone bands or siltstone breccia zones frequently occur in the base of these channel structures. Primary bedding planes are generally spaced between 0.5 and 3 m thick and may be tight to open. Bedding related structures can include clay infills, crushed seams, in-situ weathering, iron staining and limonite coating.

Joint spacing in the sandstone varies according to stratigraphy, proximity to near-surface weathering and proximity to major geological structures. Assessment of a more regional spread of geotechnical data, including that from several state-significant infrastructure projects constructed in the Hawkesbury Sandstone, including the nearby Western Harbour Tunnel (which will pass beneath nearby Balls Head and North Sydney), the nearby Sydney Metro Northwest project (which passes beneath North Sydney, Crows Nest and St Leonards to the north of the site), the WestConnex M4-M5 Link and the Sydney Metro City & Southwest project, indicates jointing within the Hawkesbury Sandstone is typically widely spaced (somewhat between 2 to 6 m). More widely spaced jointing of up to 25 m also occurs (AECOM, 2015), although localised areas of enhanced sub-vertical joints may also occur, especially for the north-northeast striking set, with spacing from 0.1 m to 0.5 m.

Residual soils derived from Hawkesbury Sandstone are generally of sandy clay or clayey sand compositions that provide limited resistance to natural erosion. As such, the residual soil profile formed from exposed Hawkesbury Sandstone is generally of limited depth (typically less than about 2 m) and are frequently absent or very shallow.

The Ashfield Shale consists of marine deposits made up of clay, silt and sand that has been mildly deformed and has developed into a laminated shale. It is generally a dark grey to black siltstone/mudstone with some minor lamentation (thin alternating layers of siltstone and sandstone). In some parts it may become carbonaceous with variable silt and clay particles throughout.

Structural defects are present in the shale; these include faults, fractures and shears.

Where it outcrops, the shale typically weathers to a stiff to hard clay with medium to high plasticity and the weathered profile generally ranges from 3 to 10 m in depth.

6.5.2 Site Information

Drilling investigations carried out at the site at the site the ground profile comprises three primary intervals, from ‘top to bottom’ namely:

- an upper thin layer, typically between 1 to 4 m thick, of residual soils derived from the in-situ weathering of the Hawkesbury Sandstone
- a moderately to highly weathered and variably fractured interval of Hawkesbury Sandstone (in this case typical of Pells class V, IV and III sandstone) between about 4 and 6 m thick, and
- slightly weathered to fresh, medium to high strength and slightly fractured to unfractured Hawkesbury Sandstone (Pells Class I and II sandstone).

Class I / II Hawkesbury Sandstone was the dominant rock type observed in those boreholes drilled at the site, in particularly those in its northern portion. An example of this type of rock is shown in Figure 6.3.

A fresh, high-strength and low-permeability laminate (siltstone) layer was also encountered in boreholes BH10A and BH11 between elevations of about 44 and 41 m AHD (i.e., between about 10 and 13 m below the basement excavation level of the planned development), whilst the Hawkesbury Sandstone beneath this was highly fractured (sheared), albeit with many of these fracture apertures having high clay contents.

No occurrences of Ashfield Shale were encountered in any of the boreholes drilled at the site, nor was it observed in any of the minor rock outcrops observed either side of Berrys Lane.

A geological cross section oriented north – south through the centre of the northern portion of the site (where the planned basement will be deepest) is shown on Figure 6.4.

Copies of the geological and geotechnical logs for each borehole are presented in WSP's Geotechnical Factual Report (GFR) in Appendix A. Further geological and geotechnical information regarding the core recovered from those boreholes drilled by WSP in the northern portion of the site is also presented in the GFR.

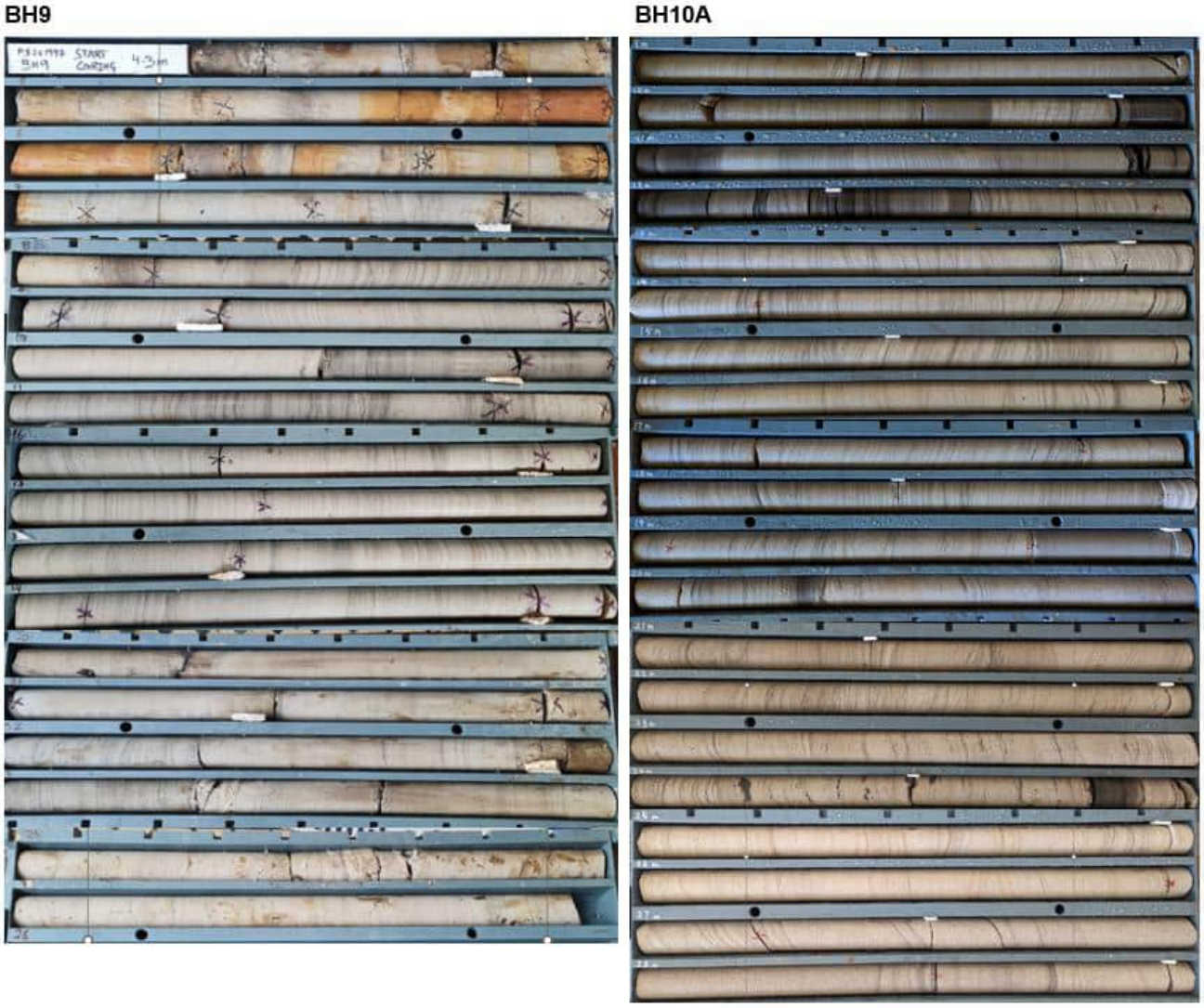


Figure 6.3 Typical high-strength Pells Class I/II Hawkesbury Sandstone in the northern portion of the site.

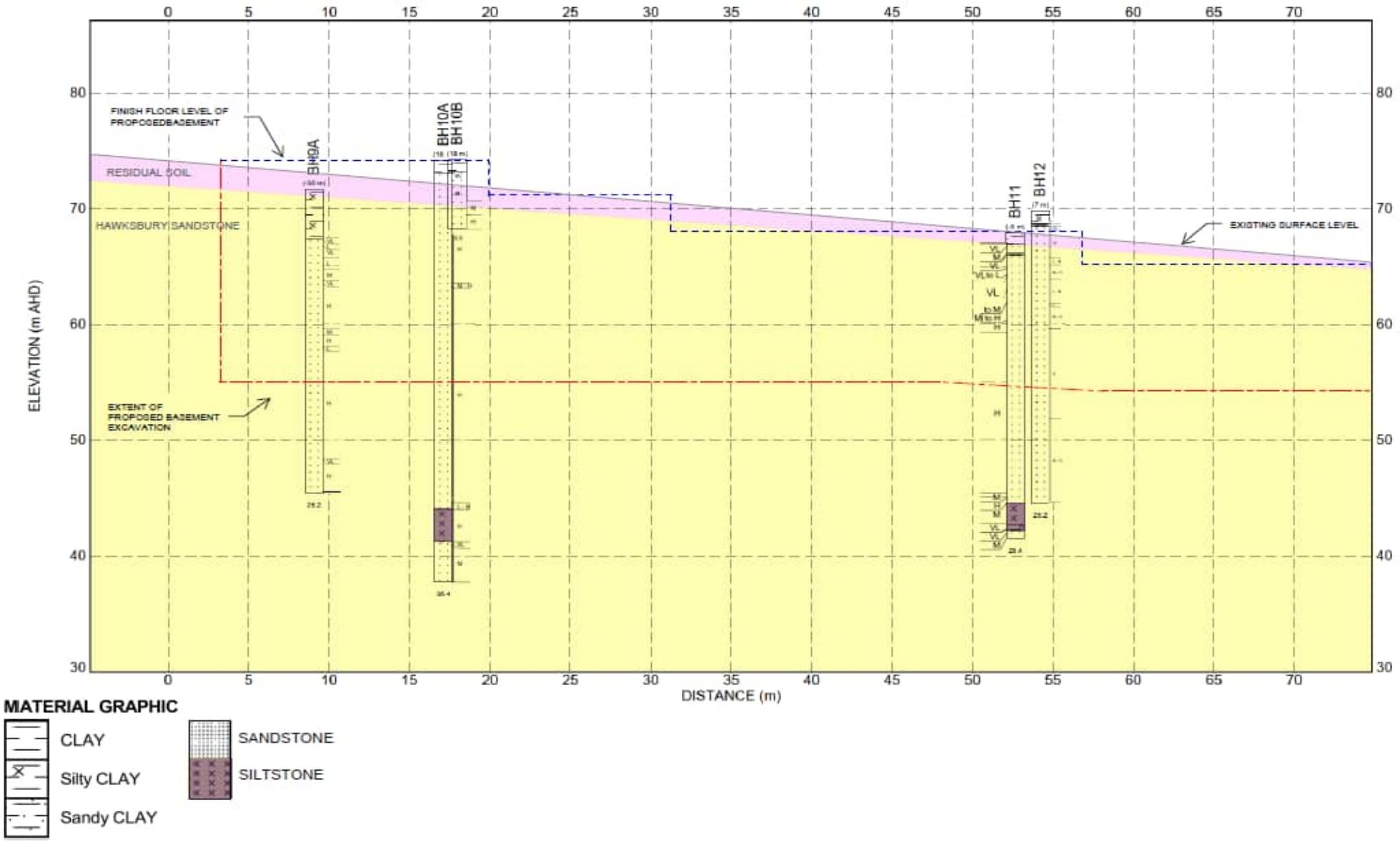


Figure 6.4 Geological cross section oriented north – south through the centre of the northern portion of the site.

6.6 Acid sulfate soils

Reference to (the former) Department of Land and Water Conservation, Acid Sulfate Soil Risk Map for Prospect/Parramatta indicates that the site and surrounds are in an area of no known occurrence of acid sulfate soils.

6.7 Regulated groundwater resources

The Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources divides the Greater Metropolitan Region of the east coast of NSW into 13 groundwater sources, of which this planned development is within the Sydney Central Basin Groundwater Source (SCBGS).

The WSP classifies the SCBGS as a porous rock groundwater source, with the Hawkesbury Sandstone (and nearby Ashfield Shale) hydrostratigraphic units listed as dominant aquifers.

6.8 Regional hydrogeology

The most extensive aquifer at and in the vicinity of the site is the Hawkesbury Sandstone aquifer. This sandstone is an unconfined aquifer at surface and may become increasingly confined with depth due to the highly stratified nature of the formation.

Some units within the Hawkesbury Sandstone exhibit remnant primary porosity, however, groundwater movement is typically controlled by secondary hydraulic conductivity and bedding. The highly stratified nature of the sandstone and the presence of interbedded shales can also result in multiple aquifer and aquitard zones within the sandstone.

McKibbin & Smith (2000) indicate that, in the top 100 m of the Hawkesbury Sandstone, the following characteristics are common.

- Low transmissivity (essentially hydraulic conductivity and saturated thicknesses) which typically decreases with depth (when not in the proximity of former palaeovalleys).
- Comprises vertically layered or stacked (as also documented by McNally & Adams, 2007) with groundwater occurring in discrete horizons.
- Vertical (in this case mostly downward) groundwater flow occurs mostly along sub-vertical fracture joints and fault zones.
- Flow mainly related to joint and bedding defect characteristics; in particular, aperture size and openness, and interconnections between joints, bedding planes and fracture control the lateral and vertical groundwater flow.
- Where the jointing frequency or density are comparatively pronounced (for example in joint swarms, shear zones or near/on dyke contact zones), the potential for preferred groundwater flow is enhanced (Chestnut in Herbert, 1983; Dale et al., 1997; Dale, 2015).
- Fractures within the top 20 m (so in the regolith and underlying transition zone) are generally more open and transmissive (higher hydraulic conductivity) than those in fresher sandstone at depth (Tammetta & Hewitt, 2004).

The Hawkesbury Sandstone is overlain in places by the finer grained unit of the Ashfield Shale and Mittagong Formation, both of which are generally considered to be aquitards.

A summary of the main stratigraphic unit and their roles in the groundwater flow system is summarised below:

Hawkesbury Sandstone

- Primary regional aquifer and an aquifer of moderate importance in the Sydney area.

- Dual porosity aquifer:
  - remnant interstitial porosity which is expected to result in groundwater seepages on any drained project surfaces, and
  - secondary porosity in the form of fracturing which could result in groundwater 'flows' to drained project structures.
- Fractured-rock medium comprising several 'stacked' aquifers (i.e., aquifer system).
- Interbedded shale lenses can provide local or extensive confining layers creating separate aquifers with different hydraulic properties.
- Horizontal hydraulic conductivity (K_h) is typically one to two orders of magnitude greater than vertical hydraulic conductivity (K_v), however in fractures with moderate to high K, K_v may be the same (or higher) than K_h.
- Flow systems typically originate at high elevations and (locally) discharge to Sydney Harbour.
- Generally, hosts fresh groundwater in flow zones above mean sea level, however oxygen-poor and iron and manganese enriched groundwater may be encountered in flow zones below sea level where flow velocities and hydraulic gradients reduced.

Ashfield Shale

- A low-yielding fractured rock aquifer of moderate to low significance throughout the Sydney region.
- Forms an unconfined aquifer at the surface which typically becomes increasingly confined with depth.
- Low transmissivity which typically decreases with depth.
- Consists mostly of low hydraulic conductivity siltstone and laminate with groundwater flow occurring mostly via saturated fractures.
- K_h expected to be one to two orders of magnitude greater than K_v.
- Where present at and around the site, these shale layers may reduce the rate of rainfall infiltration into the Hawkesbury Sandstone.
- Likely source of vertical groundwater flow (downward leakage) to the Hawkesbury Sandstone.
- Groundwater generally of 'poorer' quality than the Hawkesbury sandstone due to its high clay mineral content giving rise to a higher salinity.
- As the shale rock mass tightens below the near-surface zone of stress relief, water movement becomes more restricted.

Hydraulic properties of the Hawkesbury Sandstone exhibit a high degree of anisotropy of varying orientation, providing preferential flow pathways for groundwater. The horizontal hydraulic conductivity (K_h) of the Hawkesbury Sandstone is typically in the order of 5×10^{-7} m/sec to 5×10^{-8} m/sec whilst its horizontal to vertical hydraulic conductivity (K_v) ratio is typically in the range of 10 to 100. Hydraulic conductivity in the Hawkesbury Sandstone is generally expected to decrease with:

- depth due to progressive defect closure and decreased weathering; this will limit the volume of groundwater flow occurring within the deeper Class I/II sandstone, and
- proximity to topographic highs where fracturing, both as a result of (i) regionally significant faulting and shearing, and (ii) bulk rock-mass stress release, which has resulted in much of the near-vertical jointing and near-horizontal bedding plane partings typical throughout the sandstone, is somewhat less pervasive and continuous.

The morphology of the water table is expected to reflect a subdued expression of topography, with groundwater flowing from topographical highs to the north of the site, to the south and ultimately towards Sydney Harbour.

Groundwater recharge at and in the vicinity of the site is expected to occur via:

- direct infiltration of rainfall at all sites, although this is limited by paved surfaces
- infiltration of runoff, with paved surfaces limiting infiltration and directing runoff to areas where it can infiltrate and recharge the aquifers, including via leaky drains, and
- infiltration of rainfall and irrigation water in public open spaces, such as Gore Hill Oval to the north of the site.

At and in the vicinity of the site, residual soils and highly weathered Class IV/V sandstone overlies fresh to slightly weathered (i.e., Class I/II) sandstone and appears to form locally important aquifer zones. Secondary porosity attributes are the dominant groundwater flow mechanisms in this horizon, with groundwater flow directions and velocities directly influenced by these features.

Infiltration from rainfall and other sources percolates through the unsaturated soil profile, through joints and along bedding planes to the water table, recharging the groundwater flow system. Once recharge encounters the water table, groundwater flow is deflected laterally to reflect the topography and hydraulic gradients generally slope in the direction of discharge zones, in this case to the south of the site. Infiltration may also be intersected by low hydraulic conductivity beds (for example residual soils derived from either the Hawkesbury Sandstone and nearby – upslope – Ashfield Shale) that limit vertical downward fluxes and lead to the presence of perched water tables siting on 'the top of rock', particularly for short durations after rain.

Conceptually, recharge rates may be comparatively high on catchment divides and locations high in the landscape such as the site, and potential in areas where depths to the water table exceed 5 m (to limit interception by vegetation and evaporation). Conversely net recharge is expected to be comparatively where the Hawkesbury Sandstone is overlain by the Ashfield Shale such as to the north of the site.

6.9 Groundwater elevations

Four groundwater level monitoring events have been carried out in the southern portion of the site; three of these events were carried out by Coffey and the fourth by WSP. A summary of the depth to groundwater during these monitoring events is summarised in Table 6.4 whilst well construction details and their eastings, northings and casing elevations are summarised in Appendix C

Table 6.4 Groundwater depths and elevation

MONITORING WELL ID	4 SEPTEMBER 2018		14 FEBRUARY 2023		21 FEBRUARY 2023		31 MAY 2023	
	COFFEY		COFFEY		COFFEY		WSP	
	STANDING WATER LEVEL (m bgl)	STANDING WATER LEVEL (m AHD)	STANDING WATER LEVEL (m bgl)	STANDING WATER LEVEL (m AHD)	STANDING WATER LEVEL (m bgl)	STANDING WATER LEVEL (m AHD)	STANDING WATER LEVEL (m bgl)	STANDING WATER LEVEL (m AHD)
BH1	4.47	61.73	3.89	62.31	NOT MEASURED	--	4.21	61.99
BH3	3.82	62.38	NOT MEASURED	--	3.01	63.19	2.88	63.32
BH5	4.30	55.85	3.91	56.24	NOT MEASURED	--	4.04	56.11
BH7A	3.90	52.95	3.43	53.42	NOT MEASURED	--	3.58	53.27
BH9	5.17	54.99	4.55	55.61	NOT MEASURED	--	3.92	56.24

Based on that information Coffey presented the following overview of groundwater levels at the site.

The groundwater levels measured in 2018 and 2023 are generally consistent, with the groundwater level readings in 2023 typically 0.4m to 0.8 m higher in elevation than 2018. This is consistent with the above average rainfall recorded in Sydney during 2022.

Groundwater levels are relatively consistent with regards to depth below ground level across the site, generally varying between 3 to 4.5 m below ground level. This infers a groundwater flow direction across the site from north to south at a gradient of approximately 1V:8H, similar to the topography. It should be noted that the groundwater level measurements have only been taken from piezometers on the southern half of the site.

Based on the groundwater levels measured in February 2023, a groundwater contour plan for the southern portion of the site is shown in Figure … [reproduced below as Figure 6.5 below], *along with the inferred direction of groundwater flows.*



Figure 6.5 Groundwater elevation and flow direction in the southern portion of the site as estimated by Coffey (2023)

Five groundwater monitoring wells have been installed in the northern portion of the site under WSP's supervision. At the time of this GIA however, owing to the very low hydraulic conductivity of the Hawkesbury Sandstone within the screened intervals of these wells, groundwater levels in these wells had not recovered to their pre-investigation elevations and are therefore not known in this portion of the site. In stating this it is conservatively expected groundwater in the northern portion of the site will (similarly) be present at depths of between 3 and 5 m below ground level with no notable changes in groundwater flow directions or hydraulic gradients likely.

6.10 Aquifer hydraulic conductivity

Characterisation of hydraulic properties of the Hawkesbury Sandstone at the site has been undertaken using:

- estimates of horizontal hydraulic conductivity from the water-pressure testing (Lugeon or 'packer' tests) undertaken by WSP in boreholes BH9, BH10A, BH11 and BH12 (all of which are located in the northern portion of the site) [noting for this assessment 1 Lugeon has been assumed to be equivalent to a horizontal hydraulic conductivity of 1 x 10^{-7} m/sec]
- estimates of horizontal hydraulic conductivity derived from rising-head ('slug') tests carried out by Coffey in groundwater monitoring wells BH1, BH7A and BH9, all of which are located in the southern portion of the site
- published references regarding the hydrogeological characteristics and behaviours of the Hawkesbury Sandstone in the Sydney region, particularly those focusing on tunnelling projects where groundwater inflows have either been documented or inferred, and
- WSP's experience on tunnelling and other infrastructure projects in Sydney including the Western Harbour Tunnel, WestConnex M4-M5 Link and Sydney Metro City – SouthWest projects, all of which had hydrogeological investigations located in nearby suburbs to the site.

6.10.1 Lugeon water-pressure (packer) tests

Horizontal hydraulic conductivity values estimated from 'packer testing' are summarised in Table 6.5. Copies of the field data sheets, and test interpretations are included in Appendix F.

Table 6.5 Summary of packer hydraulic conductivity test results

BOREHOLE	TEST INTERVAL (m BGL^)	LITHOLOGY OF TEST INTERVAL††	ESTIMATE OF HORIZONTAL HYDRAULIC CONDUCTIVITY, K		ESTIMATE OF HOULSBY LUGEON VALUE (Lu‡‡)€
			(m/sec‡)	(m/day)	
BH9	10.3 – 26.2	HAWKESBURY SANDSTONE CLASS I/II	<1 X 10-8	<9 X 10-4	<0.1
	19.4 – 26.2	HAWKESBURY SANDSTONE CLASS I/II	1 X 10-8	9 X 10-4	0.1
BH10	10.6 – 16.6	HAWKESBURY SANDSTONE CLASS I/II	<1 X 10-8	<9 X 10-4	<0.1
	16.6 – 22.6	HAWKESBURY SANDSTONE CLASS I/II	2 X 10-8	2 X 10-3	0.2
	22.5 – 28.5	HAWKESBURY SANDSTONE CLASS I/II	6 X 10-8	5 X 10-3	0.6
	22.5 – 36.5	HAWKESBURY SANDSTONE CLASS I/II, LAMINATE AND HAWKESBURY SANDSTONE CLASS III TO IV (HORIZONTAL SHEAR ZONE)	2 X 10-8	2 X 10-3	0.2
	28.5 – 36.5		4 X 10-8	3.5 X 10-3	0.4
BH11	7.3 – 13.3	HAWKESBURY SANDSTONE CLASS I/II	<1 X 10-8	<9 X 10-4	<0.1
	13.3 – 19.3	HAWKESBURY SANDSTONE CLASS I/II	<1 X 10-8	<9 X 10-4	<0.1
BH12	21.0 – 25.2	HAWKESBURY SANDSTONE CLASS I/II	5 X 10-8	4 X 10-3	0.5

Notes: ^ metres below ground level

‡ metres per second

† indirect ('inferred') measure of hydraulic conductivity derived from results of the two 'packer' tests carried out in this borehole

†† Rock classification based on Sydney Sandstone and Shale Classification System (Pells et. al., 1998).

‡‡ Lugeon value as defined by Houlsby (1976)

€ 1 Lugeon assumed to be equivalent to a horizontal hydraulic conductivity of 1 x 10^{-7} m/sec

Hydraulic conductivity estimates obtained from the packer testing are within the range of expected values for the Hawkesbury Sandstone as described by Pells (2019); i.e., hydraulic conductivity ranging between 10^{-9} and 1.0 x10^{-7} m/s (i.e., about 0.01 and 1.0 Lugeons). In stating this, in some instances hydraulic conductivity estimates were at the lower end of this range (i.e., less than 0.1 Lu), particularly for those test intervals in which the Hawkesbury Sandstone had minimal (almost 'negligible') fracturing.

WSP's estimates of Lugeon values versus test midpoint elevation for those water-injection tests carried out at the site are shown on Figure 6.5. Also shown on this figure are estimates of Lugeon values for selected water-injection tests carried out for the Western Harbour Tunnel (WHT) project which will pass beneath Sydney Harbour about 1.4 km to the southeast of the site. WHT Lugeon values shown on this figure are those estimated from tests carried out at Balls Head, Waverton and North Sydney (i.e., those project locations on the northern side of Sydney Harbour) in all Pells classes of Hawkesbury Sandstone. Also shown on this figure are the following estimates of hydraulic conductivity estimated from the WHT hydraulic dataset for:

(i) the Raymer arithmetic mean for those tests carried out in all Pells' classes 'away' from the harbour and in close proximity to surface water and groundwater divides (0.4 Lugeon as shown by the orange line)

(ii) geometric mean for those tests carried out in all Pells' classes 'away' from the harbour and in close proximity to surface water and groundwater divides (0.5 Lugeon as shown by the light-blue line), and

(iii) geometric mean for those tests carried out in Class I/II Hawkesbury Sandstone (1.0 Lugeon as shown by the brown line).

Figure 6.6 suggests:

- Lugeon values of 0.1 Lu or less are evident in the Hawkesbury Sandstone on the northern side of Sydney Harbour at all elevations, including along the proposed WHT alignment at the same and similar elevations as the site
- Lugeon values of Class I/II Hawkesbury Sandstone (i.e., that tested for the WHT project) at elevations between about 74 m AHD (northern wall of the planned basement) and 54 m AHD (planned BEL) is generally less than 1.0 Lu, and more likely less than 0.5 Lu, and
- 'low' Lugeon values at the site are likely to reflect its location in the upper reaches of its catchment and accompanying reduced fracture frequency in the underlying Hawkesbury Sandstone.

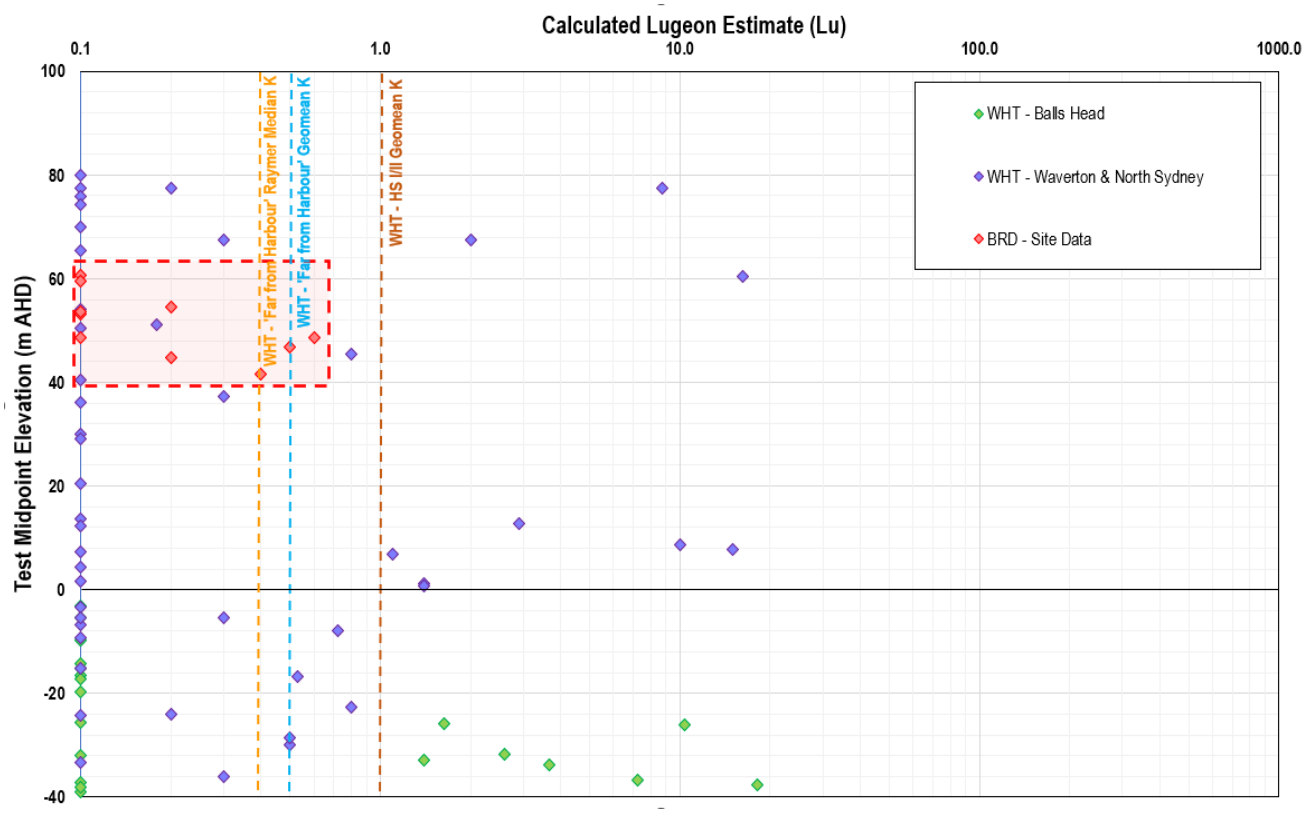


Figure 6.6 Site and selected WHT packer test Lugeon value estimates versus test midpoint elevation

6.10.2 Slug tests

Three rising head tests were carried out by Coffey in groundwater monitoring wells BH1, BH7A and BH9. Estimates of horizontal hydraulic conductivity, K_h, were then made using the Hvorslev Method (1951) with results summarised in Table 6.6.

Table 6.6 Summary of Coffey slug test results (Coffey, 2023)

BOREHOLE	GROUNDWATER MONITORING WELL				
	TEST INTERVAL (m BGL^)	LITHOLOGY OF TEST INTERVAL††	ESTIMATE OF HORIZONTAL HYDRAULIC CONDUCTIVITY		ESTIMATE OF HOULSBY LUGEON VALUE (Lu‡‡)
			(m/sec‡)	(m/day)	
BH1	3.5 – 10.1	Hawkesbury Sandstone Class I to IV	1.5 x 10-7	0.013	1.5
BH7A	3.7 – 10.3	Hawkesbury Sandstone Class II to III	1.2 x 10-7	0.010	1.2
BH9	4.0 – 10.5	Hawkesbury Sandstone Class I to III with some core loss	0.6 x 10-7	0.005	0.6

Coffey's estimates of horizontal hydraulic conductivity are above the median values for Hawksbury Sandstone reported by Best and Parker (2004) although less than the upper-end values nominated by Pells et. al. (2019) for the respective sandstone 'classes'. The test intervals do though span several ('Pells') classes of sandstone, with a review of the core photos from these boreholes suggesting the hydraulic conductivity of the sandstone in the southern portion of the site also decreases (likely notably) with depth.

6.10.3 Other information sources

Pells et. al. (2019) note the bulk or effective hydraulic conductivity of the Hawkesbury varies depending primarily on the degree of fracturing and weathering. They divide the sandstone into five 'classes' and assign typical values of horizontal hydraulic conductivity and drainable storage as summarised in Table 6.7. Generic observations from the sandstone core recovered from those boreholes drilled at the site, mostly those by WSP in the northern portion of the site where the planned basement will be deepest and groundwater inflows and drawdown consequentially also greatest, have also been added to this table.

Table 6.7 Summary of Pells class hydraulic properties of the Hawkesbury Sandstone (Pells et. al. 2019) and WSP's site observations

PELLS CLASS	BULK HYDRAULIC CONDUCTIVITY (m/sec)	LUGEON VALUE, Lu	DRAINABLE STORAGE (%)	PELLS COMMENTS	WSP'S SITE OBSERVATIONS
I	10^{-9} to 10^{-8}	0.01 to 0.1	5	Typically have wide defect spacing and are unweathered. Hydraulic conductivity and porosity tend towards substance properties [i.e. those of the pore space in the sandstone as opposed to any influence of increased porosity or hydraulic conductivity associated with fracturing].	Dominant Pells sandstone class in all boreholes drilled in the northern portion of the site where the basement of the planned development will be deepest. Slow groundwater level recovery during well development supports the low Kh of this sandstone observed from Lugeon water-injection testing.
II	10^{-8} to 10^{-7}	0.1 to 1.0	5	Have closer defect spacing, may be fresh to moderately weathered, such that hydraulic conductivity is defect dominated, and greater than Class I.	--
III	10^{-7} to 5 x 10^{-7}	1.0 to 5.0	10		--
IV	5 x 10^{-8} to 2 x 10^{-7}	0.5 to 2.0	12	Contain zones of highly and extremely weathered rock with associated increase in clay	Evident in the horizontal shear zone observed in the base of borehole BH10A.

PELLS CLASS	BULK HYDRAULIC CONDUCTIVITY (m/sec)	LUGEON VALUE, Lu	DRAINABLE STORAGE (%)	PELLS COMMENTS	WSP'S SITE OBSERVATIONS
V	10^{-8} to 5 x 10^{-8}	0.1 to 0.5	15	content, and clays along bedding seams and in joints. The result is a decrease in hydraulic conductivity compared with Classes II and III.	--

Hawkes (2017) and Tammetta and Hewitt (2004) note the horizontal hydraulic conductivity of the Hawkesbury Sandstone is typically in the order of 10^{-7} m/s (about 1 Lugeon). The horizontal (K_h) to vertical hydraulic conductivity (K_v) ratio of the Hawkesbury Sandstone is typically in the range of 10 to 100, as noted earlier. They both though note higher hydraulic conductivities though are reported adjacent to and within faults, dykes and sheared zones, as well as within the upper zones and margins of fresh rock beneath sediment-filled palaeochannels.

A regional analysis of packer test data carried out in the Hawkesbury Sandstone across the Sydney Basin by Tammetta and Hawkes (2009) indicated a trend of decreasing hydraulic conductivity with depth below ground surface which was attributed to less frequent fracture spacing and increasing lithostatic pressure with depth. Data from Tammetta and Hawkes are provided on Figure 6.7 onto which hydraulic conductivity estimates from both Lugeon water injection testing (WSP) and slug testing (Coffey) carried out at the site has been overlain.

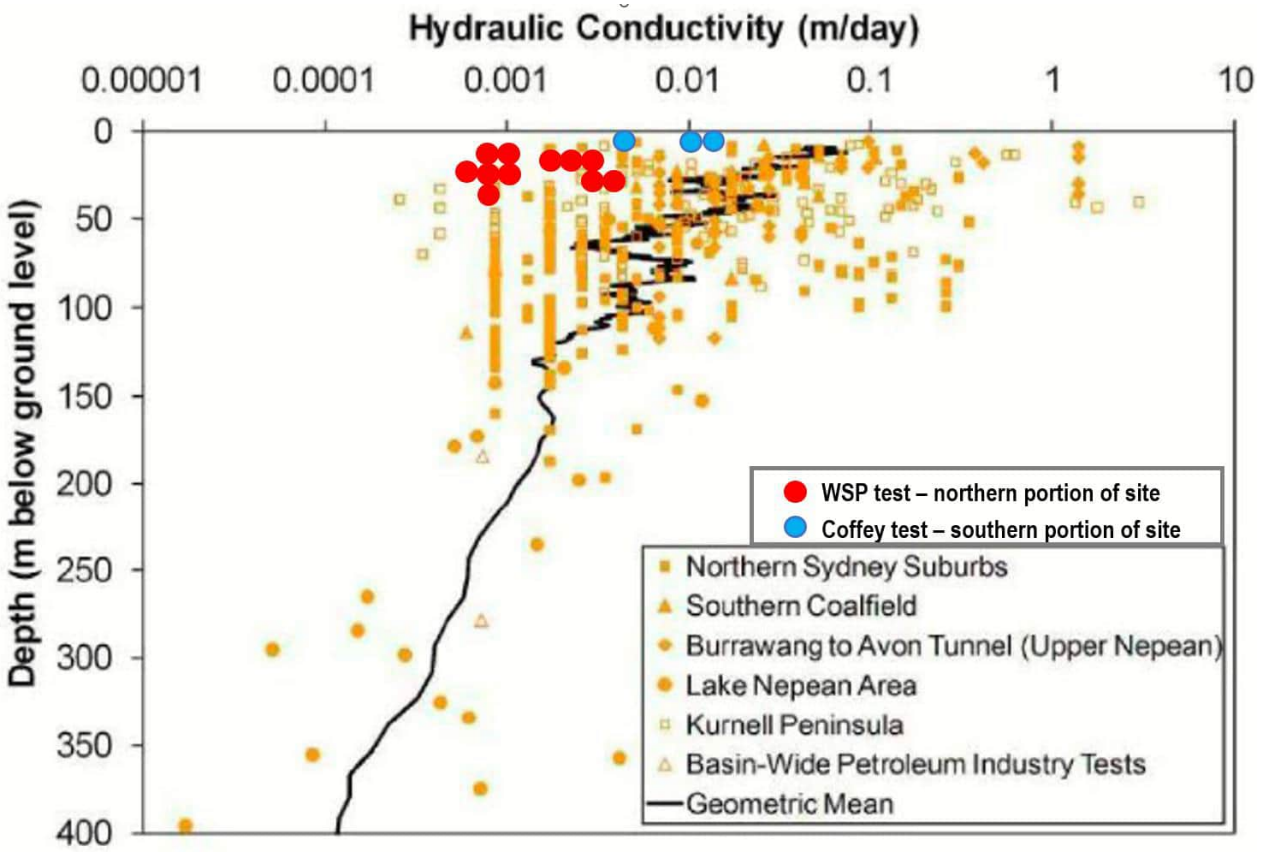


Figure 6.7 Tammetta and Hawkes (2009) hydraulic conductivity estimates from packer testing in the Sydney Basin

There are no site-derived measurements of porosity or vertical hydraulic conductivity of the Hawkesbury Sandstone. Measurements of both of these parameters were made on selected rock core samples collected from boreholes drilled for the nearby WCX M4-M5 Link (seven samples) and Rozelle Interchange (four samples) projects. Estimates of both porosity and vertical hydraulic conductivity from these samples are summarised in Table 6.8.

Table 6.8 WCX M4-M5 Link Hawkesbury Sandstone core porosity and hydraulic conductivity testing results

BOREHOLE	SAMPLE INTERVAL (M BGL[¶])	VERTICAL HYDRAULIC CONDUCTIVITY[€] (M/S[‡])	TOTAL POROSITY (%)
EP_BH04[†]	25.3 – 25.5	3.2×10^{-8}	13.6
HB_BH24	18.3 – 18.5	5.3×10^{-8}	14.1
MT_BH01	59.4 – 59.6	6.4×10^{-8}	13.1
MT_BH07	42.4 – 42.6	4.8×10^{-8}	11.3
MT_BH11	53.4 – 53.6	4.4×10^{-9}	13.6
MT_BH12	46.1 – 46.3	4.1×10^{-8}	18.7
MT_BH16	79.5 – 79.6	2.3×10^{-9}	14.6
MT_BH20	42.7 – 42.9	8.9×10^{-10}	Not tested
RZ_BH60[†]	49.2 – 49.3	1.4×10^{-9}	14.3
RZ_BH64[†]	38.4 – 38.6	2.1×10^{-9}	Not tested
RZ_BH67[†]	42.0 – 42.2	1.4×10^{-9}	Not tested

Notes: [¶] metres below ground level

[€] measured from a disturbed sample (i.e., not measured in-situ in the field)

[†] borehole drilled for the WestConnex Rozelle Interchange project

[‡] metres per second

Tammetta and Hewitt (2004) indicate the Hawkesbury Sandstone in the Sydney metropolitan area has a specific yield of between 0.01 and 0.02 (i.e., between 1 % and 2%) while Hawkes et al. (2009) reported the specific storage of the Hawkesbury Sandstone ranges between about 10^{-5} and 10^{-4}.

Values if specific storage for the Hawkesbury Sandstone used in the numerical groundwater flow model prepared for the WCX M4-M5 Link project were 5×10^{-6} m^{-1} for 'bulk' sandstone, and 6×10^{-6} m^{-1} for higher-hydraulic conductivity (and faulted bedrock) associated with major fault zones (in this case the Woolloomooloo and Luna Park Fault Zones).

6.11 Groundwater quality

Groundwater samples were collected by Coffey from groundwater monitoring wells BH1 and BH9 in February 2023. A summary of groundwater analytical results and accompanying exceedances of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) 2018 toxicant default guideline values (DGVs) for the 95% protection of organisms in marine waters (which is the end-disposal point for surface water runoff at and surrounding the site given Berrys Creek ultimately drains to Sydney Harbour) is presented in Table 6.9. Copies of the analytical certificates for these samples are included in Appendix C.

Table 6.9 Summary of groundwater analytical results and exceedances of DGVs

ANALYTE / PARAMETER	UNITS	GROUNDWATER MONITORING WELL	
		BH1	BH9
General water quality parameters and measures – laboratory analysis			
pH – laboratory	pH units	4.9	5.5
Electrical conductivity – laboratory	µS/cm	590	376
Total dissolved solids	mg/L	430	264
Total suspended solids	mg/L	367	6080
Major anions and cations – laboratory analysis			
Calcium	mg/L	1.0	13
Magnesium	mg/L	10	5.0
Sodium	mg/L	1.0	<1
Potassium	mg/L	101	53
Bicarbonate alkalinity	mg/L	<1.0	20
Total alkalinity	mg/L	<1.0	20
Chloride	mg/L	154	66
Sulfate	mg/L	73	62
Selected nutrients – laboratory analysis			
Ammonia as N	mg/L	0.07	0.17
Nitrite as N	mg/L	<0.01	<0.01
Nitrate as N	mg/L	1.26	0.06
Nitrate + nitrite as N	mg/L	1.26	0.06
Total Kjeldahl nitrogen (TKN) as N	mg/L	2.9	2.1
Total nitrogen as N	mg/L	4.2	2.2
Total phosphorus as P	mg/L	0.22	0.53
Selected dissolved heavy metals and metalloids – laboratory analysis			
Arsenic	mg/L	<0.001	0.003
Cadmium	mg/L	0.00002	<0.0001
Chromium	mg/L	<0.001	0.001
Copper	mg/L	0.009	0.002
Lead	mg/L	<0.001	<0.001
Mercury	mg/L	<0.0001	<0.0001
Manganese	mg/L	0.406	0.018
Iron	mg/L	0.08	1.17
Nickel	mg/L	0.014	0.002
Zinc	mg/L	0.089	0.030
Organic compounds (hydrocarbon contaminants) – laboratory analysis			
Total petroleum hydrocarbons	µg/L	Not detected	Not detected
Total petroleum hydrocarbons – NEPM 2013 fractions	µg/L	Not detected	Not detected
BTEXN compounds	µg/L	Not detected	Not detected
PAH – total	µg/L	Not detected	Not detected
PAH – Benzo(a)pyrene	µg/L	Not detected	Not detected

Notes: µS/cm – microSiemens per centimetre

mg/L – milligrams per litre; µg/L – micrograms per litre

BTEXN – benzene, toluene, ethylbenzene, xylene and naphthalene.

In addition to the above, the following measurements of groundwater physio-chemical parameters (namely pH, electrical conductivity, oxidation – reduction (redox) potential, dissolved oxygen and temperature) were collected during the development of those groundwater monitoring wells installed by WSP in the northern portion of the site are summarised in Table 6.10.

Table 6.10 Summary of groundwater field parameters from WSP groundwater monitoring wells

ANALYTE / PARAMETER	UNITS	GROUNDWATER MONITORING WELL				
		BH9	BH10A	BH10B	BH11	BH12
Physio-chemical water quality parameters (measured during well development)						
pH	pH units	5.1	6.4	5.1	6.3	7.3
Electrical conductivity	µS/cm	1,265	450	330	575	1,760
Oxidation-reduction potential – field probe	mV	86	28	70	41	61
Temperature	°C	17.5	17.7	17.9	17.5	17.2
Dissolved oxygen	ppm	4.3	3.7	2.6	3.8	5.1

Notes: µS/cm = microsiemens per centimetre; mV = millivolts; °C = degrees Celsius; ppm = parts per million

Analytical results for the groundwater samples collected at the site indicate the following:

- Groundwater at those depths immediately above and below the floor level of the planned development is indicative of that from active groundwater flow zones.
- Groundwater has only a moderate buffering capacity.
- Groundwater is mostly fresh and indicative of recent groundwater recharge with electrical conductivity (EC) measurements less than 1,830 µS/cm, and often less than 600 µS/cm. This is also supported by the low concentrations of all major anions and cations and dissolved solids.
- With the exception of copper and zinc, dissolved concentrations of heavy metals which are less than the DVGs for disposal of collected groundwater to stormwater and ultimately Sydney Harbour. Dissolved concentrations of copper and zinc are though in line with what could be expected in groundwater samples collected elsewhere from the Hawkesbury Sandstone in the Sydney basin and are not considered to be indicative of groundwater contamination at or in the vicinity of the site.
- Groundwater geochemistry shows some influence of urban development on water quality with notable concentrations of nitrate and total Kjeldahl nitrogen, both of which could be indicative of leakage of water from nearby sewer systems, detected in both samples submitted for laboratory analysis.
- No analyte concentrations, indicative of organic contamination, were detected in either of the groundwater samples submitted for analysis.

6.12 Groundwater abstraction and drainage

According to the WaterNSW Realtime Data online database there are no bores within 500 m of the site registered for groundwater abstraction purposes. Given the typically low yields from the Hawkesbury Shale and nature of development surrounding the site the active abstraction and use of groundwater is considered unlikely.

6.13 Nearby registered groundwater bores

There are no registered groundwater bores within 500 m of the site.

6.14 Groundwater-dependent ecosystems

Groundwater-dependent ecosystems (GDEs) are natural communities of plants, animals and other organisms which are dependent on access to groundwater on a constant or intermittent basis to sustain aquatic and terrestrial ecosystems such as vegetation, springs, wetlands, and rivers (DPIE, 2020). In New South Wales the NSW State GDEs Policy (DLWC, 2012) is designed to protect the valuable ecosystems which rely on groundwater for survival, so that wherever possible the ecological processes and biodiversity of these GDEs are maintained or restored.

There are three types of GDEs as described below.

- Surface expression GDEs – these are defined as ecosystems dependent on the discharge of groundwater on a permanent or intermittent basis to meet all or some of their water requirements to maintain their communities of plants and animals, ecological processes, and ecosystem services. Surface expression GDEs include:
  - Spring vents – a single point in the landscape where groundwater is discharged
  - Surface line GDE features – drainage lines that have some groundwater dependency, and
  - Watercourse springs – a section or sections of a watercourse where groundwater enters the stream through the streambed.
- Terrestrial GDEs – ecosystems which depend on the presence of groundwater which is accessed via their roots at depth.
- Subterranean (cave and aquifer) GDEs – these are caves dependent on the subterranean presence of groundwater. Cave GDEs may be indicated by high moisture levels and/or the presence of stygofauna. Aquifer GDEs are inherently groundwater dependent ecosystems, composed of those species that inhabit the void between sediment grains or in fractures and solution cavities in groundwater systems.

A search of the Australian GDE Atlas potential[1] GDEs within the Project area and surroundings indicates the following.

- There are no **aquatic GDEs** within 5 km of the site.
- There are several low, moderate and high potential **terrestrial GDEs** 2 km or more to the west and northwest of the site.
- There are no **subterranean GDEs** within 5 km of the site.

There are no high priority (high conservation value) GDEs listed in the *Water Sharing Plan (WSP) for the Greater Metropolitan Region Groundwater Resources* (NSW Office of Water, 2011) within 10 km of the site.

6.15 Springs

No natural springs have been identified at or within 500 m of the site.

6.16 Culturally-significant groundwater sites

No culturally significant sites were identified within the Greater Metropolitan Regional Groundwater Water Sharing Plan; at the time this Water Sharing Plan was issued this list was being prepared and to WSP's knowledge is yet to be issued.

6.17 Nearby contaminated sites

A comprehensive review of the history of the site and surrounds is beyond the scope of this Groundwater Impact Assessment.

In stating this there are also no sites in the predicted zone of groundwater drawdown (refer to Section 7 of this GIA) with 'Declaration of Significantly Contaminated Land' notifications on the *NSW Environment Protection Agency* online public search register.

[1] GDE potential describes ecosystems in terms of their "potential to be interacting with groundwater". The term "potential" is used to reflect the uncertainty inherent in identifying ecosystems as groundwater-dependant using desktop methods. Finer scale studies or fieldwork are needed to confirm this analysis.

In addition to the above a walking inspection and a review of historical aerial photographs of the site and surrounds suggest it is unlikely that:

- there are any existing notably contaminated sites within 500 m of the site, and
- historically neither the site nor surrounds have been subject to any activities that could result in notable soil and/or groundwater contamination.

7 Numerical modelling – groundwater inflow and drawdown assessment

7.1 Objective

The objective of the modelling is to estimate potential future groundwater inflows to the basement and to assess the impact on surrounding groundwater users and the environment due to groundwater drawdown created by proposed drain basement dewatering in the site area.

7.2 Conceptual model

The following bullet points summarise the conceptual hydrogeological model at and surrounding the site. It has been largely based on geological, hydrogeological, and environmental information presented in Section 6.

- The hydrogeological system largely comprises an unconfined to semi-confined fractured rock aquifer, characterised by irregularly distributed fracture zones (mostly vertical joints and sub-horizontal bedding plane partings) throughout the Hawkesbury Sandstone as encountered during hydrogeological investigations and typified in Figure 6.2.
- There are two inferred aquifers in the greater area surrounding the basement excavation. These are, from shallowest to deepest (i) a broad, shallow and hydraulically variable perched to semi-continuous unconfined aquifer hosted within the residual sandy clay soils and moderately to highly weathered sandstone, and (ii) a spatially regionally significant unconfined to semi-confined fractured rock aquifer hosted predominantly within the various fractures within the sandstones and laminites of the Hawkesbury Sandstone.
- The cemented and lithified nature of the bedrock (i.e., predominantly Class I and II sandstone) aquifer suggests groundwater storage and movement occurs almost entirely within fractures in these rocks as opposed to the interconnected pore space within them.
- Groundwater flow in the weathered and increasingly fractured Class III, IV and V sandstone (as well as the nearby Ashfield Shale to the north of the site) is also expected to occur mostly within fractures in these rocks, albeit with a greater portion of flow through the interconnected pore space in this material as opposed to fracture networks, particularly where this rock is moderately to highly weathered. This zone – coupled with any overlying residual soils – is on average 6 m thick with the degree of both weathering and fracturing decreasing significantly between about 4 and 6 m depth as shown in Figure 7.1.



Figure 7.1 Class III/IV/V Hawkesbury Sandstone from borehole BH10A

- The bulk hydraulic conductivity (i.e., that of both the rock matrix and the discontinuities in the rock mass) of the Class I and II sandstone expected to form the walls and floor of the planned excavation is estimated to be in the order of 2×10^{-8} m/sec (i.e., about 0.2 Lugeons). Hydraulic testing carried out by WSP has shown that where fresh, this sandstone has a very low hydraulic conductivity which is expected reflect:
  - the low to very low degree of fracturing of this sandstone
  - negligible (to no) degree of weathering, and
  - low to very low primary porosity of this sandstone.

  Class I/II sandstone was the most common observed rock in each of the deep boreholes drilled by WSP in the northern portion of the site. An example of this sandstone, from boreholes BH10A (drilled adjacent to the planned northern wall of the basement) and BH11 (in the north-western portion of the site), is shown in Figure 7.2. This figure shows the generally massive and unfractured nature of the sandstone which will form the walls and likely much of the floor of the planned basement of the development. BEL is shown by orange diamond markers on these figures. Lugeon values in borehole BH10A varied between <0.1 and 0.6 Lu. Lugeon values in borehole BH11 – between 7.3 and 19.3 m depth – were <0.1 Lu.



Figure 7.2 Class I/II Hawkesbury Sandstone from boreholes BH10A (left) and BH11 (right) both above and below proposed BEL

- The bulk hydraulic conductivity of the horizontal shear zone identified in the lower 3.4 m of borehole BH10A and in the base of borehole BH11 is estimated to be in the order of 6×10^{-8} m/sec (i.e., about 0.6 Lugeons). This is based on hydraulic testing carried out in the base of this borehole coupled with geological inspection of core recovered from this shear zone which shows that whilst the shear zone was moderately to highly fractured, many if not all of these fractures had clay infill coupled with somewhat 'tight' apertures; this is shown in Figure 7.3.



Figure 7.3 Horizontal shear zone in the Hawkesbury Sandstone between 33.0 and 36.4 m depth in BH10A, about 12 m below the planned basement (between about RL 41.5 m AHD and RL 38.1 m AHD)

- Corebox photographs from deeper boreholes drilled at the '88' development at St Leonards (about 330 m east of this site and shown in Figure 7.4) suggest the shear zone encountered in boreholes BH10A and BH11 is laterally continuous and potentially a regionally significant geological structure.



Figure 7.4 Horizontal shear zone in the Hawkesbury Sandstone between about 34.5 and 36.8 m depth in borehole BH5 at the '88' development in St Leonards

- The hydraulic conductivity of the residual soils and Class IV/V shale is expected to be in the order of 1×10^{-7} m/sec (Pells et. al., 2019), whilst the overlying residual soils are expected to have permeabilities of about 5×10^{-8} m/sec, thereby forming somewhat of a 'barrier' to the infiltration of rainfall recharge where these soils outcrop to the north of the site.

- Joint spacing in the sandstone at the site varies most according to proximity to near-surface weathering, particularly in the top 8 m of the sandstone; joint spacing, particularly at depth likely to be at the higher end of those spacings discussed in Section 6.5.
- There are no regionally significant vertical fracture zones – such as faults or joint swarms – passing through or in the vicinity of the site.
- Groundwater recharge is expected to be derived primarily from the infiltration of excess rainfall. Given much of the greater area is urbanised and opportunities for rainfall infiltration reduced when compared to 'greenfield' sites, recharge is likely to be about 1.5% of annual mean rainfall. This is consistent with WSP's estimates of rainfall recharge at other urban-set sites throughout the Sydney metropolitan area including at and along the nearby WestConnex M8 project.
- Groundwater flow to the excavation and basement will occur along the northern, eastern and western boundaries (planned basement walls) of the site.

7.3 Groundwater model

7.3.1 Modelling code

A 3D numerical groundwater model was developed using MODFLOW-USG (Panday et al., 2013) modelling code and the Groundwater Vistas 8 graphical user interface to estimate the groundwater inflow to the basement of the planned development and to assess drawdown impact on the surrounding groundwater users and the environment. MODFLOW-USG allows for refined and unstructured grids, and variably saturated flow conditions. Details of this model and the scenarios assessed are provided in the following sections.

7.3.2 Model class

The numerical groundwater flow model described in this document is considered to have a Class 1 (i.e., lowest) Confidence Level based on Table 2-1 of the Australian Groundwater Modelling Guidelines (Barnett et al, 2012). Primary reasons for this are:

- No long-term transient groundwater level data was available for model calibration, nor is it possible to calibrate the model
- Measurements of regional and/or local groundwater recharge rates are not available, and
- Information regarding groundwater levels in other areas more distant from the site (as opposed to those locations only around the perimeter of the basement) is not available.

7.3.3 Model geometry

The model domain is 600 m north-south by 770 m east-west. The major hydrostratigraphic units are represented by six model layers (refer to Section 7.3.3.1), whilst model cell size is 10 × 10 m over most of the model domain, albeit reduced to 2.5 x 2.5 m with the footprint of the planned development. The total number of active model cells is 34,884 with those cells outside the model domain in active. The model domain and inactive (no-flow) cells are shown in Figure 7.5.

Modelled surface elevations are shown in Figure 7.6



Figure 7.5 Model domain, no-flow cells, constant head boundary

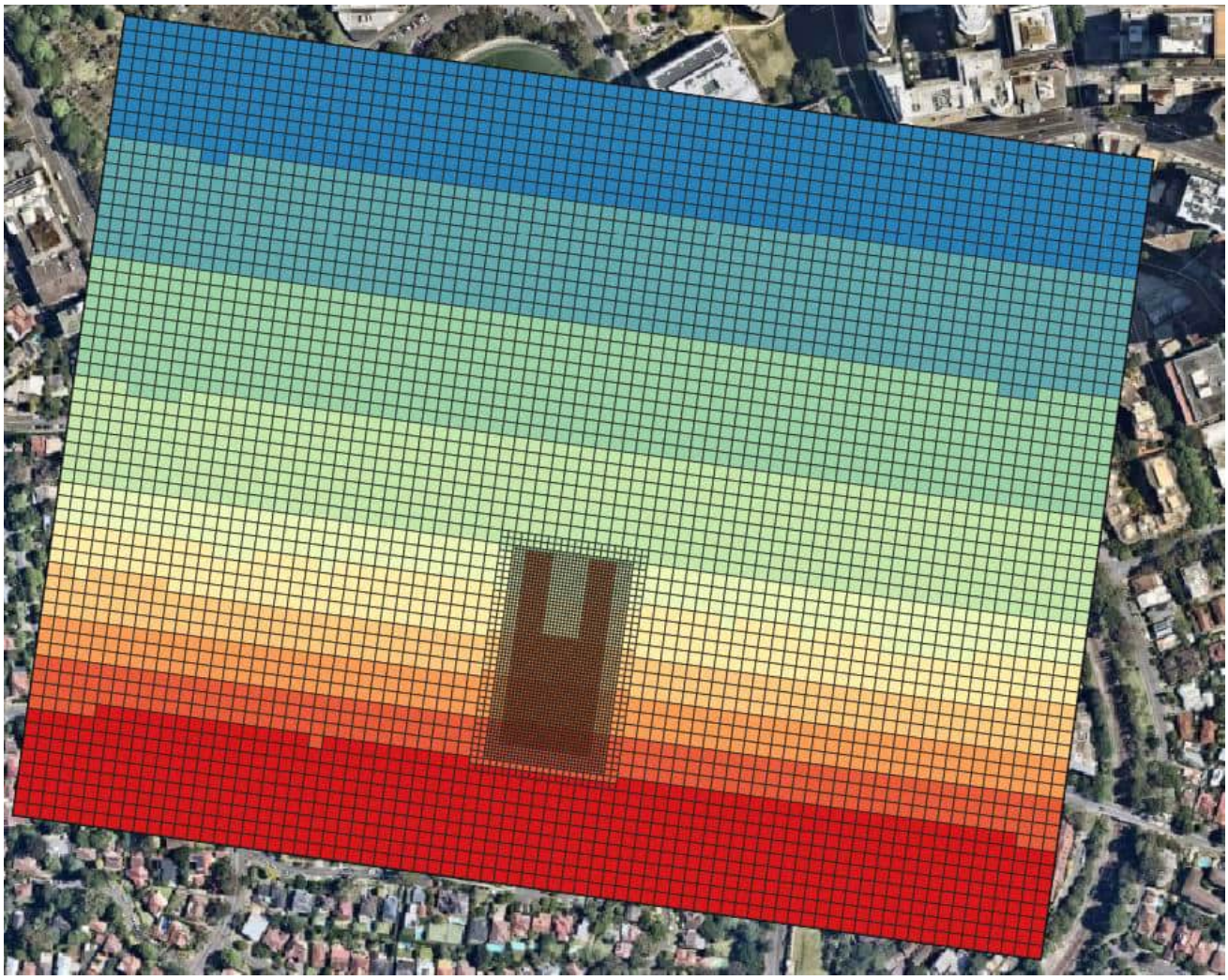


Figure 7.6 Model domain, no-flow cells, constant head boundaries and model topography

7.3.3.1 Model layers and hydraulic properties

The groundwater system and hydrogeological units were represented by six model layers with hydraulic properties as summarised in Table 7.1. Model layers are shown in the screen-grab taken from the MODFLOW model shown in Figure 7.7.

Simplified topographic contour data was created for the top elevation (ground surface) of the model as shown in Figure 7.6. No vertical geological faults have been incorporated into the groundwater flow model, however the horizontal shear observed in the base of borehole BH10A has been included.

Table 7.1 Hydraulic properties of model layers

GEOLOGICAL UNIT MATERIAL	MODEL LAYER NUMBERS	HORIZONTAL K (m/sec†)	VERTICAL K (m/sec)	K_H:K_V RATIO	SPECIFIC STORAGE (m^{-1})	SPECIFIC YIELD	LAYER THICKNESS (m)	TOP OF LAYER (m AHD)	BASE OF LAYER (m AHD)
Hawkesbury Sandstone Class IV / V and accompanying residual soils	1 (southern portion of model)	5×10^{-7} †† (testing carried out for other projects in Sydney)	2.5×10^{-7} ††	2:1††	0.005	0.10	6.0	Variable across model extent	Variable across model extent
Hawkesbury Sandstone – Class I / II regional basement	3 (basement walls), 4 (basement floor) and 6 (model base unit).	2×10^{-8} (hydraulic testing carried out at the site)	2×10^{-9}††	10:1††	0.001 (Pells et. al., 2019)	0.05 (Pells et. al., 2019)	Layer 3 – max 21.0 m Layer 4 – max 13.0 m Layer 6 – 36.0 m	75.0 54.0 36.0	54.0 41.0 0.0
Hawkesbury Sandstone – shear zone	5	6×10^{-8} (hydraulic testing carried out at the site)	3×10^{-8} ††	2:1††	0.001	0.05	5.0	41.0	36.0
Ashfield Shale Class IV / V and accompanying residual soils	1 (northern portion of model, north of the site)	2×10^{-7} †† (testing carried out for other projects in Sydney and Pells et. al., 2019)	1×10^{-7} ††	2:1††	0.005 (Pells et. al., 2019)	0.05 (Pells et. al., 2019)	6.0	Variable across model extent	Variable across model extent
Ashfield Shale – Class I / II	2 (northern portion of model, north of the site)	1×10^{-8} †† (testing carried out for other projects in Sydney and Pells et. al., 2019)	1×10^{-9} ††	10:1††	0.0001 (Pells et. al., 2019)	0.02 (Pells et. al., 2019)	Variable in northern portion of model	Variable across model extent	75.0

Notes: K: Hydraulic conductivity † metres per second †† estimated from experience-based judgement and published references

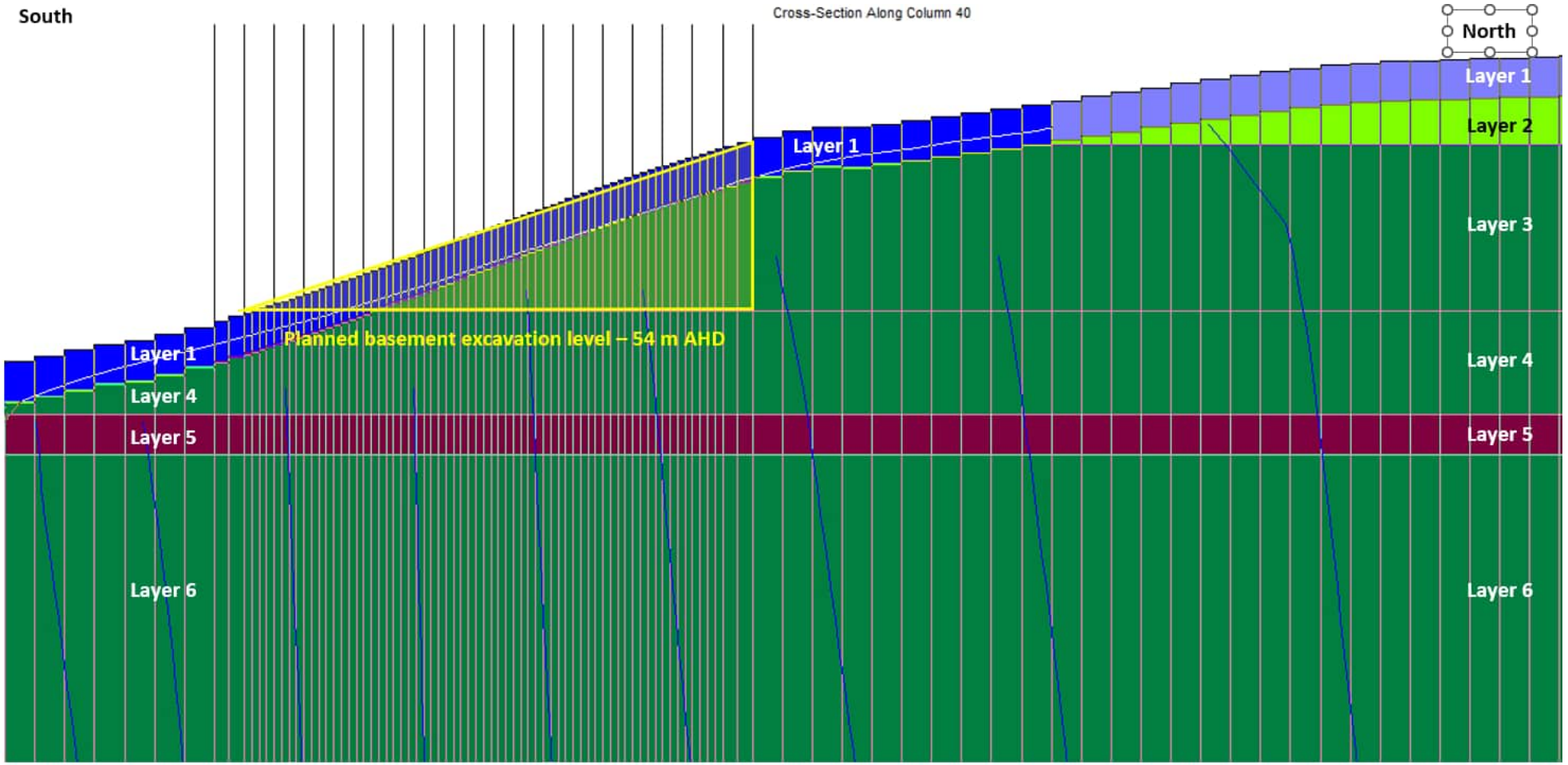


Figure 7.7 Numerical groundwater flow model layering oriented north – south (right to left) through the model and site

7.3.3.2 Boundary conditions

Aquifer recharge was applied to the model using the MODFLOW recharge package (RCH) at the topmost active cell. Rainfall recharge was applied uniformly. The average rainfall recharge applied in the model is 5×10^{-5} m/day (1.5% of average annual rainfall, 1,232 mm as measured at the nearby BoM weather station at the Sydney Observatory); refer to Section 6.4).

MODFLOW general-head boundaries (GHBs) were applied along the northern (85 m AHD) and southern (38 m AHD) boundaries of the model to simulate a water table of 4 below ground level at the project site; conductance of 5 m^2/day were applied to these boundaries and they applied at a distance of 500 m from the GHB.

A MODFLOW drain boundary (zero-pressure cells) was used to simulate the drained basement of the planned development. The drain stage elevation was set at 54 m AHD and assigned a conductance of 100 m^2/day.

A no-flow boundary was also applied to the base of the model.

Surface drainage was not included in the model.

7.3.3.3 Initial groundwater level

The pre-development groundwater level was set at 4 m below ground level across the site. This was based on groundwater level measurements made by Coffey in those groundwater monitoring wells in the southern portion of the site and is shown in Figure 7.8.



Figure 7.8: Initial pre-development modelled groundwater levels (left) and groundwater levels estimated by Coffey from groundwater monitoring wells in the southern portion of the site (right)

7.3.4 Model calibration

The model was not calibrated; the modelled groundwater flow direction is though consistent with topography and expected groundwater levels (as shown in Figure 7.3).

The model has a mass balance error of 0.0%, which is below the accepted threshold of 1% (Barnett et al., 2012).

The mass balance for the modelled scenario is presented in Table 7.2 for the steady-state model and Table 7.3 for the transient state model.

Table 7.2 Mass balance in steady state model

MASS BALANCE COMPONENT	INFLOW (m^3/day)	OUTFLOW (m^3/day)
Recharge	23.1	0.0
General head	5.1	28.2
Total	28.2	28.2
Percent Error	0.00%	

Table 7.3 Mass balance in transient model

MASS BALANCE COMPONENT	INFLOW (m^3/day)	OUTFLOW (m^3/day)
Recharge	23.1	0.0
General head	5.2	25.7
Drain	0.0	3.6
Storage	1.0	0.0
Total	29.3	29.3
Percent Error	0.00%	

7.3.5 Model limitations

The groundwater flow model simulates a simplified version of a complex geological and hydrogeological system. This simplification is required to allow the model to be run and utilised within a reasonable timeframe. Further, the model assumptions that were incorporated were deemed appropriate and acceptable given the purpose of the model (i.e., to estimate groundwater inflow to the planned basement of the Park Road development and associated drawdown). In this context, the assumptions made are considered conservative in respect of the scale of the groundwater impacts predicted (i.e., the assumptions, when compounded, would tend to overestimate the scale of the impact).

A summary of the assumptions incorporated into the model, and their resulting limitations, include:

- The model is based on the conceptual hydrogeological model in Section 7.1
- The residual soils layer (model layer 1) has been assigned a uniform thickness of 5 m for the purposes of modelling however in reality the thickness of this layer varies across the model domain.
- The model has drawn on aquifer hydraulic property data collected at the site and based on the published literatures
- Groundwater level measurements are only available for five monitoring wells in the southern portion of the site (with no data available in the northern portion of the site where the planned basement will be deepest and impacts greatest)
- The number of layers within the model has been limited to six; vertical discretisation of the model layers though is deemed reasonable for the purpose of determining groundwater inflow to the basement and to estimate the extent of drawdown due to project-induced passive dewatering of the Hawkesbury Sandstone, and
- The model is uncalibrated as the available groundwater monitoring information was very limited.

When considering the groundwater inflows and maximum drawdown shown the tables and figures below the following should be recognised.

- Pre-development groundwater levels in the area are not known with confidence, with the depth to groundwater in the northern portion of the site not known.
- WSP have not measured groundwater recharge rates for this assessment, but rather used values derived from groundwater modelling work carried out for the nearby other projects in the site area.

- It has been assumed there is hydraulic continuity between groundwater in the residual soils and weathered zone (which may be a perched aquifer siting above the top of fresh rock) and that in the sandstone; there is insufficient information at this stage to ascertain whether these aquifers are hydraulically separated which is common elsewhere in the Hawkesbury Sandstone in the Sydney Basin.

7.4 Groundwater inflow and drawdown assessment outcomes

7.4.1 Groundwater inflows

Passive groundwater inflows to the planned drained basement walls and subsurface drainage were calculated throughout model simulations. Inflow rates represent the estimated total rate of groundwater flowing into the excavation and the volume (per unit time) from each wall and floor of the excavation for the development during both the remaining phase of construction and operation of the building.

A summary of estimated monthly groundwater inflows is presented in Table 7.4. It is noted that in the first time step the simulated inflow is high as the time varying excavation schedule was not considered; i.e., the basement excavation was modelled as an instantaneous drainage feature at RL 54 m AHD thereby resulting in 'artificially' high estimates of groundwater inflows during the first simulated monthly timestep.

Table 7.4 Estimated construction-phase groundwater inflows

MONTH DURING CONSTRUCTION	AVERAGE INFLOW (L/sec)	AVERAGE DAILY INFLOW (KL†/day)	TOTAL MONTHLY INFLOW (KL†/month)	TOTAL ANNUAL INFLOW (ML/year)
1	1.24#	107.2#	3.26#	6.5
2	0.19	16.5	0.50	
3	0.15	13.1	0.40	
4	0.13	11.3	0.34	
5	0.12	10.1	0.31	
6	0.11	9.3	0.28	
7	0.10	8.7	0.26	
8	0.09	8.2	0.25	
9	0.09	7.8	0.24	
10	0.09	7.5	0.23	
11	0.08	7.2	0.22	
12	0.08	7.0	0.21	
13	0.08	6.8	0.21	2.2
14	0.08	6.6	0.20	
15	0.07	6.4	0.20	
16	0.07	6.3	0.19	
17	0.07	6.2	0.19	
18	0.07	6.1	0.18	
19	0.07	6.0	0.18	
20 ‡	0.07	5.9	0.18	
21 ‡	0.07	5.8	0.18	

MONTH DURING CONSTRUCTION	AVERAGE INFLOW (L/sec)	AVERAGE DAILY INFLOW (KL†/day)	TOTAL MONTHLY INFLOW (KL†/month)	TOTAL ANNUAL INFLOW (ML/year)
22 ‡	0.07	5.7	0.17	
23 ‡	0.07	5.6	0.17	
24 ‡	0.06	5.5	0.16	

Notes: † KL = kilolitres, ML= megalitres

basement excavation modelled as an instantaneous excavation and drainage feature at RL 54 m AHD resulting in conservatively high estimates of groundwater inflows during this timestep

‡ Full duration of project construction (from basement excavation to occupancy) estimated to be between 20 and 24 months.

Simulated estimates of groundwater inflows during long-term operation of the development is presented in Table 7.5. Results indicate that the model reached steady state after about 30 years with groundwater inflow to the basement of the planned development during building occupation varying between about 1.3 and 2.2 ML/year.

Table 7.5 Estimates of operational-phase groundwater inflows

TIME SINCE START OF CONSTRUCTION (YEARS)	AVERAGE DAILY INFLOWS (KL/DAY)	TOTAL ANNUAL INFLOWS (ML/YEAR)
2	5.57	2.2
3	5.11	1.9
4	4.83	1.8
5	4.63	1.7
6	4.49	1.6
7	4.37	1.6
8	4.28	1.6
9	4.21	1.5
10	4.15	1.5
15	3.93	1.4
20	3.81	1.4
25	3.72	1.4
30	3.66	1.3
35	3.62	1.3
40	3.58	1.3
50†	3.58	1.3
100†	3.58	1.3

Notes: KL = kilolitres

ML= megalitres

† Transient groundwater flow model reaches steady state conditions after approximately 40 years and these values estimated from the YR40 timesetp.

In providing the above estimates, particularly those for construction phase of work listed in Table 7.5, it should be noted that an 'instantaneous' excavation below the water table has been modelled (i.e., excavation staging and the progressive lowering of groundwater levels and accompanying inflow rates has not been considered). As such groundwater inflow rates during construction are considered conservative, particularly those in the first six months of the modelled scenarios.

7.4.2 Drawdown

Predictions of the maximum (i.e., long-term) extent of groundwater drawdown (cone of depression) in the sandstone bedrock aquifer for the planned drained basement design were estimated from the 3D numerical groundwater flow modelling. The extent of drawdowns after 2 years (i.e., the end of project construction) and 100 years (steady-state conditions) are presented in Figure 7.9 and Figure 7.10 respectively. These figures suggest:

- at the end of construction:
  - project-induced groundwater level drawdown of 0.5 m or more may extend about 40 m from the planned northern wall and adjacent northern portions of the eastern and western walls of the basement
  - groundwater around all walls of the basement will drain to the planned BEL with maximum groundwater level drawdown of about 15 m occurring along the northern walls of the basement, and
- after 100 years of operation (and indeed after only about 40 years of operation) project-induced groundwater level drawdown of 1 m or more may extend about 150 m from the planned northern wall and adjacent northern portions of the eastern and western walls of the basement.

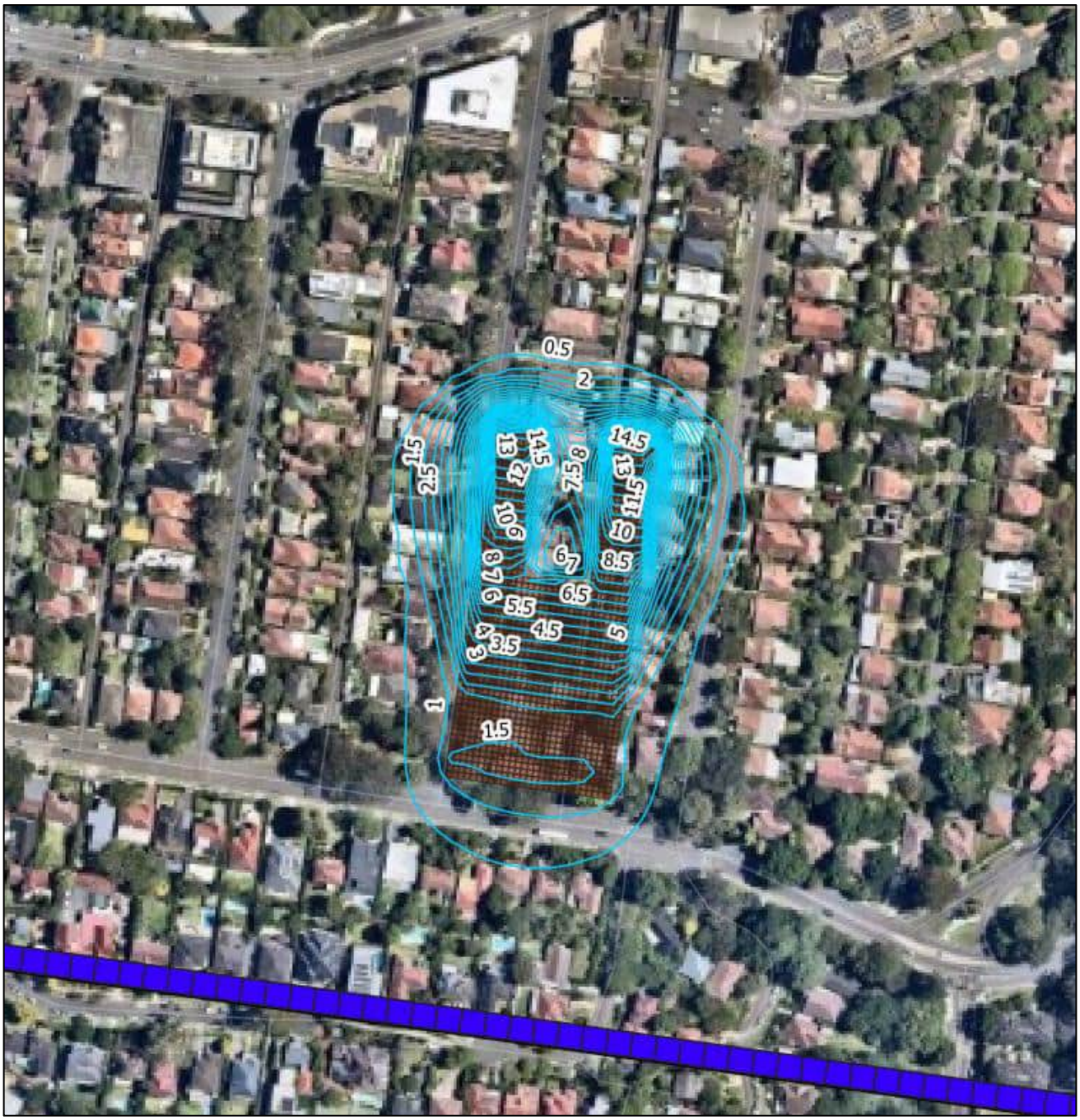


Figure 7.9 Modelled groundwater level drawdown at the end of construction (24 months)

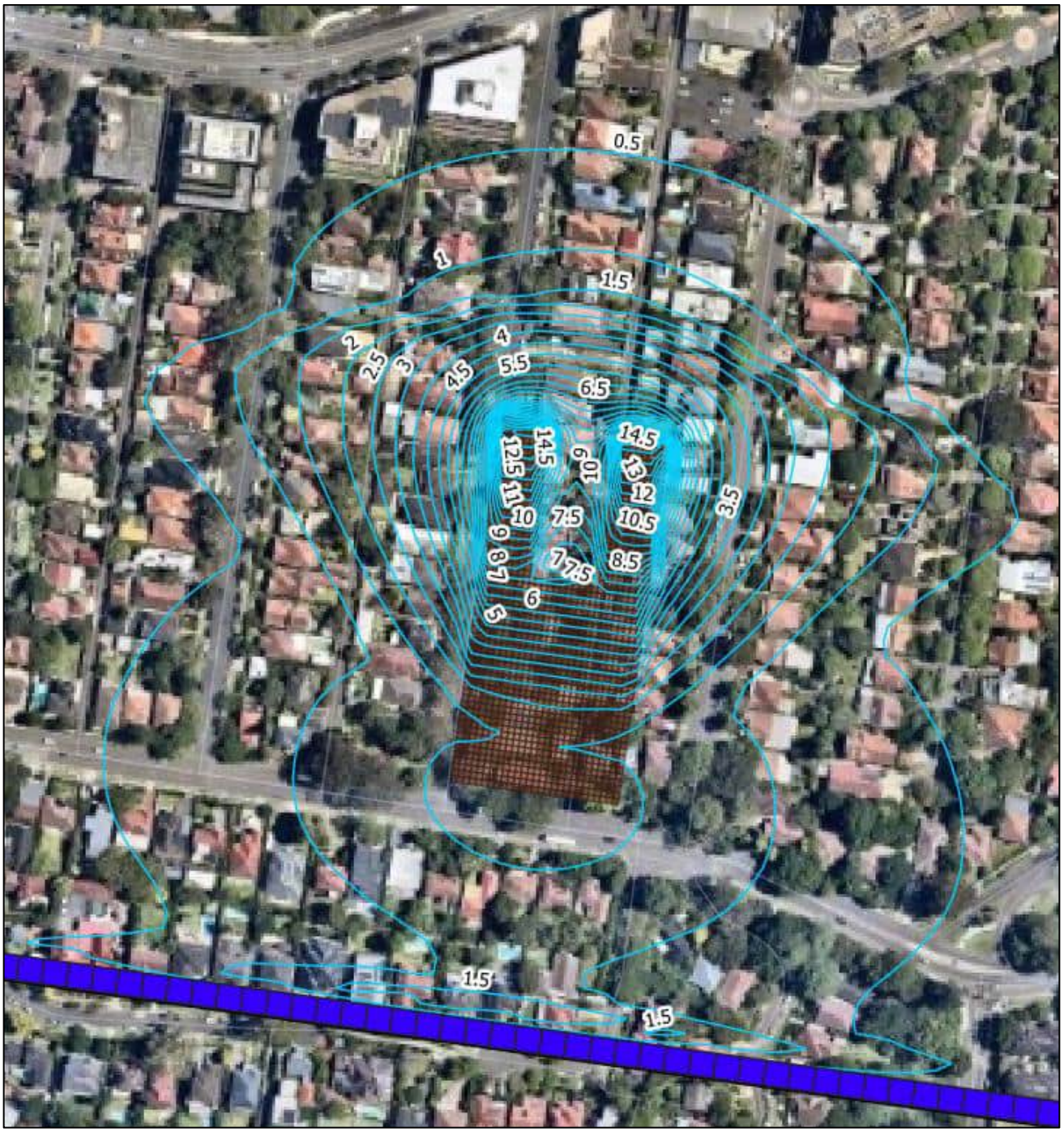


Figure 7.10 Modelled steady-state groundwater level drawdown (after 100 years of operation)

7.4.3 Settlement

The primary aquifer at and surrounding the site is located within low permeability, medium to high strength sandstone bedrock. As such those predicted changes in the elevation of the water table attributable to dewatering and any depressurisation due to the proposed development is expected to result in negligible consolidation and settlement.

Groundwater may also occur in the residual soils across and surrounding the site. Drainage from these soils to the planned excavation is expected to result in lower groundwater levels in the residual soils in these areas, possibly resulting in consolidation in the soils which have not previously been dewatered. In stating this, however, the residual soils at and surrounding the site are over-consolidated (as they are derived from the weathering of the Class IV / V Hawkesbury Sandstone), and these soils would have experienced past wetting and drying cycles associated with climate cycles, hence

any subsidence of these soils is likely to be insignificant and less than the ground disturbance that could reasonably be expected due to construction activities.

In light of the above, it is considered any change in groundwater levels as a result of either short or long-term drainage of groundwater due to the proposed basement excavation will have negligible impact to neighbouring developments and/or infrastructure including:

- underground services along and beneath the boundaries of the site, and
- existing neighbouring public and private assets.

7.4.4 Groundwater drainage quality

Groundwater analytical results presented in Section 6.11 indicates that with the exception of those concentrations of total kjeldahl nitrogen (TKN), no contaminants have been detected within groundwater sampled at the site. The origin of the nitrate and TKN is unknown but is expected to be associated with leakage from nearby sewers.

Although not considered indicative of contamination, concentrations of dissolved iron and manganese are considered to be high and if discharged from the site without treatment then could cause staining in nearby receptors.

Concentrations of copper and zinc, whilst greater than those DVGs for the disposal of collected groundwater to stormwater and ultimately Sydney Harbour, are in line with what could be expected in groundwater samples collected elsewhere from the Hawkesbury Sandstone in the Sydney Basin. Similarly the pH of groundwater at the site is typical of that elsewhere in the Hawkesbury Sandstone. As such these concentrations are not considered to be indicative of groundwater contamination at or in the vicinity of the site but may need consideration for collected water disposal purposes.

At this stage it is not possible to definitively state what potential contaminants may be present in groundwater collected in the basement; however, based on a first-pass appraisal of the site setting and surrounding land uses, potential contaminants of concern may include:

- nitrate
- TKN
- iron, and
- manganese.

It is noted DPE (2022) requires a broader range of analytes to be analysed and monitored both prior to and during construction-phase dewatering; refer to those analytes presented Tables A1 and A2 in Appendix A of DPE (2022). These analytes have been included in the groundwater sampling and monitoring work outlined in Section 9.

Any untreated groundwater released from the site to the stormwater system is expected to discharge to Sydney Harbour and possibly interact with the aquatic habitats of the Gore Cove reserve wetland. As such routine groundwater treatment measures such as pH adjustment and sediment reduction may be necessary prior to groundwater being released directly to the stormwater system. Possible treatment measures, which should be installed and operational prior to the commencement of excavation at the site, includes a groundwater filtration and pH buffering treatment system, which could comprise:

- a baffled treatment tank
- an automated in-line chemical dosing systems for the addition of pH buffering solutions and coagulants (this is expected to coincidentally also reduce dissolved concentrations of iron and manganese in any collected water), and
- a sedimentation tank to provide additional residence time and sedimentation.

Pumping to the stormwater system will be subject to the approval of the relevant authority, either Mane Cove Municipal Council or Sydney Water depending on the stormwater pits used.

8 Groundwater impact assessment

8.1 Minimal impact considerations

The Aquifer Interference Policy (AIP) includes a set of minimal impact considerations for assessing the impacts of aquifer interference activities including those regulated under the WMA 2000, the Water Act 1912 and those decided under the terms and conditions of other legislation. It indicates the term 'aquifer' is commonly understood to mean a groundwater system of sufficient hydraulic conductivity to allow water to move in it, and which can yield productive volumes of groundwater, however, notes those criteria and considerations in the AIP are equally applicable to low-yielding and/or saline groundwater systems.

The area surrounding the site is underlain by stiff to hard clays and mostly high strength rocks including sandstone of the Hawkesbury Sandstone. These soils and rocks are of relatively low yield (<5 L/s) and are a 'less productive groundwater source' as outlined in the AIP.

Table 1 of the AIP outlines minimal impact considerations for both highly productive and less-productive groundwater sources. The AIP also states '*if … predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable*'. An assessment of the 'minimal impact considerations' defined in the AIP for a less-productive groundwater source and responses to these are presented in Table 8.1.

Table 8.1 Minimal impact consideration under the Aquifer Interference Policy

AIP LEVEL 1 MINIMUM IMPACT CONSIDERATION	ASSESSMENT
Water Sharing Plan and Groundwater source	Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 – Sydney Basin Central Groundwater Source
Aquifer	Porous rock
Category	Less productive
Water table Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 m from any high priority: — groundwater dependent ecosystem (GDE), or — culturally significant site — listed in the schedule of the relevant water sharing plan. A maximum of a 2 m declines cumulative at any water *supply* work.	**Water table** The closest GDEs to the site are located 2 km or more to the west and northwest of the site. Given both construction-phase and long-term drawdown (due to the necessitated dewatering works and inclusion of a drained basement) is estimated to extend no more than 400 m from the site boundary, the planned development is not expected to impact these wetlands.

AIP LEVEL 1 MINIMUM IMPACT CONSIDERATION	ASSESSMENT
Water pressure A cumulative water pressure head decline of no more than 2 m at any water supply work.	**Water pressure** No registered water supply works are in the estimated zone of groundwater drawdown (depressurisation). As such the proposed dewatering works and long-term drainage into the planned basement of the planned development are not expected to result in a decline of more than 2 m of the water level in any water supply work.
Water quality Any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	**Water quality** The proposed development (incorporating a drained basement) is not expected to lower the beneficial use category of groundwater beyond 40 m of the site.

Based on the assessment presented in Table 8.1, the proposed development is expected to have impacts that are less than the Level 1 minimum impact considerations, which according to the AIP minimal consideration requirements, would be considered as acceptable.

8.2 Water sharing plan rules for water access approval

The site is in the Greater Metropolitan Region Groundwater Sources (of Sydney) and Sydney Basin Central Groundwater Source. A summary of the rules in this Water Sharing Plan for the granting of water access licences, compared against the results of the groundwater impact assessment, is presented below in Table 8.2. These rules are to be used as a guide only and actual licence conditions are granted at the discretion of WaterNSW.

Table 8.2 Water Sharing Plan rules and groundwater impact assessment considerations

WATER SHARING PLAN RULE	ASSESSMENT
Granting of access licences may be considered for the following: — Commercial access licenses under a control allocation order made in relation to any unassigned water in this water source.	--
To minimise interference between neighbouring water supply works, no water supply works will be granted or amended within the following distances of existing bores: — 400 m from an aquifer access licenced bore on another landholding, or — 100 m from a basic landholder rights bore on another landholding, or — 50 m from a property boundary (unless written consent from the neighbour), or — 1000 m from a local or major water utility bore, or	The proposed development (and therefore the proposed water supply works) will be located more than: — 400 m from an aquifer access licenced bore on another landholding — 100 m from a basic landholder rights bore on another landholding — 1000 m from a local or major water utility bore, and — 200 m from a NSW Office of Water monitoring bore. Given the planned development includes the excavation of basements levels below the regional water table, drainage of water from the regional bedrock aquifer into the planned drained basement will occur within 50 m of most – if not all – boundaries of the site and therefore neighbouring properties.

WATER SHARING PLAN RULE	ASSESSMENT
— 200 m from a NSW Office of Water monitoring bore (unless written consent provided by *WaterNSW* / NSW Office of Water.	However, there are no known registered groundwater supply bores located on any neighbouring properties and is it unlikely a water supply well will be installed near any neighbouring property given: (i) the urbanised and developed nature of the area, and (ii) typical low yields of the Hawkesbury Sandstone (which typically make this resource uneconomical).
To protect bores located near contamination, no water supply works are to be granted or amended within: — 250 m of contamination as identified in the plan, or — 250 to 500 m of contamination as identified in the plan unless no drawdown or water will occur within 250 m of the contamination source, or — Greater than 500 m of contamination as identified in the plan if necessary to protect the water source, the environment or public health and safety. *The plan though also lists circumstances in which these distances may be varied.*	The site is located more than 5 kilometres from the nearest soil and groundwater contamination zone identified in the Water Sharing Plan for the Greater Metropolitan Region (2011). There are also no sites in the predicted zone of groundwater drawdown with 'Declaration of Significantly Contaminated Land' notifications on the *NSW Environment Protection Agency* online public search register.
To protect bores located near sensitive environmental areas, no water supply works will be granted or amended within the following distances of high priority Groundwater Dependent Ecosystems (non-karst) as identified within the plan: — 100 m from bores used solely for extracting basic landholder rights, or — 200 m from bores used for all other access licences. No water supply works will be granted or amended within the following distances from these identified features: — 500 m of high priority karst GDEs, or — Greater than 500 m of a high priority karst GDE if the Minister is satisfied that the work is likely to cause drawdown at the perimeter if the high priority karst GDE, or — 40 m of a river or stream or lagoon (third-order or above), or — 40 m from a first or second-order stream, unless: (i) the water supply work is drilled into underlying parent material and slotted intervals commence deeper than 30 m, or	The planned development will be located more than: — 1,000 m from the nearest GDE — 100 m from any registered bores used solely for extracting basic landholders (water) rights — 200 m of the closest registered bore licenced for water supply purposes — 40 m from a river, third-order or above stream or lagoon — 500 m from a high-priority karst GDE, and — 100 m from the top of an escarpment.

WATER SHARING PLAN RULE	ASSESSMENT
(ii) the Minister is satisfied that a hydrogeological study, submitted by the applicant and assessed as adequate by the Minister, demonstrates that the water supply work will have no more than minimal impact on base flows in the river. — 100 m from the top of an escarpment.	
To protect groundwater dependent culturally sensitive sites, no water supply works will be granted or amended within the following distances of groundwater-dependent culturally significant sites as identified in the plan: — 100 m for bores used for extracting groundwater for basic landholder rights, or — 200 m for bores used for all other aquifer access licences. *The plan though also lists circumstances in which these distances may be varied.*	Based on a review of the Water Sharing Plan there are no groundwater-dependent culturally significant sites within 1 km of site-associated dewatering works. As such the proposed development is not expected to interfere or interact with any groundwater dependent culturally sensitive sites.
Available Water Determinations (AWDs): — 100% stock and domestic, total and major utilities and specific purpose access licences — 1 ML/unit of share aquifer access licences. AWD for aquifer access licences may be reduced in response to a growth in use.	Post-construction (steady-state) groundwater inflows are estimated to be less than 3 ML/year. As such this development could be considered as a 'minor aquifer interference activity' and therefore will not require a water access licence during its operation (post construction).
Trading Rules — Into the groundwater source – not permitted. — Within the groundwater source – permitted subject to local impact assessment. — Conversion to another category of access licence – not permitted.	

9 Monitoring and reporting

9.1 Requirements

Hydrogeological monitoring will be required to meet the requirements of the NSW Government presented in the document titled *Minimum Requirements for Building Site Groundwater Investigations and Reporting* (DPE, 2022). This document prescribes certain requirements that must be complied with to meet the requirements of the Water Management Act 2000, relevant Water Sharing Plans and the NSW AIP.

DPIE (2021) set out the following requirements (which are presented in italics), to which WSP have annotated for the purposes of this Groundwater Impact Assessment. Where relevant the recommended monitoring should be carried out using the following groundwater monitoring wells, including using those automated water-pressure transducers and data loggers in these wells:

- BH10A in the north-eastern corner of the site
- BH11 in the north-western portion of the site, and
- BH9 (which was installed by Coffey in 2018) at the southern end of Berry Road just to the southeast of the site.

Should groundwater monitoring wells BH9 (the Coffey well at the southern end of Berry Road), BH10A or BH11 be damaged or lost, they should be replaced with like for like replacement wells.

That monitoring and reporting presented in Table 9.1 is recommended during the remaining duration of project construction.

Table 9.1 Summary of monitoring and reporting requirements

ITEM	MONITORING	MONITORING FREQUENCY	REPORTING
Groundwater levels	Monitoring of groundwater levels using automated loggers in groundwater monitoring wells BH10A, BH11 and BH9 (southern end of the site). Manual measurement of groundwater levels in BH10B during logger download events. [Automated water pressure transducers and data loggers, also referred to as 'water level loggers', to be retained in the above nominated wells at the site.]	Monthly data logger downloads at hourly intervals	Monthly.
Groundwater quality	Sampling and laboratory analysis of collected groundwater from in-excavation sumps and discharge water for those analytes nominated by DPE (2022).	Sampling and laboratory testing to be conducted monthly throughout construction-stage activities and dewatering. Additionally, weekly measurements of pH, turbidity, temperature, redox and EC of groundwater and any discharge water until construction works are complete, extending to monthly during building operation for as long a dewatering continues.	
Inflow rates	Groundwater inflows to be measured using calibrated meters.	Weekly meter readings throughout construction dewatering and then monthly during building operations for as long as dewatering is carried out.	Weekly during construction and then as required by WaterNSW during building occupancy.

ITEM	MONITORING	MONITORING FREQUENCY	REPORTING
Quantity of dewater	If required, a calibrated flow meter connected to any dewater or treated effluent pump-out system.	Weekly meter readings throughout construction dewatering and then monthly during building operations for as long as dewatering is carried out.	Weekly during construction and then as required by WaterNSW during building occupancy.

9.2 Threshold criteria

Table 9.2 summarises the proposed thresholds and actions to be adopted during construction-stage dewatering.

Table 9.2 Proposed inflow threshold and actions for temporary dewatering

THRESHOLD DESCRIPTION	THRESHOLD / TRIGGER LEVEL	ACTION
Green – Alert	Groundwater inflow at various time-steps <80% than that presented in Table 7.4 and/or Measured groundwater drawdown at various time-steps <80% of that predicted drawdown	— Continue work — Maintain monitoring at the nominated intervals and compare this with water disposal volumes. — Forward monitoring reports and accompanying data sets to all stakeholders (refer to Section 9.3).
Amber – Alarm	Actual groundwater inflows ≥80% and ≤120% of predicted groundwater inflows and/or Actual groundwater drawdown ≥80% and ≤120% of predicted drawdown at each monitoring point	— Continue excavation. — Review monitoring data and compare with predicted inflows presented in Table 7.4. — Increase frequency of monitoring of (i) groundwater inflows to 24-hour intervals, and (ii) groundwater levels to hourly, until notified otherwise by the nominated engineers in consultation with the Builder. — Notify stakeholders (refer to Section 9.3).
Red – Action	Groundwater inflow >120% of predicted inflows and/or Measured groundwater drawdown at various time-steps >120% of that predicted drawdown at each monitoring point	— Cease excavation immediately. — Notify stakeholders (refer to Section 9.3). — Inspect walls and floor of excavation for any areas of enhanced groundwater inflow and unforeseen change(s) in ground conditions (e.g., previously unknown fracture zones). — Undertake a risk assessment and develop an action plan to mitigate ongoing unacceptable inflow volumes including the grouting of any localised high-flow geological features.

9.3 Stakeholders

Lane Cove Municipal Council (Council) is the only stakeholder. They should be contacted within seven days should any *alarm* or *action* items be triggered, and/or any unforeseen adverse impact groundwater at or immediately surrounding the site. Copies of all monitoring reports and accompanying data sets should also be sent to Council.

10 Other considerations

If deemed appropriate, approval for the disposal of groundwater effluent to stormwater will need to comply with the appropriate level of protection (LOP) trigger levels marine water quality outlined in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018 (published by ANZG 2018). The use of the LOPs for dewater disposal assessments assumes Berrys Creek and the nearby Sydney Harbour are slightly (95% LOP) disturbed ecosystems (as defined in Section 3.1 of the guidelines) given they receive surface water runoff from urban catchments which include various type of land uses and accompanying activities, all of which impact surface water quality.

11 Conclusions

Predicted maximum long-term steady-state groundwater (and passive) inflows to the planned drained basement during operation of the development are expected to be between 1.3 ML/year to 2.2 ML/year. Based on this, the passive collection of groundwater in the planned drained basement during the long-term operation of the development will not require a Water Access Licence from WaterNSW; this decision will be at the discretion of WaterNSW.

This annual volume of groundwater intake is expected to have minimal impact to the surrounding groundwater system, neighbouring properties, and other water supply works.

The maximum modelled groundwater drawdown extent (0.5 m drawdown contour) remains within 150 m from the edge of the of basement of the planned development.

Additionally, the planned development is not expected to:

- adversely impact groundwater quality
- interfere with any off-site soil and/or groundwater contamination which could be expected to constitute a significant risk or harm to human health or the environmental, or
- interfere and/or impact any acid sulfate soils, as there are no mapped acid sulfate soils.

Based on the hydrogeological investigation, modelling and impact assessment, it is considered that a drained basement is suitable for the planned development, albeit with this decision ultimately at the discretion of Lane Cove Municipal Council.

12 Limitations

Your attention is drawn to the below. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be and to present you with recommendations on how to minimise the risks associated with the services provided for this project. The document is not intended to reduce the level of responsibility accepted by WSP, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

This Report is provided by WSP Australia Pty Limited (WSP) for Berry Road Developments Pty Ltd (Client) in response to specific instructions from the Client and in accordance with WSP's proposal dated 17 March 2023 and agreement with the Client also dated 17 March 2023 (Agreement).

12.1 Permitted purpose

This Report is provided by WSP for the purpose described in the Agreement and no responsibility is accepted by WSP for the use of the Report in whole or in part, for any other purpose (Permitted Purpose).

12.2 Qualifications and assumptions

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Appendix A

Geotechnical Factual Report

JQZ Pty Ltd

Park Rd St Leonards Development

Geotechnical Factual Report

June 2023



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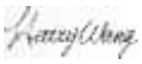
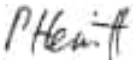
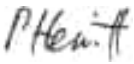
Park Rd St Leonards Development
Geotechnical Factual Report

JQZ Pty Ltd

WSP
Level 27, 680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
wsp.com

Rev	Date	Details
A	07/06/2023	Draft - Appendix to Hydrogeological Report

	Name	Date	Signature
Prepared by:	Harry Wang	05/06/2023	
Reviewed by:	Paul Hewitt	06/06/2023	
Approved by:	Paul Hewitt	06/06/2023	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Table of contents

1 Introduction 1
1.1 Background 1
1.2 Proposed Development 1
1.3 Scope Of This Report 1
2 Site Characterisation 2
2.1 Site Description 2
2.2 Geology 2
3 Desk Study 3
3.1 Previous Studies 3
3.2 Investigation Summary 3
4 Geotechnical Investigations 5
4.1 Site Work Overview 5
4.2 Investigation Methodology 5
4.2.1 Preliminaries 5
4.2.2 Service Location 5
4.2.3 Borehole drilling 6
4.2.4 Point Load Testing 6
4.2.5 Groundwater Monitoring Well Installation 6
4.2.6 Borehole Imaging 6
5 Investigations Results 7
5.1 Subsurface Conditions and Ground Model 7
5.2 Groundwater Conditions 7
5.3 Borehole Imaging 8
6 Limitations 9
References 11

LIST OF DRAWINGS

PS201997-GEO-DRG-0001 – Geotechnical investigation location locality plan

PS201997-GEO-DRG-0002 – Geotechnical cross section AA (North-South Direction)

LIST OF APPENDICES

Appendix A Engineering borehole logs, core photographs and explanation sheets

Appendix B Borehole imaging

Appendix C SYDGE304523-1-AA

Appendix D Survey Plan

1 Introduction

1.1 Background

WSP Australia Pty Ltd (WSP) was engaged by JQZ Pty Ltd (JQZ) to carry out a combined geotechnical and hydrogeological investigation for a proposed development at 26-32 Park Road and 27-35 Berry Road, St Leonards (Site), in general accordance with our proposal PP201997-WSP-SYD-WAT-PRP-00001 Rev1 of 17 March 2023.

This report presents the factual results of the geotechnical site investigation conducted in May 2023. The outcome of the hydrogeological site assessment is provided in a separate report (Ref: PS201997-WSP-SYD-GEO-REP-00001-A).

1.2 Proposed Development

The proposed development consists of the demolition of the existing site structures and construction of four separate residential structures between 7 and 12 storeys in height. A combined basement structure will be constructed beneath the towers which will vary between 2 (at the south part of the site) to 6 stories below ground level (at the north). This will include excavations up to about 20m below ground level (55m AHD) in the northern part of the site.

1.3 Scope Of This Report

In accordance with proposal PP201997-WSP-SYD-WAT-PRP-00001 Rev1 on 17 March 2023 provided to JQZ, the scope of work for the geotechnical investigation and analysis is as follows:

- Review of relevant, available information.
- Preparing of a Health, Environment and Safety Plan (HESP), Ground Penetration Permits (GPP) and presence at the service locating works.
- Drilling of geotechnical and hydrogeological investigation boreholes:
  - Five (5) no. boreholes to a maximum target depth of about 35 metres below ground level (mBGL).
  - Point Load Tests (PLT) on recovered rock core samples, to assess rock strength.
  - Imaging of two (2) boreholes using both the optical televiewer (OTV) and acoustic televiewer (ATV) methods.
  - Installation of five (5) no. groundwater monitoring wells.
- Logging and sampling of retrieved material by an experienced geotechnical engineer in accordance with AS 1726-2017 *Geotechnical site investigations.*
- Production of Geotechnical factual report (GFR) addressing the following aspects:
  - Fieldwork methodology
  - Factual results of the geotechnical site investigation
  - Characterisation of subsurface soil and rock profile.

2 Site Characterisation

2.1 Site Description

The site is rectangular shaped with an approximate area of 12,700m^2 at 26 Park Rd, St Leonards NSW, 2065, approximately 5km north-west of Sydney CBD.

The site is currently occupied by several one and two storey residential properties with some medium height trees and garden areas. The site is bounded by Berry Road to the east, River Road to the south, Park Road to the west and existing residential properties to the north.

The topography of the site slopes from north to south towards River Road, with surface elevation varying from approximately 75m AHD (Australian Height Datum) in the north, to 55m AHD to the south, with an average gradient of 1V:8H.

2.2 Geology

The 1:100,000 Geological map of Sydney indicates that the site lies close to or on the interface between Ashfield Shale, Mittagong Formation and the underlying Hawkesbury Sandstone. The Ashfield Shale is described as black to dark grey shale and laminate, whilst the Hawkesbury Sandstone is described as medium to coarse grained quartz sandstone with very minor shale and laminate lenses.

At the interface between Ashfield Shale and the Hawkesbury Sandstone, the Mittagong Formation is also encountered and is characterised by interbedded sandstones and shales of variable strength, generally less than 8m thick.

3 Desk Study

3.1 Previous Studies

Tetra Tech Coffey Pty Ltd (Coffey) had carried out a geotechnical investigation for an earlier stage of the development at the southern portion of the project site in 2018 (*SYDGE219558-GAR-RPT-02, Coffey, 2018*). This included the drilling of 10 boreholes (BH1 to BH9 and BH7A) to characterise the geotechnical and hydrogeological conditions of the site. A total of five standpipe piezometer were installed to monitor groundwater levels.

3.2 Investigation Summary

A summary of the Coffey completed geotechnical boreholes (2018) is presented in Table 3-1. Investigation locations are further summarised on the site plan provided in Appendix C. Engineering logs, including in-situ test results are presented in Appendix C of this report.

Table 3-1 Summary of boreholes completed by Coffey in 2018

Borehole ID	Easting (m)	Northing (m)	RL AHD	Termination Depth (m BGL)	Termination remark	Surface completion
BH1	332593.14	6255592.88	66.20	10.02	Target Depth	Standpipe piezometer with Gatic cover
BH2	332633.74	6255580.28	64.47	10.11	Target Depth	Backfilled
BH3	332663.83	6255579.14	66.20	10.08	Target Depth	Standpipe piezometer with Gatic cover
BH4	332612.49	6255561.93	63.02	10.42	Target Depth	Backfilled
BH5	332631.96	6255544.25	60.15	10.00	Target Depth	Standpipe piezometer with Gatic cover
BH6	332657.29	6255533.79	61.36	10.07	Target Depth	Backfilled
BH7	332584.02	6255511.96	56.93	1.6	Services Present	Backfilled
BH7A	3328584.41	6255512.40	56.85	10.26	Target Depth	Standpipe piezometer with Gatic cover

Borehole ID	Easting (m)	Northing (m)	RL AHD	Termination Depth (m BGL)	Termination remark	Surface completion
BH8	332627.64	6255510.97	54.92	10.00	Target Depth	Backfilled
BH9	332666.75	6255516.48	60.16	10.48	Target Depth	Standpipe piezometer Gatic cover

4 Geotechnical Investigations

4.1 Site Work Overview

The geotechnical investigation was completed on 26 May 2023 and comprised five (5) boreholes to a maximum depth 36.4 mBGL with associated Point Load Tests (PLT), borehole imaging survey and groundwater monitoring wells installation.

A summary of the completed geotechnical boreholes is presented in Table 4-1. Investigation locations are further summarised on the site plan provided in drawing PS201997-GEO-DRG-0001. Engineering logs, including PLT results and ground water monitoring well details are presented in Appendix A of this report.

Table 4-1 Summary of geotechnical investigation by WSP in 2023 .

Borehole ID	Easting (m)	Northing (m)	RL AHD	Termination Depth (m BGL)	Termination remark	Borehole Imaging	Surface completion
BH9A	332602.87	6255665.93	71.69	26.20	Target Depth	YES	Standpipe piezometer with Gatic cover
BH10A	332651.06	6255657.89	74.17	36.40	Target Depth	YES	Standpipe piezometer with Gatic cover
BH10B	332650.51	6255657.04	74.25	6.00	Target Depth	-	Standpipe piezometer with Gatic cover
BH11	332627.58	6255622.34	67.92	26.40	Target Depth	-	Standpipe piezometer Gatic cover
BH12	332639.82	6255620.78	69.80	25.21	Target Depth	-	Standpipe piezometer Gatic cover

4.2 Investigation Methodology

4.2.1 Preliminaries

The geotechnical investigation was undertaken in accordance with the approved Health Environment and Safety Plan (HESP) and WSP Ground Penetration Permits. Relevant Safe Work Method Statement (SWMS) were adhered to during the extent of the site works.

We conducted a site walkover on 29 March 2023 to assess the accessibility of the borehole locations. Prior to the geotechnical intrusive investigation, pavements and topsoil have been stripped and removed by JQZ.

4.2.2 Service Location

Prior to attending site, a dial-before-you-dig (DBYD) service search was completed and service plans for potential services collected. To determine the presence of underground services, a combination of scanning techniques was used, including a ground penetrating radar (GPR) scan and electrical resistance tomography (ERT).

The proposed borehole investigation locations were identified to be clear of underground utilities prior to the commencement of breaking ground.

4.2.3 Borehole drilling

All field work was managed by an experienced WSP geotechnical engineer and a hydrogeologist who was responsible for supervising drilling activities, soil and rock logging, collecting core samples, directing in-situ testing and preparing engineering logs. All boreholes were drilled using a track-mounted Comacchio GEO 205 drilling rig. A solid flight auger fitted with a tungsten carbide (TC) bit was used to drill through soil strata. Augering continued to refusal, at depths ranging from 1.10 to 4.30 meters below ground level (mBGL). All boreholes were progressed in the rock using HQ3 coring techniques to termination depths in the range 6.00 m to 36.40 mBGL.

Standpipe piezometers were installed to the termination depth on completion of drilling facilitate longer-term monitoring of groundwater levels.

All geotechnical investigation work was carried out in general accordance with AS 1726-2017 *Geotechnical site investigations*.

4.2.4 Point Load Testing

WSP conducted axial and diametral point load strength index testing on core at 1m intervals using a calibrated point load testing machine. Testing followed AS4133.4.1:2007 'Methods of Testing Rocks for Engineering Purposes, Determination of Point Load Strength Index'. Results are shown on the borehole engineering logs as Is(50) values in Appendix A.

4.2.5 Groundwater Monitoring Well Installation

A total of five (5) groundwater monitoring wells were installed during the investigation to allow for further groundwater monitoring and sampling. The standpipes were installed from depth ranging from 19.0 m to 25.5 m.

Each standpipe was constructed using standard 50mm uPVC with 0.4mm machine slotted screen sections from the base of hole, followed by blank 50 mm uPVC casing sections to the ground surface. The standpipes were backfilled with 2 mm sand topped off with a bentonite pellet seal and finished with a gatic cover mounted flush to the existing ground level.

4.2.6 Borehole Imaging

Downhole geophysical testing was carried out to acquire information about discontinuities and defects intersected by the boreholes. Data acquisition and processing was carried out by a team of experienced geophysicists from WSP. Borehole wall imaging was completed using Mechanical Calliper, Acoustic Televiewer (ATV) and Optical Televiewer (OTV).

Data collection was carried out after completion of the borehole drilling, water pressure testing and removal of the drill rods to the top of rock. Drill casing remained in place through soils to prevent sediment collapse into the boreholes. Prior to testing, the borehole was flushed with clean water to remove residual sediment present in the water column.

5 Investigations Results

5.1 Subsurface Conditions and Ground Model

Based on the results of the geotechnical investigation, the geology identified across the site is consistent with the regional geology indicated by the 1:100,000 Sydney Geological map. The ground profile across the site extent can be generally summarised as follows:

- Residual soils, typically comprising medium to high plasticity silty / sandy clay, overlying,
- Sandstone (inferred Hawkesbury Sandstone), typically comprising very low to high strength sandstone.

For geotechnical characterisation of the subsurface conditions and to inform engineering design, the soil and rock types encountered across the site have been generalised into the Geotechnical Units presented in Table 5-1.

Table 5-1 Summary of subsurface conditions and inferred geotechnical ground model

Geotechnical Unit	Generalised Description	Depth to Top of Unit (mBGL)	Thickness (m)
1. Residual Soil All BH	Silty / Sandy CLAY Medium to high plasticity Dark grey to brown-grey With medium to coarse grained sand	0	1.0 to 4.3
2a. Hawkesbury Sandstone All BH	SANDSTONE Medium to coarse grained Brown-grey to orange-red Very low to medium strength Highly weathered to moderately weathered	1.0 to 4.3	3.6 to 5.0
2b. Hawkesbury Sandstone All BH	SANDSTONE Fine to coarse grained Pale grey to brown Medium to high strength Moderately weathered to fresh	4.7 to 8.2	Not penetrated, drilled to a maximum depth of 36.40 m 2.83 m thickness SILTSTONE encountered at 30.12 mBGL in BH10A 2.21m thickness SILTSTONE / BRECCIA encountered at 23.40 mBGL in BH11

5.2 Groundwater Conditions

A total of five (5) groundwater monitoring wells were installed and the monitoring of groundwater levels is ongoing. Referring to the Groundwater Impact Assessment (Ref: PS201997-WSP-SYD-GEO-REP-00001-A) for groundwater monitoring data, packer test results and groundwater assessment.

5.3 Borehole Imaging

Borehole imaging will be provided upon the receipt of the full strip logs.

6 Limitations

Scope of services

This geotechnical site assessment report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and WSP (scope of services). In some circumstances, the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on data

In preparing the report, WSP has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

Geotechnical investigation

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared to meet the specific needs of individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor or even some other consulting civil engineer. This report was prepared expressly for the client and expressly for purposes indicated by the client or his/her representative. Use by any other persons for any purpose, or by the client for a different purpose, might result in problems. The client should not use this report for other than its intended purpose without seeking additional geotechnical advice.

This geotechnical report is based on project-specific factors

This geotechnical engineering report is based on a subsurface investigation, which was designed for project-specification factors, including the nature of any development, its size and configuration, the location of any development on the site and its orientation, and the location of access roads and parking areas. Unless further geotechnical advice is obtained, this geotechnical engineering report cannot be used:

- When the nature of any proposed development is changed.
- When the size, configuration location or orientation of any proposed development is modified.

This geotechnical engineering report cannot be applied to an adjacent site.

The limitations of site investigation

When assessing a site from a limited number of boreholes or test pits there is the possibility that variations may occur between test locations. Site exploration identifies specific subsurface conditions only at those points from which samples have been taken. The risk that variations will not be detected can be reduced by increasing the frequency of test locations; however, this often does not result in any overall cost savings for the project. The investigation program undertaken is a professional estimate of the scope of investigation required to provide a general profile of the subsurface conditions. The data derived from the site investigation program and subsequent laboratory testing are extrapolated across the site to form an inferred geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regards to the proposed development. Despite investigation the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

The borehole logs are the subjective interpretation of subsurface conditions at a particular location, made by trained personnel. The interpretation may be limited by the method of investigation and cannot always be definitive. For example, inspection of an excavation or test pit allows a greater area of the subsurface profile to be inspected than borehole investigation, however, such methods are limited by depth and site disturbance restrictions. In borehole investigation, the actual interface between materials may be more gradual or abrupt than a report indicates.

Subsurface conditions are time dependent

Subsurface conditions may be modified by changing natural forces or man-made influences. A geotechnical engineering report is based on conditions which existed at the time of subsurface exploration.

Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept appraised of any such events and should be consulted to determine if additional tests are necessary.

Avoid misinterpretation

A geotechnical engineer should be retained to work with other appropriate design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

Bore/profile logs should not be separated from the engineering report

Final bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings. To minimise the likelihood of bore/profile log misinterpretation, contractors should be given access to the complete geotechnical engineering report prepared or authorised for their use. Providing the best available information to contractors helps prevent costly construction problems. For further information on this matter reference should be made to ‘Guidelines for the Provision of Geotechnical Information in Construction Contracts’ published by the Institution of Engineers Australia, National Headquarters, Canberra 1987.

Geotechnical involvement during construction

During construction, excavation is frequently undertaken which exposes the actual subsurface conditions. For this reason, geotechnical consultancy should be retained through the construction stage to identify variations if they are exposed, and to conduct additional tests, which may be required and to deal quickly with geotechnical problems if they arise.

Report for benefit of client

The report has been prepared for the benefit of the client and no other party. WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other limitations

WSP will not be liable to update or revise the report to consider any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

References

- Herbert C., 1983, *Sydney 1:100 000 Geological Sheet 9130, 1st edition*. Geological Survey of New South Wales, Sydney.
- Australian Standard AS1726 – 2017: Geotechnical Site Investigations, Standards Australia.
- Australian Standard, AS 1289 *Methods of testing soils for engineering purposes.*
- Tetra Tech Coffey Pty Ltd *St Leonards Development Geotechnical Assessment Report,* Ref: SYDGE219558-GAR-RPT-02, dated 30 August 2022.
- Tetra Tech Coffey Pty Ltd *Park Rd St Leonards Dewatering management plan,* Ref: YDGE304523-1-AA, dated 30 March 2023.
- WSP Australia Pty Ltd *St Leonards South Development Groundwater Impact Assessment,* Ref: PS201997-WSP-SYD-REP-00001-A, dated 07 June 2023.

DRAWINGS

PS106114-GEO-DRG-0001



REV	DATE	BY	DESCRIPTION	CHK	APPD
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REFERENCE COORDINATION DRAWINGS

DESCRIPTION	DRAWING NO.	REV	CHK
N/A	N/A		

SURVEY DATUM

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SCALES: NTS

A3 ORIGINAL
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wsp
Level 27, 680 George Street, Sydney
GPO Box 5394, NSW 2001, Australia
Tel: +61 2 9272 5100 Fax: +61 2 9272 5101
wsp.com

CLIENT: JQZ

PROJECT: Park Rd St Leonards Development

TITLE: GEOTECHNICAL INVESTIGATION LOCATION LOCALITY PLAN

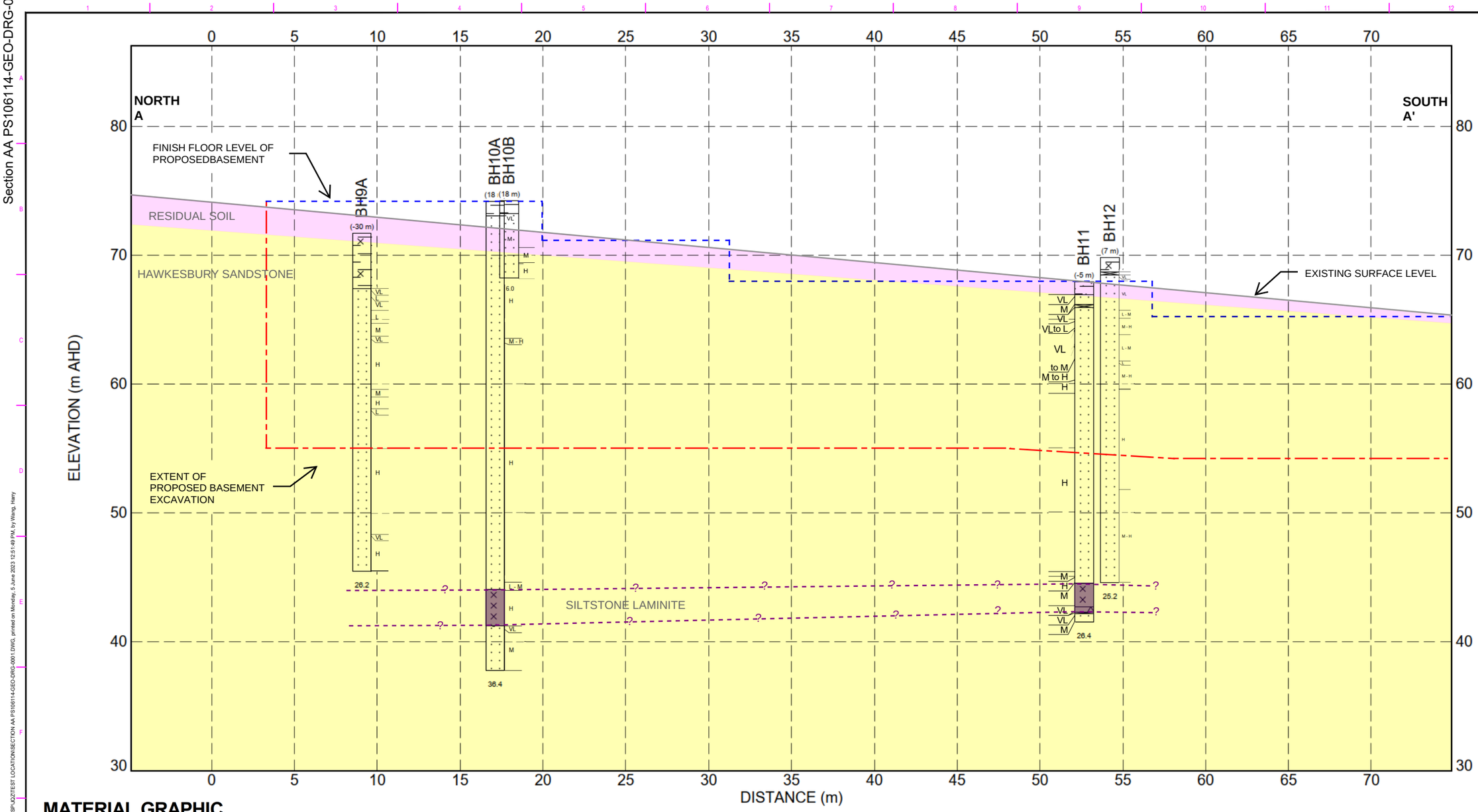
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DESIGNED:	CHECKED:	APPROVED:
Harry Wang	PAUL HEWITT	PAUL HEWITT
PROJECT No:	DRAWN:	DATE:
PS201997	Harry Wang	05/06/2023

DRAWING No: PS201997-GEO-DRG-0001 REV: A

File name:C:\USERS\AUWS002783\ONEDRIVE - WSP O365\PS\201997 ST LEONARD JQZ\GFR\PS106114-GEO-DRG-0001.DWG, printed on Monday, 5 June 2023 7:45:24 AM, by Wang, Harry

Section AA PS106114-GEO-DRG-0001



MATERIAL GRAPHIC

CLAY

Silty CLAY

Sandy CLAY

SANDSTONE

SILTSTONE

REV	DATE	BY	DESCRIPTION	CHK	APPD
A	06/06/2023	HW	DA	PH	PH

REFERENCE COORDINATION DRAWINGS

DESCRIPTION	DRAWING NO.	REV	CHK
DKO Drawing Section 2	DA310	B	XD

SURVEY DATUM

HORIZONTAL DATUM: N/A

VERTICAL DATUM: N/A

SCALES: NTC

A3 ORIGINAL
DO NOT SCALE THIS DRAWING

APPROVED

SIGNED:

DATE: RPEQ:

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wsp
Level 27, 680 George Street, Sydney
GPO Box 5394, NSW 2001, Australia
Tel: +61 2 9272 5100 Fax: +61 2 9272 5101
wsp.com

CLIENT: JQZ

PROJECT: Park Rd St Leonards Development

TITLE: GEOLOGICAL CROSS SECTION
SECTION AA'(NORTH - SOUTH DIRECTION)

DRAWING STATUS: DEVELOPMENT APPLICATION

DESIGNED:	CHECKED:	APPROVED:
Harry Wang	PAUL HEWITT	PAUL HEWITT
PROJECT No:	DRAWN:	DATE:
PS201997	Harry Wang	05/06/2023

DRAWING No: PS201997-GEO-DRG-0002 REV: A

File name C:\USERS\AUWX0278\ONEDRIVE - THE UNIVERSITY OF SYDNEY (STUDENTS)\WSP\JQZ\TEST LOCATION\SECTION AA PS106114-GEO-DRG-0001.DWG, printed on Monday, 5 June 2023 12:51:49 PM, by Wang, Harry

Appendix A

Engineering borehole logs, core photographs and explanation sheets



NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BH9A

FILE / JOB NO : PS201997
SHEET : 1 OF 4

CLIENT : JQZ
LOCATION : 26 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332602.9, N: 6255665.9 (MGA2020-56) SURFACE ELEVATION : 71.69 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 17/5/2023 DATE COMPLETED : 18/5/2023 DATE LOGGED : 18/5/2023 LOGGED BY : MS CHECKED BY : AK

DRILLING					MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m) RL (m AHD)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
VE	(NFGWE)	E-F			0.0 71.7			Silty CLAY: high plasticity, pale grey, with medium to coarse grained sand, inferred soft to stiff			RESIDUAL SOIL
					1.0 70.7						
					2.0 69.7		CH		w>PL	S to St	
AD/T					3.0 68.7						
					4.0 67.7			4.30m			
								Continued as Cored Drill Hole			
					5.0 66.7						
					6.0 65.7						
					7.0 64.7						
					8.0 63.7						
					9.0 62.7						
					10.0 61.7						

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 14:26 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH9A

FILE / JOB NO : PS201997
SHEET : 2 OF 4

CLIENT : JQZ
LOCATION : 26 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332602.9, N: 6255665.9 (MGA2020-56) SURFACE ELEVATION : 71.69 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 17/5/2023 DATE COMPLETED : 18/5/2023 DATE LOGGED : 18/5/2023 LOGGED BY : MS CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : Good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
					0.0							
					1.0							
					2.0							
					3.0							
					4.0		4.30m START CORING AT 4.30m					
HQ3	100% RETURN	0% LOSS 4.82	100				SANDSTONE: medium to coarse grained, dark grey to grey - brown, thinly bedded to medium bedded at 5°-10°	HW				P, 10°, clay IF, PR, RF P, 10°, CN, PR, RF
	100% RETURN	0% LOSS 6.29	100	Is(50) D=0.14 MPa Is(50) A=0.14 MPa Is(50) D=0.05 MPa Is(50) A=0.05 MPa	5.0							DB DB
	100% RETURN	0% LOSS 7.84	100	Is(50) D=0.21 MPa Is(50) A=0.30 MPa Is(50) D=0.29 MPa Is(50) A=0.53 MPa	6.0		5.82m: becoming dark brown to brown 6.29m: becoming dark grey to brown - grey					P, 10°, Fe SN, PR, RF P, 10°, Fe SN, PR, RF DB DB P, 10°, Fe SN, PR, RF
	100% RETURN	0% LOSS 9.34	100	Is(50) D=1.28 MPa Is(50) A=1.91 MPa	7.0		7.00m SANDSTONE: medium to coarse grained, pale grey to grey, thinly bedded to thickly bedded at 5°-10°	MW SW				DB DB
	100% RETURN	0% LOSS	100	Is(50) D=1.15 MPa Is(50) A=1.17 MPa	8.0			SW to FR				DB P, 15°, CN, PR, RF P, 10°, CN, PR, RF
					9.0							DB DB DB
					10.0							DB

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 15:08 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH9A

FILE / JOB NO : PS201997
SHEET : 3 OF 4

CLIENT : JQZ
LOCATION : 26 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332602.9, N: 6255665.9 (MGA2020-56) SURFACE ELEVATION : 71.69 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 17/5/2023 DATE COMPLETED : 18/5/2023 DATE LOGGED : 18/5/2023 LOGGED BY : MS CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : Good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2, L -6, M -20, H -60, VH -200, EH	NATURAL FRACTURE (mm) 20, 40, 100, 300, 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
HQ3	100% RETURN	0% LOSS 10.85	100	Is(50) D=0.71 MPa Is(50) A=1.77 MPa	10.0		SANDSTONE: medium to coarse grained, pale grey to grey, thinly bedded to thickly bedded at 5°-10° *(continued)*	SW to FR				DB IS, clay IF, 10 mm DB DB
	100% RETURN	0% LOSS 12.36	100	Is(50) D=0.51 MPa Is(50) A=2.93 MPa	11.0 12.0							P, 5°, CN, PR, RF P, 15°, CN, PR, RF DB DB
	100% RETURN	0% LOSS 13.82	100	Is(50) D=0.24 MPa Is(50) A=0.59 MPa	13.0							DB DB J, 80°, CN, PR, RF IS, sandy and clay IF, PR, RF, 10 mm DB
	100% RETURN	0% LOSS 15.40	100	Is(50) D=0.63 MPa Is(50) A=3.01 MPa Is(50) D=0.14 MPa Is(50) A=2.40 MPa	14.0 15.0							DB DB DB IS, sandy and clay IF, PR, RF, 10 mm DB
	100% RETURN	0% LOSS 16.90	100	Is(50) D=1.04 MPa Is(50) A=1.29 MPa	16.0							DB DB DB
	100% RETURN	0% LOSS 18.37	100	Is(50) D=1.13 MPa Is(50) A=1.12 MPa Is(50) D=1.66 MPa Is(50) A=1.34 MPa	17.0 18.0							DB DB DB DB
	100% RETURN	0% LOSS 19.88	100	Is(50) D=1.25 MPa Is(50) A=1.70 MPa Is(50) D=1.55 MPa Is(50)	19.0 20.0							DB DB P, 5°, CN, PR, RF DB

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:33 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH9A

FILE / JOB NO : PS201997
SHEET : 4 OF 4

CLIENT : JQZ
LOCATION : 26 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332602.9, N: 6255665.9 (MGA2020-56) SURFACE ELEVATION : 71.69 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 17/5/2023 DATE COMPLETED : 18/5/2023 DATE LOGGED : 18/5/2023 LOGGED BY : MS CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : Good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
HQ3	100% RETURN	0% LOSS 21.45	100	A=1.83 MPa Is(50) D=1.06 MPa Is(50) A=1.72 MPa	20.0 21.0		SANDSTONE: medium to coarse grained, pale grey to grey, thinly bedded to thickly bedded at 5°-10° *(continued)*	SW to FR				DB P, 10°, carbonaceous material IF, PR, RF DB
	100% RETURN	0% LOSS 22.89	100	Is(50) D=1.13 MPa Is(50) A=1.32 MPa	22.0		21.45m: becoming pale brown					DB DB DB
	100% RETURN	0% LOSS 24.45	92	Is(50) D=1.35 MPa Is(50) A=1.52 MPa Is(50) D=1.01 MPa Is(50) A=1.42 MPa	23.0 24.0							DB DB IS4, sand and clay IF, 20 mm DB
	100% RETURN	0% LOSS 25.94	100	Is(50) D=1.06 MPa Is(50) A=1.32 MPa Is(50) D=1.60 MPa	25.0							FZ, Cr IF, 50 mm
	100% RETURN	0% LOSS 26.20	100	Is(50) A=1.96 MPa	26.0		26.20m Hole Terminated at 26.20 m Target depth					
					27.0 28.0 29.0 30.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:33 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH9A

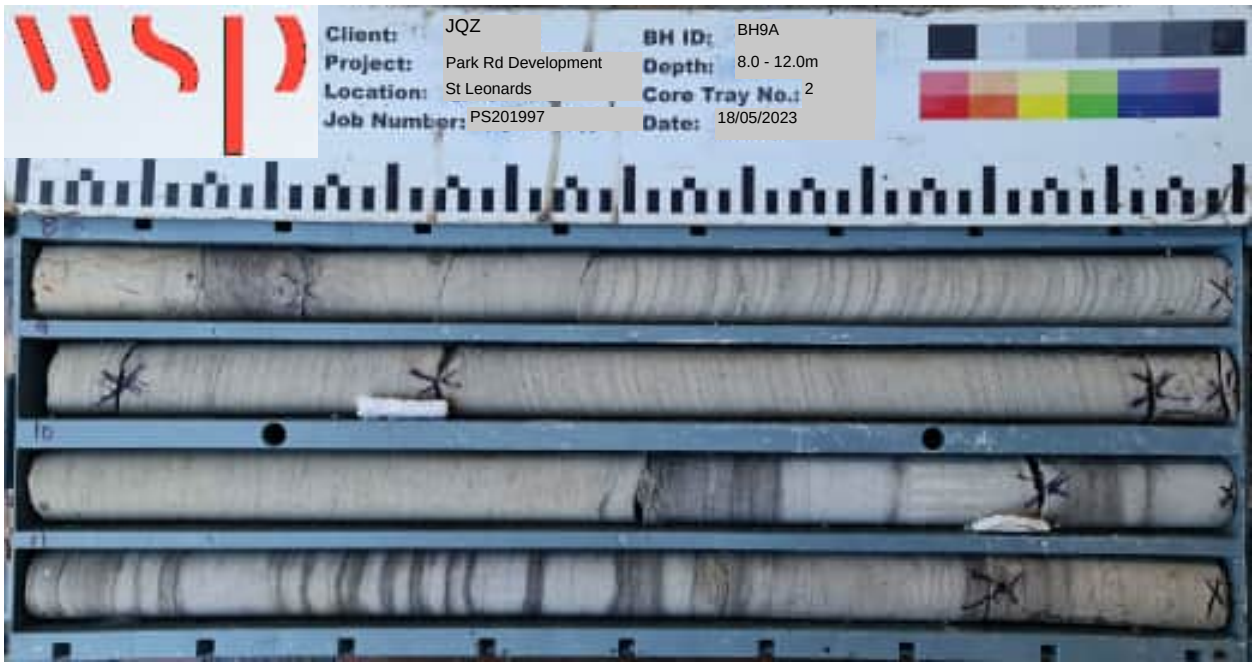
CLIENT: JQZ
PROJECT: Park Road St Leonards Development
LOCATION: St Leonards
JOB NO: PS201997

INCLINATION: -90°
HOLE DIA: 110 mm HOLE DEPTH: 26.20 m

DRILL RIG: GEO205
CONTRACTOR: NUMAC
LOGGED: MS DATE: 18/5/23
CHECKED: AK DATE: 02/5/23



PointID : BH9A Depth Range: 4.30 - 8.00 m



PointID : BH9A Depth Range: 8.00 - 12.00 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

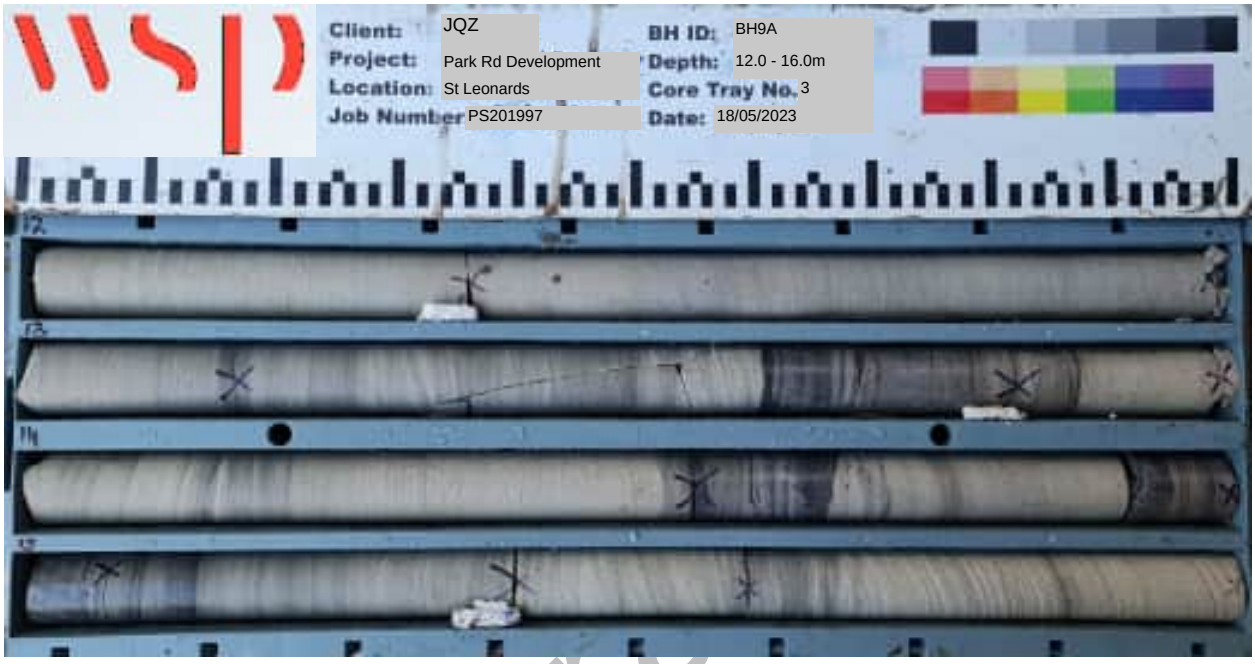
WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:57 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH9A

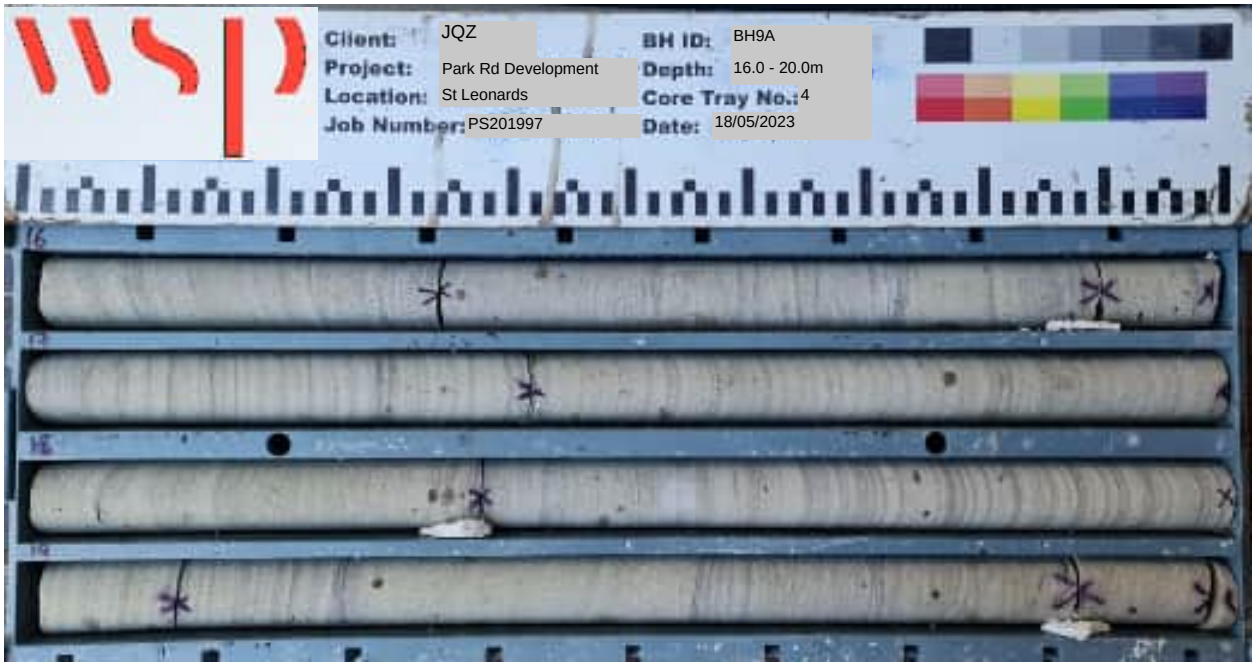
CLIENT: JQZ
PROJECT: Park Road St Leonards Development
LOCATION: St Leonards
JOB NO: PS201997

INCLINATION: -90°
HOLE DIA: 110 mm HOLE DEPTH: 26.20 m

DRILL RIG: GEO205
CONTRACTOR: NUMAC
LOGGED: MS DATE: 18/5/23
CHECKED: AK DATE: 02/5/23



PointID : BH9A Depth Range: 12.00 - 16.00 m



PointID : BH9A Depth Range: 16.00 - 20.00 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:57 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH9A

SHEET: 3 OF 3

CLIENT: JQZ
DRILL RIG: GEO205

PROJECT: Park Road St Leonards Development
CONTRACTOR: NUMAC

LOCATION: St Leonards
INCLINATION: -90°
LOGGED: MS DATE: 18/5/23

JOB NO: PS201997
HOLE DIA: 110 mm HOLE DEPTH: 26.20 m
CHECKED: AK DATE: 02/5/23



PointID : BH9A Depth Range: 20.00 - 24.00 m



PointID : BH9A Depth Range: 24.00 - 26.20 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

GAP gINT FN. F28
RL1

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:57 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

HOLE NO : BH9A

CLIENT : JQZ
LOCATION : 26 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

FILE / JOB NO : PS201997
SHEET : 1 OF 2

POSITION : E: 332602.9, N: 6255665.9 (MGA2020-56) SURFACE ELEVATION : 71.69 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC

DATE STARTED : 17/5/2023 DATE COMPLETED : 18/5/2023 DATE LOGGED : 18/5/2023 LOGGED BY : MS CHECKED BY : AK

PERMIT NUMBER :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	
			0.0			Silty CLAY: high plasticity, pale grey, with medium to coarse grained sand, inferred soft to stiff	ID: BH9A, Type: Standpipe, Stick Up & RL: 0.00 m 71.69 m AHD, Tip Depth & RL: 22.00 m 49.69 m AHD, Installation Date, Static Water Level
VE	(NFGWE)		2.0		CH		
AD/T			4.0			4.30m	
	100% RETURN		6.0			SANDSTONE: medium to coarse grained, dark grey to grey - brown, thinly bedded to medium bedded at 5°-10° 5.82m: becoming dark brown to brown 6.29m: becoming dark grey to brown - grey	
						7.00m	
			8.0			SANDSTONE: medium to coarse grained, pale grey to grey, thinly bedded to thickly bedded at 5°-10°	
			10.0				
			12.0				
			14.0				
HQ3			16.0				16.00 m 16.00 m
			18.0				
			20.0				
			22.0			21.45m: becoming pale brown	22.00 m 22.00 m
			24.0				
			26.0			26.20m	
	100% RETURN		28.0			Hole Terminated at 26.20 m Target depth	

Gatic Cover
Grout
Bentonite
Gravel
ID: BH9A STICKUP: 0.00 m RL: 71.69 m AHD
Sand

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0.UB.GLB Log IS AU PIEZOMETER INSTALLATION 2 PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 21:34 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BH10A

FILE / JOB NO : PS201997
SHEET : 1 OF 5

CLIENT : JQZ
LOCATION : 27 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332651.1, N: 6255657.9 (MGA2020-56) SURFACE ELEVATION : 74.17 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 19/5/2023 DATE COMPLETED : 22/5/2023 DATE LOGGED : 22/5/2023 LOGGED BY : HW CHECKED BY : AK

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m) RL (m AHD)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
VE	(NFGWE)	E-F			0.0 74.2		CH	CLAY: high plasticity, grey-brown, with fine to coarse grained sand, inferred soft to stiff	w>PL	S to St	RESIDUAL SOIL
					1.0 73.2			1.10m Continued as Cored Drill Hole			
					2.0 72.2						
					3.0 71.2						
					4.0 70.2						
					5.0 69.2						
					6.0 68.2						
					7.0 67.2						
					8.0 66.2						
					9.0 65.2						
					10.0 64.2						

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 14:27 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH10A
FILE / JOB NO : PS201997
SHEET : 2 OF 5

CLIENT : JQZ
LOCATION : 27 Berry Rd St Leonards
PROJECT : Park Road St Leonards Development

POSITION : E: 332651.1, N: 6255657.9 (MGA2020-56) SURFACE ELEVATION : 74.17 (AHD) ANGLE FROM HORIZONTAL : 90°
RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY
DATE STARTED : 19/5/2023 DATE COMPLETED : 22/5/2023 DATE LOGGED : 22/5/2023 LOGGED BY : HW CHECKED BY : AK
CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2, L -6, M -20, H -60, VH -200, EH	NATURAL FRACTURE (mm) 20, 40, 100, 300, 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
					0.0							
					1.0		1.10m START CORING AT 1.10m					
HQ3	100% RETURN	0% LOSS 1.80	63		2.0		SANDSTONE: medium to coarse grained, pale grey to brown-grey, heavily stained orange and red, thinly bedded to medium bedded at 5°-15°	XW HW				EW, sand and clay IF, 150 mm Px5, 5 - 15°, Fe SN, PR, RF
	100% RETURN	0% LOSS 3.35	54	Is(50) D=0.08 MPa Is(50) A=0.35 MPa Is(50) D=0.38 MPa Is(50) A=1.26 MPa	3.0							Px8, 5 - 10°, PR, RF EW, clay IF, 70 mm IS, clay IF, 20 mm EW, clay IF
	100% RETURN	0% LOSS 4.85	75	Is(50) D=0.10 MPa Is(50) A=0.40 MPa	4.0		4.15m: becoming fine to medium grained, grey to pale grey, slightly mottled orange, medium to thickly bedded at 0°-10°	MW				EW, sand and clay IF, 50 mm Px4, 0 - 10°, Fe SN, PR, RF IS Px7, 0 - 10°, Fe SN, PR, RF
	100% RETURN	0% LOSS 6.35	87	Is(50) D=0.45 MPa Is(50) A=1.46 MPa Is(50) D=0.95 MPa Is(50) A=1.57 MPa	5.0 6.0			SW to FR				J, 45°, Fe SN, PR, RF P, 0°, CN, PR, RF IS, clay IF, 20 mm P, 5°, CN, PR, RF DB P, 5°, CN, PR, RF P, 5°, CN, PR, RF
	100% RETURN	0% LOSS 7.85	98	Is(50) D=0.77 MPa Is(50) A=1.52 MPa	7.0							Px4, 0 - 5°, CN, PR, RF DB Px4, 0 - 5°, CN, PR, RF
	100% RETURN	0% LOSS 9.40	100	Is(50) D=0.36 MPa Is(50) A=1.86 MPa Is(50) D=0.21 MPa Is(50) A=0.98 MPa	8.0 9.0							P, 5°, CN, PR, RF DB
	80% RETURN	0% LOSS	100	Is(50) D=0.91 MPa Is(50)	10.0							J, 50°, Fe SN, PR, RF

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:35 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH10A

FILE / JOB NO : PS201997
SHEET : 3 OF 5

CLIENT : JQZ
LOCATION : 27 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332651.1, N: 6255657.9 (MGA2020-56) SURFACE ELEVATION : 74.17 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 19/5/2023 DATE COMPLETED : 22/5/2023 DATE LOGGED : 22/5/2023 LOGGED BY : HW CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
HQ3	80% RETURN	0% LOSS 10.85	100	A=1.17 MPa	10.0		SANDSTONE: medium to coarse grained, pale grey to brown-grey, heavily stained orange and red, thinly bedded to medium bedded at 5°-15° *(continued)*	SW to FR				P, 15°, Fe SN, PR, RF P, 0°, CN, PR, RF
	85% RETURN	0% LOSS 12.35	99	Is(50) D=0.29 MPa Is(50) A=0.96 MPa	11.0		10.90 - 11.15m: interbedded with Siltstone, dark grey					DB
				Is(50) D=1.08 MPa Is(50) A=1.08 MPa	12.0		11.90 - 12.50m: interbedded with Siltstone, dark grey					Px7, 0 - 5°, CN, PR, RF
	90% RETURN	0% LOSS 13.90	100	Is(50) D=0.91 MPa Is(50) A=1.79 MPa	13.0		12.60m: becoming medium to coarse grained, thickly bedded at 0°-15°					P, 0°, CN, PR, RF P, 0°, CN, PR, RF DB
	85% RETURN	0% LOSS 15.45	100	Is(50) D=1.29 MPa Is(50) A=1.50 MPa Is(50) D=2.00 MPa Is(50) A=1.97 MPa	14.0 15.0							P, 0°, CN, PR, RF DB P, 10°, CN, PR, RF
	85% RETURN	0% LOSS 16.95	100	Is(50) D=0.98 MPa Is(50) A=1.40 MPa	16.0							P, 0°, CN, PR, RF P, 5°, CN, PR, RF
	85% RETURN	0% LOSS 18.47	100	Is(50) D=1.25 MPa Is(50) A=1.44 MPa Is(50) D=1.51 MPa Is(50) A=1.83 MPa	17.0 18.0							DB P, 0°, CN, PR, RF DB P, 5°, CN, PR, RF
	85% RETURN	0% LOSS 19.96	100	Is(50) D=1.60 MPa Is(50) A=2.02 MPa Is(50) D=0.68 MPa Is(50)	19.0 20.0		19.70m: becoming fine to medium grained, grey					DB DB DB

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:35 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH10A

FILE / JOB NO : PS201997

SHEET : 4 OF 5

CLIENT : JQZ

LOCATION : 27 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332651.1, N: 6255657.9 (MGA2020-56) SURFACE ELEVATION : 74.17 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 19/5/2023 DATE COMPLETED : 22/5/2023 DATE LOGGED : 22/5/2023 LOGGED BY : HW CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
HQ3	85% RETURN	0% LOSS 21.42	100	A=1.63 MPa Is(50) D=1.62 MPa Is(50) A=1.51 MPa	20.0 21.0		SANDSTONE: medium to coarse grained, pale grey to brown-grey, heavily stained orange and red, thinly bedded to medium bedded at 5°-15° *(continued)* 20.00m: becoming coarse grained, pale brown, very thickly bedded at 5°-15°	SW to FR				P, 5°, CN, PR, RF
	85% RETURN	0% LOSS 22.96	100	Is(50) D=2.24 MPa Is(50) A=2.50 MPa	22.0							
	85% RETURN	0% LOSS 24.50	100	Is(50) A=1.84 MPa Is(50) D=1.69 MPa Is(50) A=1.54 MPa	23.0 24.0							
	85% RETURN	0% LOSS 25.95	100	Is(50) D=1.31 MPa Is(50) A=1.97 MPa Is(50) D=1.53 MPa	25.0 26.0		24.80-25.00m: interbedded with Siltstone, dark grey					Px3, 0 - 10°, CN, PR, RF
	85% RETURN	0% LOSS 27.53	100	Is(50) A=1.45 MPa Is(50) D=1.52 MPa Is(50) A=2.01 MPa	27.0							DB DB
	85% RETURN	0% LOSS 28.97	100	Is(50) D=1.64 MPa Is(50) D=1.78 MPa Is(50) A=1.98 MPa	28.0							P, 15°, CN, PR, RF DB
	85% RETURN	0% LOSS	73	Is(50) D=1.14 MPa Is(50) A=1.45 MPa Is(50) D=0.43 MPa Is(50)	29.0 30.0							J, 10°, CN, PR, RF IS, sand and clay IF, 40 mm Jx4, 45 - 90°, CN, PR, RF

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB:GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:35 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH10A

FILE / JOB NO : PS201997
SHEET : 5 OF 5

CLIENT : JQZ
LOCATION : 27 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332651.1, N: 6255657.9 (MGA2020-56) SURFACE ELEVATION : 74.17 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 19/5/2023 DATE COMPLETED : 22/5/2023 DATE LOGGED : 22/5/2023 LOGGED BY : HW CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2, L -6, M -20, H -60, VH -200, EH	NATURAL FRACTURE (mm) 20, 40, 100, 300, 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
HQ3	85% RETURN	0% LOSS 30.52	73	A=0.31 MPa	30.0		30.12m	SW to FR				ISx5, clay IF, 10 mm
		0% LOSS 31.98	100	Is(50) D=0.28 MPa Is(50) A=1.11 MPa	31.0		SILTSTONE: dark grey to grey, laminated to thinly bedded at 0°-5°.					J20, 20°, CN, CU, RF DB DB DB DB DB J, 45°, CN, PR, RF
		0% LOSS 33.54	94	Is(50) D=0.88 MPa Is(50) A=1.37 MPa Is(50) D=0.57 MPa Is(50) A=1.36 MPa	32.0		31.40m-33.95m: with fine grained Sandstone lamination (30%) 32.95m					DB P, 0°, CN, PR, RF DB J, 55°, CN, PR, RF
		0% LOSS 35.05	83	Is(50) D=0.54 MPa Is(50) A=0.77 MPa Is(50) D=0.44 MPa Is(50) A=0.39 MPa	33.0 34.0 35.0		SANDSTONE: medium to coarse grained, grey to pale grey, thinly bedded to medium bedded at 5°-20°					J, 50°, CN, PR, RF J, 50°, CN, PR, RF J, 90°, Cr IF, IR, RF Px3, 0 - 5°, clay IF, PR, RF Px5, 10 - 20°, CN, PR, RF P, 10°, CN, PR, RF J, 60°, CN, PR, RF P, 15°, CN, PR, RF P, 15°, CN, PR, RF P, 10°, CN, PR, RF
		0% LOSS 36.40	73	Is(50) D=0.64 MPa Is(50) A=0.78 MPa	36.0		36.40m Hole Terminated at 36.40 m Target depth					P, 15°, CN, PR, RF DB P, 5°, CN, PR, RF DB P, 5°, CN, PR, RF P, 5°, CN, PR, RF DB P, 15°, CN, PR, RF P, 15°, CN, PR, RF FZ, sand and clay IF, 90 mm Px7, 5 - 15°, sand infill, IR, RF
					37.0 38.0 39.0 40.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

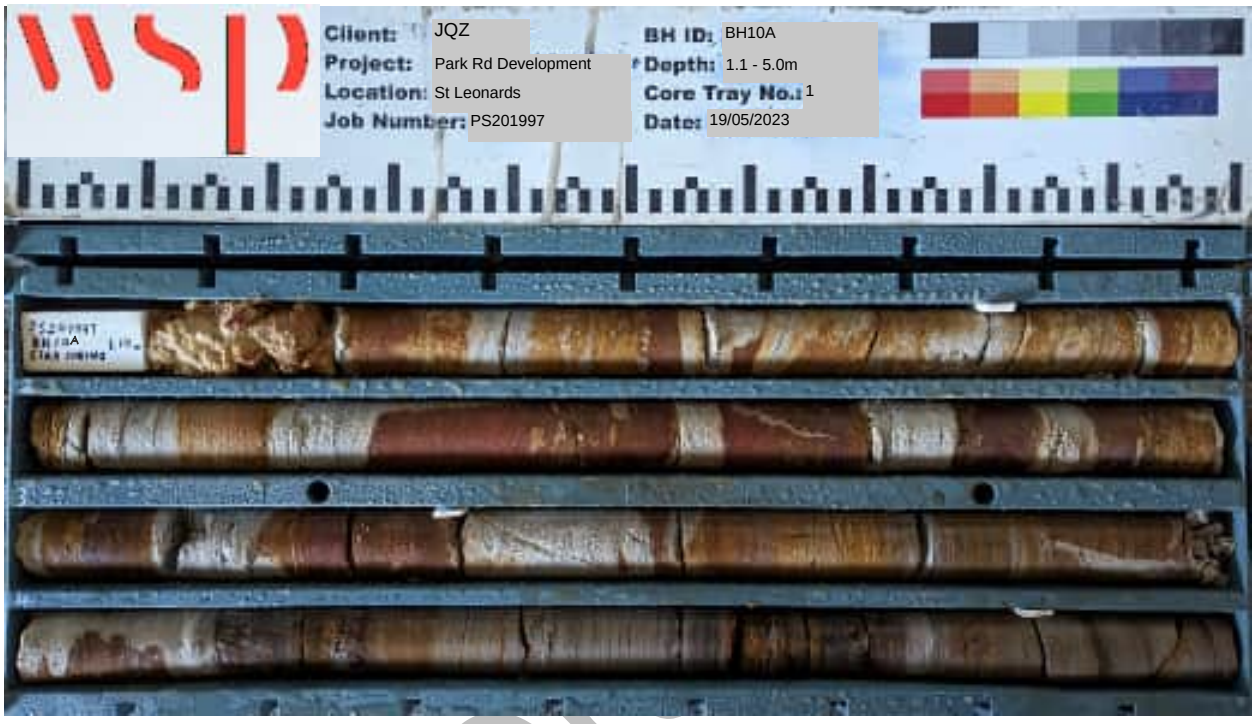
WSP-AU 5.04.0 LIB.GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:35 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH10A

CLIENT: JQZ
PROJECT: Park Road St Leonards Development
LOCATION: St Leonards
JOB NO: PS201997

INCLINATION: -90°
HOLE DIA: 110 mm HOLE DEPTH: 36.40 m

DRILL RIG: GEO205
CONTRACTOR: NUMAC
LOGGED: HW DATE: 22/5/23
CHECKED: AK DATE: 02/5/23



PointID : BH10A Depth Range: 1.10 - 5.00 m



PointID : BH10A Depth Range: 5.00 - 9.00 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:57 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH10A

CLIENT: JQZ
PROJECT: Park Road St Leonards Development
LOCATION: St Leonards
JOB NO: PS201997

INCLINATION: -90°
HOLE DIA: 110 mm HOLE DEPTH: 36.40 m

DRILL RIG: GEO205
CONTRACTOR: NUMAC
LOGGED: HW DATE: 22/5/23
CHECKED: AK DATE: 02/5/23



PointID : BH10A Depth Range: 9.00 - 13.00 m



PointID : BH10A Depth Range: 13.00 - 17.00 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:57 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH10A

CLIENT: JQZ
PROJECT: Park Road St Leonards Development
LOCATION: St Leonards
JOB NO: PS201997

INCLINATION: -90°
HOLE DIA: 110 mm HOLE DEPTH: 36.40 m

DRILL RIG: GEO205
CONTRACTOR: NUMAC
LOGGED: HW DATE: 22/5/23
CHECKED: AK DATE: 02/5/23



PointID : BH10A Depth Range: 17.00 - 21.00 m



PointID : BH10A Depth Range: 21.00 - 25.00 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH10A

CLIENT: JQZ
PROJECT: Park Road St Leonards Development
LOCATION: St Leonards
JOB NO: PS201997

INCLINATION: -90°
HOLE DIA: 110 mm HOLE DEPTH: 36.40 m

DRILL RIG: GEO205
CONTRACTOR: NUMAC
LOGGED: HW DATE: 22/5/23
CHECKED: AK DATE: 02/5/23



PointID : BH10A Depth Range: 25.00 - 29.00 m



PointID : BH10A Depth Range: 29.00 - 33.00 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0 LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH10A

SHEET: 5 OF 5

CLIENT: JQZ
DRILL RIG: GEO205
PROJECT: Park Road St Leonards Development
CONTRACTOR: NUMAC
LOCATION: St Leonards
INCLINATION: -90°
LOGGED: HW DATE: 22/5/23
JOB NO: PS201997
HOLE DIA: 110 mm HOLE DEPTH: 36.40 m
CHECKED: AK DATE: 02/5/23



PointID : BH10A Depth Range: 33.00 - 36.40 m

Draft

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

HOLE NO : BH10A

FILE / JOB NO : PS201997
SHEET : 1 OF 2

CLIENT : JQZ
LOCATION : 27 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332651.1, N: 6255657.9 (MGA2020-56) SURFACE ELEVATION : 74.17 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC

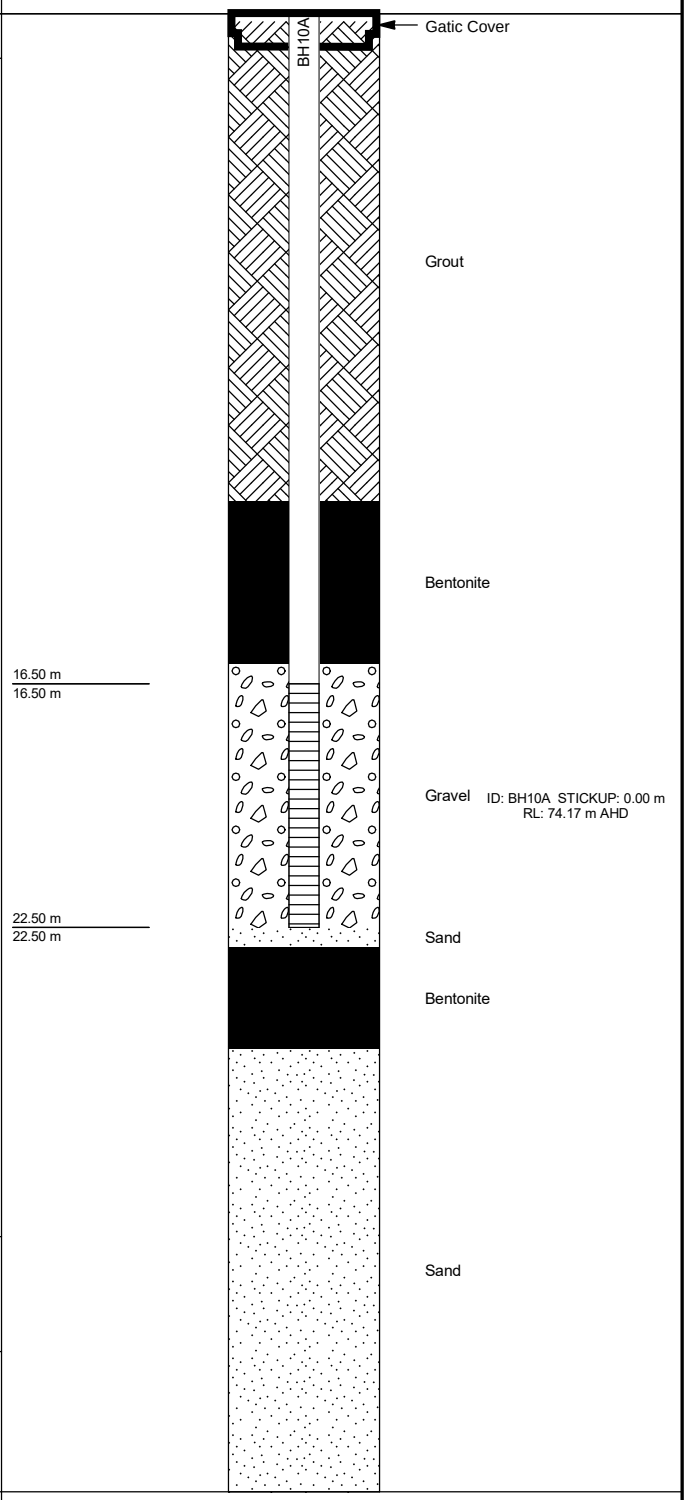
DATE STARTED : 19/5/2023 DATE COMPLETED : 22/5/2023 DATE LOGGED : 22/5/2023 LOGGED BY : HW CHECKED BY : AK

PERMIT NUMBER :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	
			0.0		CH	CLAY: high plasticity, grey-brown, with fine to coarse grained sand, inferred soft to stiff	
			1.10m			SANDSTONE: medium to coarse grained, pale grey to brown-grey, heavily stained orange and red, thinly bedded to medium bedded at 5°-15°	
			5.0			4.15m: becoming fine to medium grained, grey to pale grey, slightly mottled orange, medium to thickly bedded at 0°-10°	
			10.0			10.90 - 11.15m: interbedded with Siltstone, dark grey 11.90 - 12.50m: interbedded with Siltstone, dark grey 12.60m: becoming medium to coarse grained, thickly bedded at 0°-15°	
			15.0				
			20.0			19.70m: becoming fine to medium grained, grey 20.00m: becoming coarse grained, pale brown, very thickly bedded at 5°-15°	
			25.0			24.80-25.00m: interbedded with Siltstone, dark grey	
			30.0				
			30.12m			SILTSTONE: dark grey to grey, laminated to thinly bedded at 0°-5°. 31.40m-33.95m: with fine grained Sandstone lamination (30%)	
			32.95m			SANDSTONE: medium to coarse grained, grey to pale grey, thinly bedded to medium bedded at 5°-20°	
			35.0				
			36.40m			Hole Terminated at 36.40 m Target depth	
			40.0				

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH10A	Standpipe	0.00 m 74.17 m AHD	22.50 m 51.67 m AHD		



HQ3

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0.UB.GLB Log IS AU PIEZOMETER INSTALLATION 2 PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 21:34 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BH10B

FILE / JOB NO : PS201997
SHEET : 1 OF 2

CLIENT : JQZ
LOCATION : 27 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332650.5, N: 6255657.0 (MGA2020-56) SURFACE ELEVATION : 74.25 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 26/5/2023 DATE COMPLETED : 26/5/2023 DATE LOGGED : 26/5/2023 LOGGED BY : HW CHECKED BY : AK

DRILLING					MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m) RL (m AHD)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
VE		E-F			0.0 74.3		CH	CLAY: high plasticity, grey-brown, with fine to coarse grained sand, inferred soft to stiff	w>PL	S to St	RESIDUAL SOIL
					1.00m 1.0 73.3			SANDSTONE: medium to coarse grained, dark orange-brown to pale grey			ROCK
AD/T	(NFGWE)	H-VH			2.0 72.3						
					3.0 71.3						
					3.67m			Continued as Cored Drill Hole			
					4.0 70.3						
					5.0 69.3						
					6.0 68.3						
					7.0 67.3						
					8.0 66.3						
					9.0 65.3						
					10.0 64.3						

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 14:27 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH10B

FILE / JOB NO : PS201997
SHEET : 2 OF 2

CLIENT : JQZ
LOCATION : 27 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332650.5, N: 6255657.0 (MGA2020-56) SURFACE ELEVATION : 74.25 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 26/5/2023 DATE COMPLETED : 26/5/2023 DATE LOGGED : 26/5/2023 LOGGED BY : HW CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : good

DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS= $I_{a(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
					0.0							
					1.0							
					2.0							
					3.0							
							3.67m START CORING AT 3.67m					
HQ3	100% RETURN	0% LOSS 4.63	35		4.0		SANDSTONE: medium to coarse grained, pale grey to brown-grey, heavily stained orange and red, thinly bedded to medium bedded at 5°-15°, inferred medium strength	HW				IS, sand and clay IF, 20 mm Px4, 0 - 10°, Fe SN, PR, RF J, 70°, clay IF, PR, RF Px5, 0 - 10°, Fe SN, PR, RF P, 0°, Fe SN, PR, RF P, 5°, Fe SN, PR, RF P, 15°, Fe SN, PR, RF J, 90°, Fe SN, IR, RF
	100% RETURN	0% LOSS 6.00	53		5.0		4.80m: inferred becoming high strength					P, 0°, Fe SN, PR, RF P, 0°, Fe SN, PR, RF P, 0°, Fe SN, PR, RF P, 10°, Fe SN, PR, RF P, 0°, Fe SN, PR, RF P, 0°, Fe SN, PR, RF P, 15°, Fe SN, PR, RF P, 0°, Fe SN, PR, RF P, 5°, Fe SN, PR, RF P, 0°, Fe SN, PR, RF
					6.0		5.60m: becoming fine to medium coarse grained, grey to pale grey, slightly stained orange-brown 6.00m	MW				
							Hole Terminated at 6.00 m Target depth					
					7.0							
					8.0							
					9.0							
					10.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:36 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH10B

SHEET: 1 OF 1

CLIENT:	JQZ		DRILL RIG:	GEO205	
PROJECT:	Park Road St Leonards Development		CONTRACTOR:	NUMAC	
LOCATION:	St Leonards	INCLINATION: -90°	LOGGED:	HW	DATE: 26/5/23
JOB NO:	PS201997	HOLE DIA: 110 mm HOLE DEPTH: 6.00 m	CHECKED:	AK	DATE: 02/5/23



PointID : BH10B Depth Range: 3.67 - 6.00 m

Draft

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

HOLE NO : BH10B

CLIENT : JQZ
LOCATION : 27 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

FILE / JOB NO : PS201997
SHEET : 1 OF 2

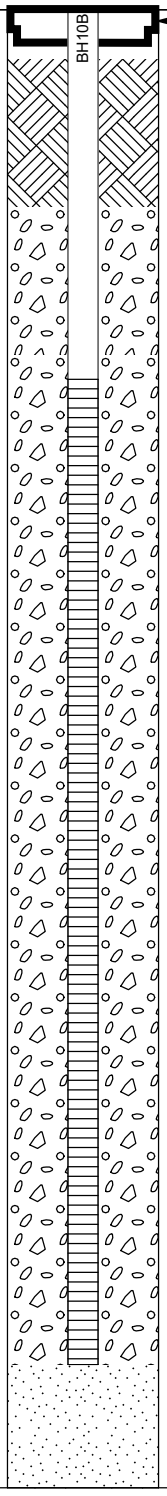
POSITION : E: 332650.5, N: 6255657.0 (MGA2020-56) SURFACE ELEVATION : 74.25 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC

DATE STARTED : 26/5/2023 DATE COMPLETED : 26/5/2023 DATE LOGGED : 26/5/2023 LOGGED BY : HW CHECKED BY : AK

PERMIT NUMBER :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	
			0.0				ID: BH10B; Type: Standpipe; Stick Up & RL: 0.00 m 74.25 m AHD; Tip Depth & RL: 5.50 m 68.75 m AHD; Installation Date; Static Water Level
VE					CH	CLAY: high plasticity, grey-brown, with fine to coarse grained sand, inferred soft to stiff	
			1.00m				
AD/T	(NFGWE)		1.0			SANDSTONE: medium to coarse grained, dark orange-brown to pale grey	
			2.0				
			3.0				
			3.67m				
HQ3	100% RETURN		4.0			SANDSTONE: medium to coarse grained, pale grey to brown-grey, heavily stained orange and red, thinly bedded to medium bedded at 5°-15°, inferred medium strength	
						4.80m: inferred becoming high strength	
	100% RETURN		5.0				
						5.60m: becoming fine to medium coarse grained, grey to pale grey, slightly stained orange-brown	
			6.00m				
			6.0			Hole Terminated at 6.00 m Target depth	



See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU PIEZOMETER INSTALLATION 2 PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 21:35 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BH11

FILE / JOB NO : PS201997
SHEET : 1 OF 4

CLIENT : JQZ
LOCATION : 32 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332627.6, N: 6255622.3 (MGA2020-56) SURFACE ELEVATION : 67.92 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 24/5/2023 DATE COMPLETED : 24/5/2023 DATE LOGGED : 24/5/2023 LOGGED BY : HW CHECKED BY : AK

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m) RL (m AHD)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
VE	(NFGWE)	E-F			0.0 67.9		CI-CH	Sandy CLAY: medium to high plasticity, grey-brown, medium to coarse grained sand, inferred soft to stiff	w>PL	S to St	RESIDUAL SOIL
					1.0 66.9			1.00m Continued as Cored Drill Hole			
					2.0 65.9						
					3.0 64.9						
					4.0 63.9						
					5.0 62.9						
					6.0 61.9						
					7.0 60.9						
					8.0 59.9						
					9.0 58.9						
					10.0 57.9						

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 14:28 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH11

FILE / JOB NO : PS201997
SHEET : 2 OF 4

CLIENT : JQZ
LOCATION : 32 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332627.6, N: 6255622.3 (MGA2020-56) SURFACE ELEVATION : 67.92 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 24/5/2023 DATE COMPLETED : 24/5/2023 DATE LOGGED : 24/5/2023 LOGGED BY : HW CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
					0.0							
							1.00m START CORING AT 1.00m					
HQ3	100% RETURN	0% LOSS 1.75	82	Is(50) D=0.45 MPa Is(50) A=0.72 MPa	1.0		SANDSTONE: medium to coarse grained, pale grey to orange-brown, thinly bedded to medium bedded at 5°-15°	XW HW				EW, sand and clay IF, 140 mm IS, sand and clay IF, 20 mm P, 5°, Fe SN, PR, RF
							1.75m					
	100% RETURN	17% LOSS 3.15	40	Is(50) D=0.02 MPa Is(50) A=0.03 MPa	2.0		NO CORE 0.25m (1.75-2.00) CORE LOSS					
							2.00m					
							SANDSTONE: fine to coarse grained, pale grey to orange-brown, extremely weathered, recovered as sandy clay	XW				EW, sand and clay IF, 100 mm EW, clay IF, 350 mm
							2.45m					
							SANDSTONE: fine to medium grained, pale grey to dark red-brown, very thinly bedded to thinly bedded at 0°-10°	HW				P, 0°, Fe SN, PR, RF
					3.0							P, 0°, Fe SN, PR, RF P, 0°, Fe SN, PR, RF P, 0°, Fe SN, PR, RF
	100% RETURN	0% LOSS 4.75	60	Is(50) D=0.08 MPa Is(50) A=0.11 MPa Is(50) D=0.04 MPa								J, 50°, CN, PR, RF
								XW				FZ, Cr IF, 150 mm
								HW				J, 90°, CN, PR, RF
					4.0							FZ, Cr IF, 10 mm J, 75°, CN, PR, RF
	100% RETURN	0% LOSS 6.25	77	Is(50) A=0.03 MPa Is(50) D=0.16 MPa Is(50) A=0.28 MPa	5.0		5.00m: becoming dark red to orange-brown, medium bedded	XW HW				P, 10°, Fe SN, IR, RF P, 10°, Fe SN, IR, RF FZ, Cr IF, 100 mm IS, sand IF, 20 mm
							6.00m					Px3, 5°, Fe SN, PR, RF
	100% RETURN	0% LOSS 7.75	100	Is(50) D=0.55 MPa Is(50) A=0.970 MPa	6.0		SANDSTONE: fine to medium grained, pale grey to grey, thinly bedded to medium bedded at 0°-10° with Siltstone lamination (20%), dark grey	SW to FR				P, 5°, Fe SN, PR, RF IS, Cr IF, 10 mm P, 5°, Fe SN, PR, RF P, 5°, Fe SN, PR, RF DB P, 10°, Fe SN, PR, RF P, 10°, Fe SN, PR, RF IS, sand and clay IF, 10 mm
					7.0							
	100% RETURN	0% LOSS 9.30	100	Is(50) D=1.07 MPa Is(50) A=2.42 MPa	8.0							P, 5°, CN, PR, RF P, 5°, CN, PR, RF P, 5°, CN, PR, RF
							8.68m					
							SANDSTONE: medium to coarse grained, pale grey, thinly bedded at 5°-15°					P, 5°, CN, PR, RF DB
					9.0							
	100% RETURN	0% LOSS	100	Is(50) D=1.04 MPa Is(50) A=1.05 MPa Is(50) D=1.19 MPa Is(50)	10.0							

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:38 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH11

FILE / JOB NO : PS201997

SHEET : 3 OF 4

CLIENT : JQZ

LOCATION : 32 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332627.6, N: 6255622.3 (MGA2020-56) SURFACE ELEVATION : 67.92 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 24/5/2023 DATE COMPLETED : 24/5/2023 DATE LOGGED : 24/5/2023 LOGGED BY : HW CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
HQ3	100% RETURN	0% LOSS 10.80	100	A=1.48 MPa	10.0		SANDSTONE: medium to coarse grained, pale grey, thinly bedded at 5°-15° *(continued)*	SW to FR				P, 10°, CN, PR, RF DB
	100% RETURN	0% LOSS 12.30	100	Is(50) D=1.47 MPa Is(50) A=1.73 MPa Is(50) D=1.24 MPa Is(50) A=1.52 MPa	11.0 12.0							P, 0°, CN, PR, RF P, 5°, PR, healed
	100% RETURN	0% LOSS 13.78	100	Is(50) D=1.20 MPa Is(50) A=1.85 MPa	13.0							DB P, 10°, CN, PR, RF DB
	100% RETURN	0% LOSS 15.24	100	Is(50) D=1.34 MPa Is(50) A=1.56 MPa Is(50) D=0.37 MPa Is(50) A=1.97 MPa	14.0 15.0		14.60m-15.00m: becoming fine to medium grained, thinly bedded at 5°, with carbonaceous material 15.00m: becoming fine to coarse grained, medium to thickly bedded at 5°-15°					DB DB Px4, 5°, CN, PR, RF DB
	100% RETURN	0% LOSS 16.74	100	Is(50) D=1.76 MPa Is(50) A=2.21 MPa	16.0		15.50m: becoming medium to coarse grained					P, 15°, CN, PR, RF P, 5°, CN, PR, RF DB
	100% RETURN	0% LOSS 18.26	100	Is(50) D=1.41 MPa Is(50) A=1.92 MPa Is(50) D=1.60 MPa Is(50) A=1.85 MPa	17.0 18.0							P, 5°, CN, PR, RF
	100% RETURN	0% LOSS 19.74	100	Is(50) D=1.25 MPa Is(50) A=1.53 MPa	19.0		19.52m: becoming coarse grained					P, 5°, carbonaceous material CT, PR, RF DB
		0% LOSS	100	Is(50) D=1.37 MPa Is(50)	20.0							P, 5°, carbonaceous material CT, PR, RF DB DB

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:38 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH11

FILE / JOB NO : PS201997
SHEET : 4 OF 4

CLIENT : JQZ
LOCATION : 32 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332627.6, N: 6255622.3 (MGA2020-56) SURFACE ELEVATION : 67.92 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 24/5/2023 DATE COMPLETED : 24/5/2023 DATE LOGGED : 24/5/2023 LOGGED BY : HW CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : good

DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
HQ3	100% RETURN	0% LOSS 21.26	100	A=1.22 MPa Is(50) D=1.57 MPa Is(50) A=1.96 MPa	20.0 21.0		SANDSTONE: medium to coarse grained, pale grey, thinly bedded at 5°-15° *(continued)*	SW to FR				P, 5°, CN, PR, RF DB
	100% RETURN	0% LOSS 22.72	95	Is(50) D=1.42 MPa Is(50) A=1.84 MPa	22.0							DB P, 10°, CN, IR, RF DB P, 0°, CN, PR, RF IS, sand IF, 20 mm P, 0°, CN, PR, RF
	100% RETURN	0% LOSS 24.23	78	Is(50) D=0.41 MPa Is(50) A=0.59 MPa Is(50) D=0.36 MPa Is(50) A=0.78 MPa	23.0 24.0		23.40m SILTSTONE: dark grey, laminated to very thinly bedded at 0°-5°					DB P, 5°, CN, PR, RF DB IS, sand IF, 10 mm P, 10°, CN, PR, RF IS, clay IF, 10 mm J, 75°, CN, PR, RF P, 0°, CN, PR, RF P, 0°, CN, PR, RF DB DB P, 0°, CN, PR, RF IS, Cr IF, 10 mm
	100% RETURN	0% LOSS 25.61	67	Is(50) A=0.800 MPa Is(50) D=0.090 MPa Is(50) A=0.080 MPa	25.0		25.20m BRECCIA: dark grey, 2mm-30mm angular to sub-angular SILTSTONE fragments in clay matrix, matrix supported. 25.61m 25.74m NO CORE 0.13m (25.61-25.74) CORELOSS					Px10, 0 - 5°, CN, PR, RF J, 50°, CN, PR, RF IS, clay IF, 20 mm P, 0°, CN, PR, RF
	100% RETURN	16% LOSS 26.40	13		26.0		SANDSTONE: medium to coarse grained, white-grey, inferred medium strength 26.40m	XW SW				FZ, Cr IF, 220 mm Jx3, 70 - 90°, Cr IF, PR, RF
					27.0 28.0 29.0 30.0		Hole Terminated at 26.40 m Target depth					

See Explanatory Notes for details of abbreviations & basis of descriptions.

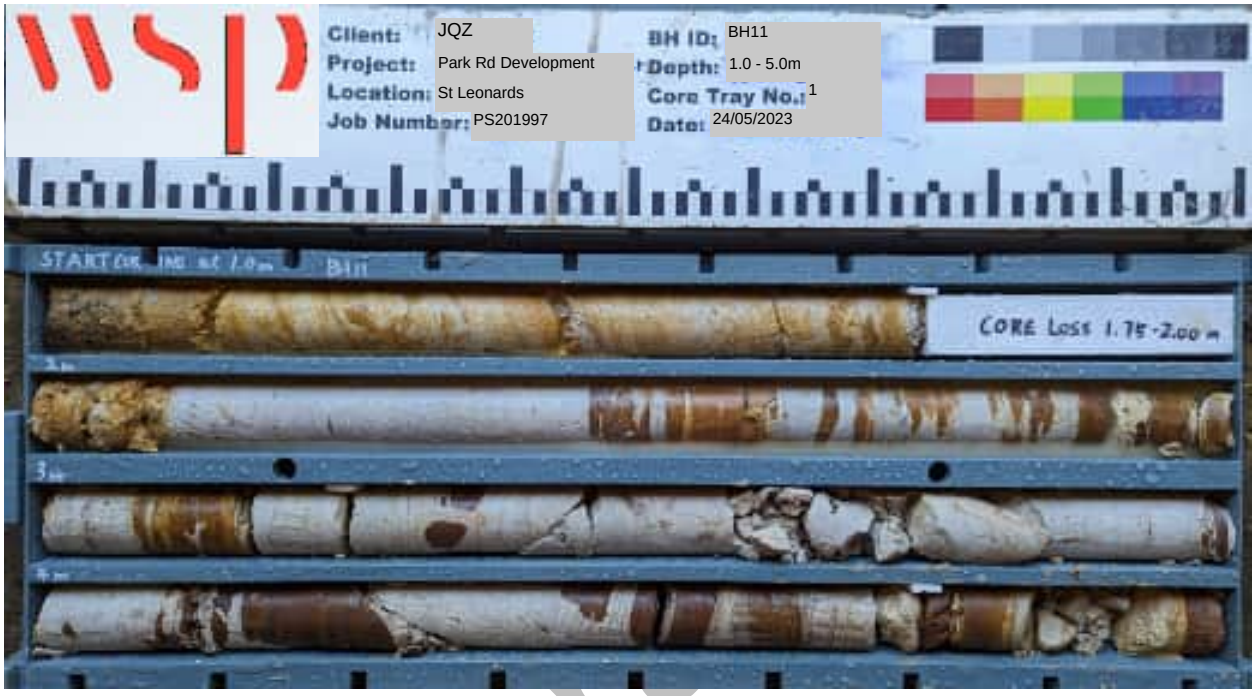
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DRAFT REPORT OF CORE PHOTOGRAPHS: BH11

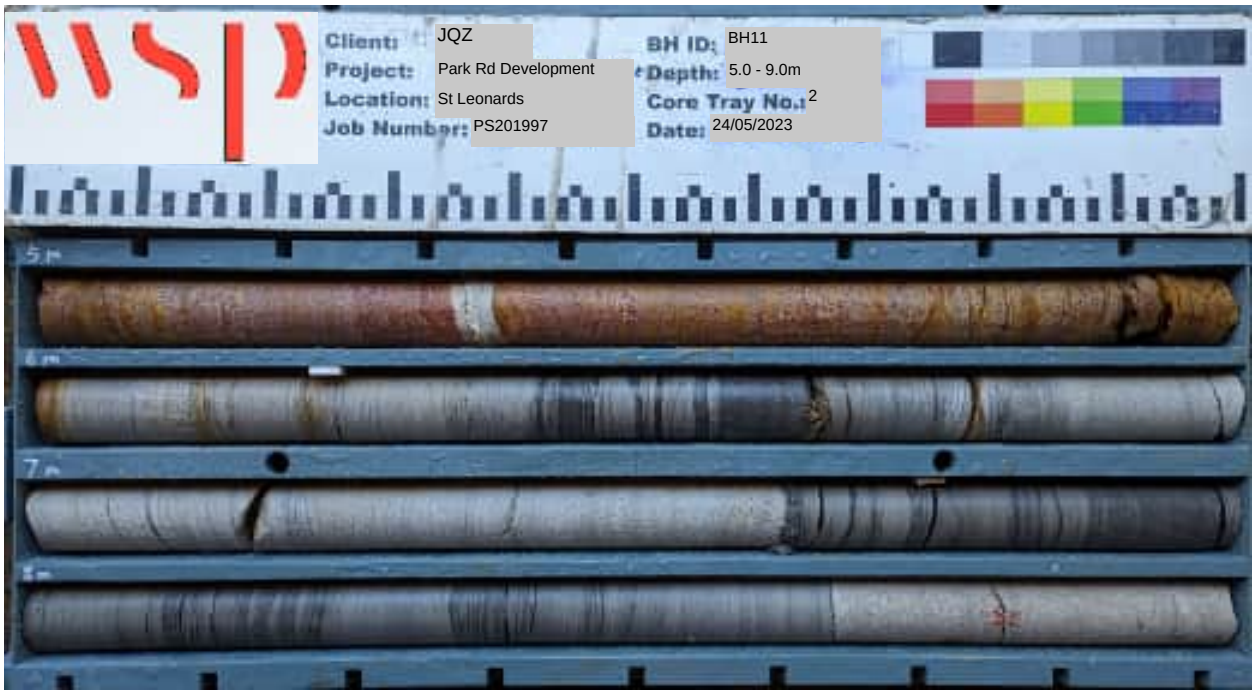
CLIENT: JQZ
PROJECT: Park Road St Leonards Development
LOCATION: St Leonards
JOB NO: PS201997

INCLINATION: -90°
HOLE DIA: 110 mm HOLE DEPTH: 26.40 m

DRILL RIG: GEO205
CONTRACTOR: NUMAC
LOGGED: HW DATE: 24/5/23
CHECKED: AK DATE: 02/5/23



PointID : BH11 Depth Range: 1.00 - 5.00 m



PointID : BH11 Depth Range: 5.00 - 9.00 m

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WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH11

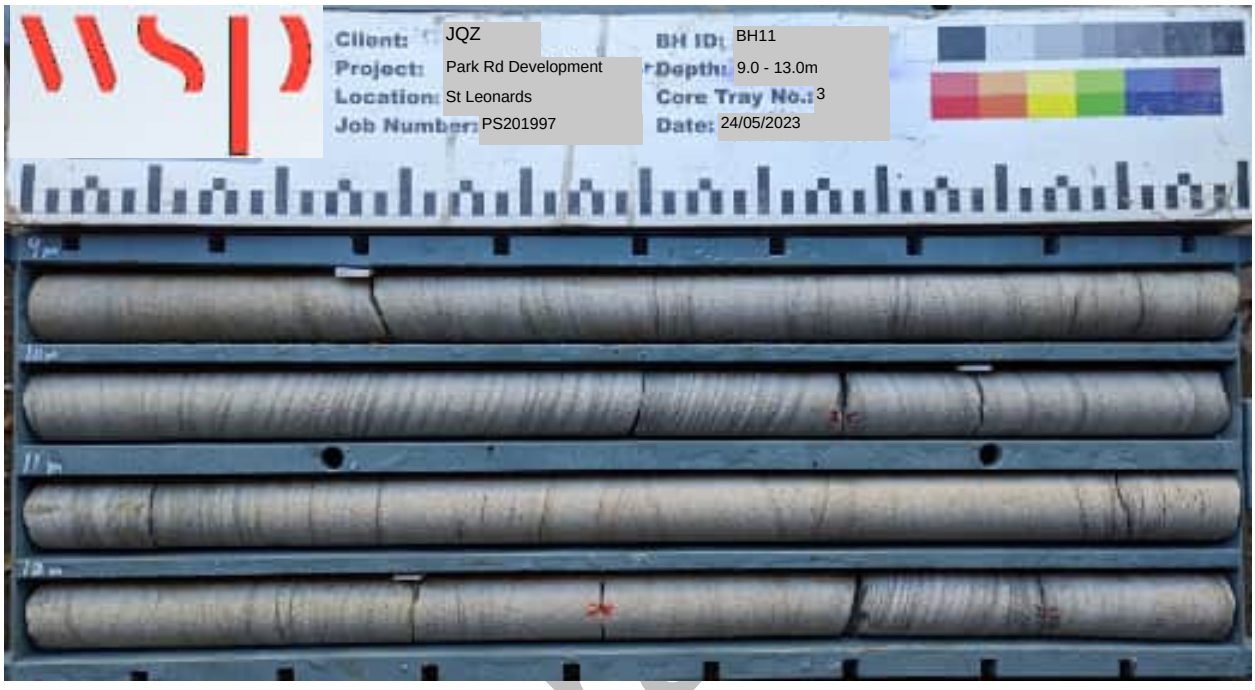
SHEET: 2 OF 4

CLIENT: JQZ
DRILL RIG: GEO205

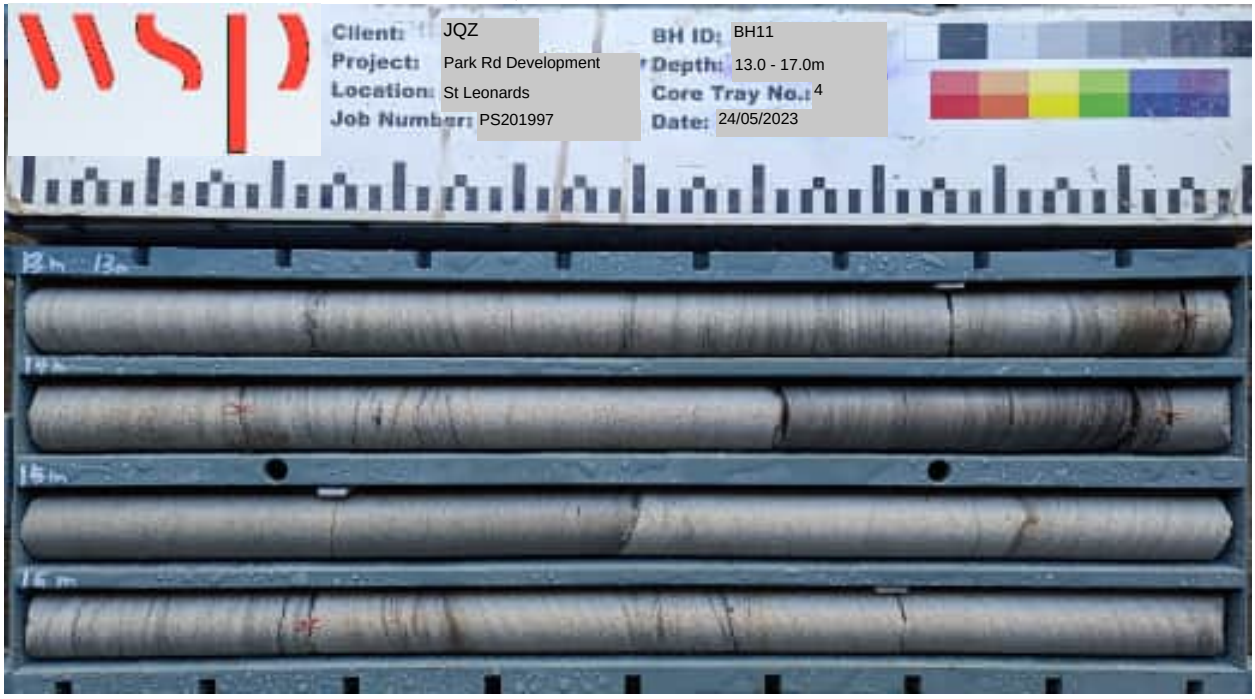
PROJECT: Park Road St Leonards Development
CONTRACTOR: NUMAC

LOCATION: St Leonards
INCLINATION: -90°
LOGGED: HW DATE: 24/5/23

JOB NO: PS201997
HOLE DIA: 110 mm HOLE DEPTH: 26.40 m
CHECKED: AK DATE: 02/5/23



PointID : BH11 Depth Range: 9.00 - 13.00 m



PointID : BH11 Depth Range: 13.00 - 17.00 m

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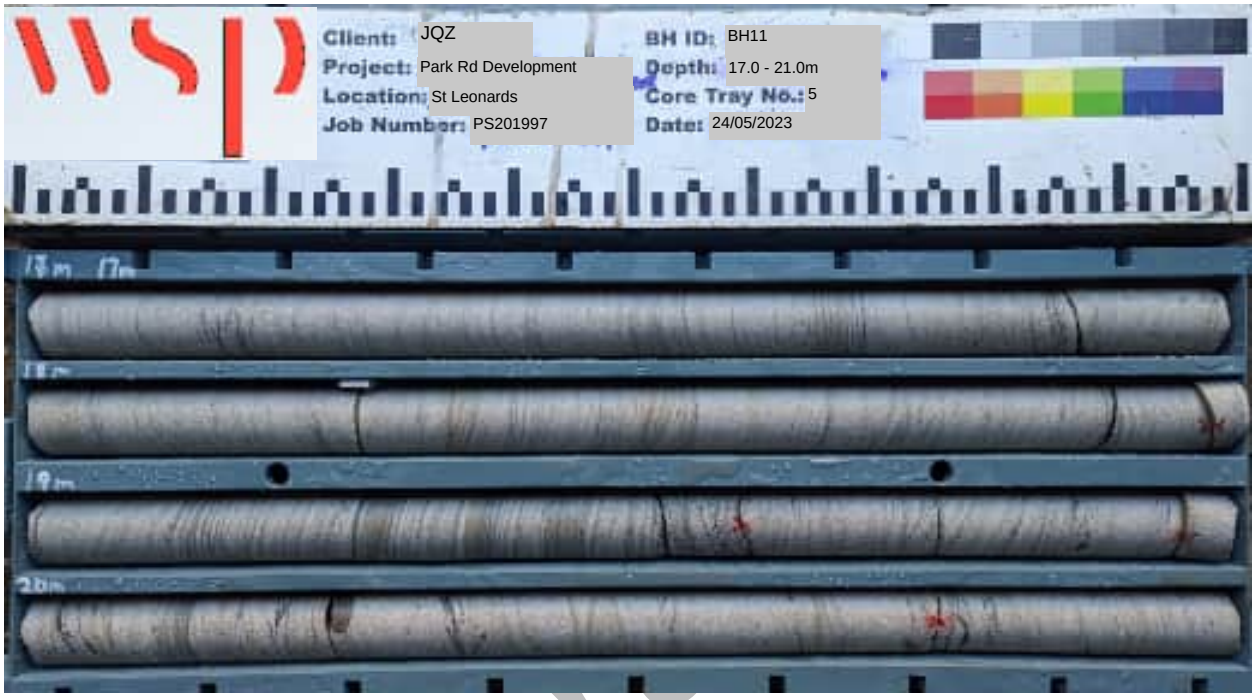
GAP gINT FN. F28
RL1

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

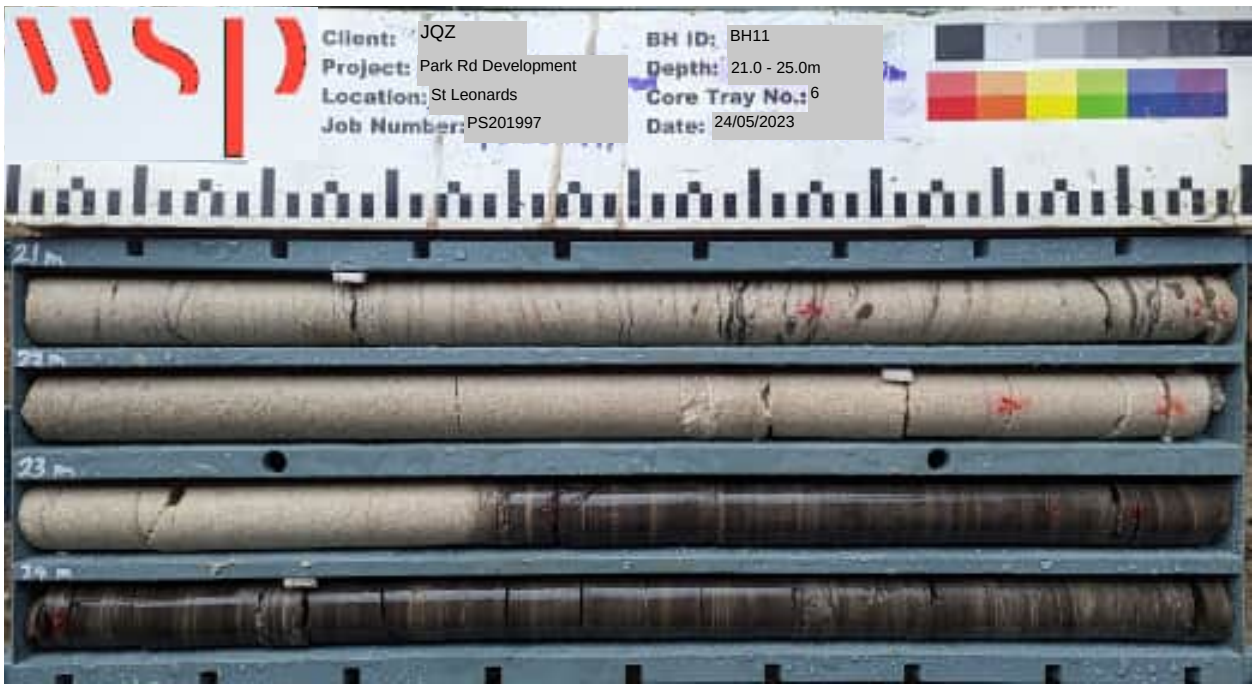
DRAFT REPORT OF CORE PHOTOGRAPHS: BH11

SHEET: 3 OF 4

CLIENT: JQZ
DRILL RIG: GEO205
PROJECT: Park Road St Leonards Development
CONTRACTOR: NUMAC
LOCATION: St Leonards
INCLINATION: -90°
LOGGED: HW DATE: 24/5/23
JOB NO: PS201997
HOLE DIA: 110 mm HOLE DEPTH: 26.40 m
CHECKED: AK DATE: 02/5/23



PointID : BH11 Depth Range: 17.00 - 21.00 m



PointID : BH11 Depth Range: 21.00 - 25.00 m

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GAP gINT FN. F28
RL1

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH11

SHEET: 4 OF 4

CLIENT: JQZ
DRILL RIG: GEO205
PROJECT: Park Road St Leonards Development
CONTRACTOR: NUMAC
LOCATION: St Leonards
INCLINATION: -90°
LOGGED: HW DATE: 24/5/23
JOB NO: PS201997
HOLE DIA: 110 mm HOLE DEPTH: 26.40 m
CHECKED: AK DATE: 02/5/23



PointID : BH11 Depth Range: 25.00 - 26.40 m

Draft

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

HOLE NO : BH11

CLIENT : JQZ
LOCATION : 32 Park Rd St Leonards

PROJECT : Park Road St Leonards Development

FILE / JOB NO : PS201997
SHEET : 1 OF 2

POSITION : E: 332627.6, N: 6255622.3 (MGA2020-56) SURFACE ELEVATION : 67.92 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC

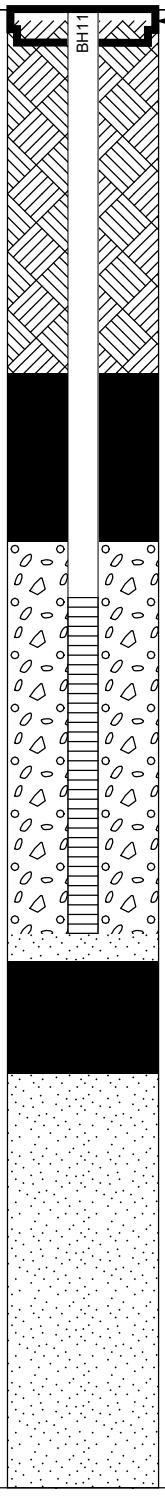
DATE STARTED : 24/5/2023 DATE COMPLETED : 24/5/2023 DATE LOGGED : 24/5/2023 LOGGED BY : HW CHECKED BY : AK

PERMIT NUMBER :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	
			0.0		CI-CH	Sandy CLAY: medium to high plasticity, grey-brown, medium to coarse grained sand, inferred soft to stiff	
			1.00m				
			1.75m				
			2.00m				
			2.45m			SANDSTONE: medium to coarse grained, pale grey to orange-brown, thinly bedded to medium bedded at 5°-15°	
						CORE LOSS	
			4.0			SANDSTONE: fine to coarse grained, pale grey to orange-brown, extremely weathered, recovered as sandy clay	
						SANDSTONE: fine to medium grained, pale grey to dark red-brown, very thinly bedded to thinly bedded at 0°-10° 5.00m: becoming dark red to orange-brown, medium bedded	
			6.00m				
			6.0			SANDSTONE: fine to medium grained, pale grey to grey, thinly bedded to medium bedded at 0°-10° with Siltstone lamination (20%), dark grey	
			8.0				
			8.68m				
						SANDSTONE: medium to coarse grained, pale grey, thinly bedded at 5°-15°	
			10.0				
			12.0				
			14.0				
						14.60m-15.00m: becoming fine to medium grained, thinly bedded at 5°, with carbonaceous material 15.00m: becoming fine to coarse grained, medium to thickly bedded at 5°-15° 15.50m: becoming medium to coarse grained	
			16.0				
			18.0				
						19.52m: becoming coarse grained	
			20.0				
			22.0				
			23.40m				
			24.0			SILTSTONE: dark grey, laminated to very thinly bedded at 0°-5°	
			25.20m				
			25.61m 25.74m			BRECCIA: dark grey, 2mm-30mm angular to sub-angular SILTSTONE fragments in clay matrix, matrix supported.	
			26.0				
			26.40m			CORELOSS	
						SANDSTONE: medium to coarse grained, white-grey, inferred medium strength	
						Hole Terminated at 26.40 m Target depth	
			28.0				

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH11	Standpipe	0.00 m 67.92 m AHD	16.50 m 51.42 m AHD		



VE

HQ3

100% RETURN

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0.UB.GLB Log IS AU PIEZOMETER INSTALLATION 2 PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 21:35 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

NON-CORE DRILL HOLE - GEOLOGICAL LOG

HOLE NO : BH12

FILE / JOB NO : PS201997
SHEET : 1 OF 4

CLIENT : JQZ
LOCATION : 35 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332639.8, N: 6255620.8 (MGA2020-56) SURFACE ELEVATION : 69.80 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 16/5/2023 DATE COMPLETED : 16/5/2023 DATE LOGGED : 16/5/2023 LOGGED BY : MS CHECKED BY : AK

DRILLING						MATERIAL					
PROGRESS: DRILLING & CASING	PROGRESS: WATER	DRILLING PENETRATION	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	DEPTH (m) RL (m AHD)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	STRUCTURE & Other Observations
VE	(NFGWE)	E-F			0.0 69.8		CI-CH	Silty CLAY: medium to high plasticity, dark grey, with fine grained sand, inferred soft to stiff	w>PL	S to St	RESIDUAL SOIL
					1.0 68.8			1.10m Continued as Cored Drill Hole			
					2.0 67.8						
					3.0 66.8						
					4.0 65.8						
					5.0 64.8						
					6.0 63.8						
					7.0 62.8						
					8.0 61.8						
					9.0 60.8						
					10.0 59.8						

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 14:29 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH12

FILE / JOB NO : PS201997

SHEET : 2 OF 4

CLIENT : JQZ

LOCATION : 35 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332639.8, N: 6255620.8 (MGA2020-56) SURFACE ELEVATION : 69.80 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 16/5/2023 DATE COMPLETED : 16/5/2023 DATE LOGGED : 16/5/2023 LOGGED BY : MS CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : Good

DRILLING					MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS (VL -2, L -6, M -20, H -60, VH -200, EH)	NATURAL FRACTURE (mm) (20, 40, 100, 300, 1000)	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
					0.0							
					1.0		1.10m START CORING AT 1.10m					
HQ3	100% RETURN	31% LOSS 1.90	0				NO CORE 0.25m (1.10-1.35) CORELOSS 1.35m					
							SANDSTONE: medium to coarse grained, dark red to brown-grey, very thinly bedded to thinly bedded at 5°-20°	XW HW				EW, sand and clay infill, 150mm P, 15°, Fe SN, PR, RF P, 15°, Fe SN, PR, RF EW, sand and clay infill, 80mm
	100% RETURN	0% LOSS 3.42	53	Is(50) D=0.240 MPa	2.0		2.10m: becoming pale grey stained yellow-red	MW				P11, 5 - 15°, Fe SN, PR, RF
					3.0							P, 5°, Fe SN, PR, RF DB DB J, 90°, Fe SN, CU, RF P, 5°, Fe SN, PR, RF
	100% RETURN	0% LOSS 4.92	77	Is(50) A=0.400 MPa			3.70m: becoming brown to yellow-grey					DB DB DB J, 90°, Fe SN, CU, RF P, 5°, Fe SN, PR, RF
					4.0							P, 5°, Fe SN, PR, RF P, 5°, Fe SN, PR, RF P, 5°, Fe SN, PR, RF DB P, 10°, Fe SN, PR, RF P, 5°, Fe SN, PR, RF
	100% RETURN	0% LOSS 6.41	80	Is(50) A=1.05 MPa Is(50) D=0.0600 MPa Is(50) D=0.0200 MPa	5.0		5.40m: becoming pale grey stained yellow-red					P, 0°, Fe SN, PR, RF
					6.0			MW to HW				DB
	100% RETURN	0% LOSS 7.85	96	Is(50) A=0.380 MPa Is(50) D=0.300 MPa Is(50) A=0.260 MPa	7.0		7.50m: becoming fine to coarse grained, pale brown-grey, very thinly bedded to medium bedded at 10°-20°					J, 70 - 80°, Fe SN, CU, RF DB DB DB DB P, 10°, Fe SN, PR, RF P, 10°, Fe SN, PR, RF
					8.0		8.05-8.20m: interbedded with siltstone	SW				DB P, 5°, CN, PR, RF
	100% RETURN	0% LOSS 9.41	100	Is(50) D=0.0800 MPa Is(50) A=0.190 MPa	9.0		9.00m: becoming fine to medium grained					P, 5°, CN, PR, RF DBx7
		0% LOSS	100		10.0		9.60m: becoming medium to thickly bedded					P, 5°, CN, PR, RF

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB.GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:40 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH12

FILE / JOB NO : PS201997
SHEET : 3 OF 4

CLIENT : JQZ
LOCATION : 35 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332639.8, N: 6255620.8 (MGA2020-56) SURFACE ELEVATION : 69.80 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 16/5/2023 DATE COMPLETED : 16/5/2023 DATE LOGGED : 16/5/2023 LOGGED BY : MS CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : Good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
HQ3	100% RETURN	0% LOSS 10.88	100	Is(50) D=1.64 MPa Is(50) A=1.58 MPa	10.0		SANDSTONE: medium to coarse grained, dark red to brown-grey, very thinly bedded to thinly bedded at 5°-20° *(continued)* 10.30m: becoming medium to coarse grained, brown, very thinly bedded to medium bedded at 5°-20°	SW				P, 5°, CN, PR, RF P, 5°, CN, PR, RF DB P, 15°, CN, PR, RF
	100% RETURN	0% LOSS 12.42	100	Is(50) D=1.17 MPa Is(50) A=1.43 MPa Is(50) D=0.92 MPa Is(50) A=0.75 MPa Is(50) D=1.92 MPa	11.0 12.0							DB DB P, 15°, CN, PR, RF P, 0°, CN, PR, RF
	100% RETURN	0% LOSS 14.03	100		13.0							P, 15°, CN, PR, RF
	100% RETURN	0% LOSS 15.49	100	Is(50) D=1.05 MPa Is(50) A=1.05 MPa Is(50) D=1.44 MPa Is(50) A=1.24 MPa	14.0 15.0							DB DB P, 15°, CN, PR, RF DB DB
	100% RETURN	0% LOSS 17.01	100	Is(50) D=0.59 MPa Is(50) A=1.17 MPa	16.0 17.0							P, 5°, CN, PR, RF P, 5°, CN, PR, RF DB
	100% RETURN	0% LOSS 18.45	100	Is(50) D=1.69 MPa Is(50) A=1.47 MPa	18.0							P, 5°, CN, PR, RF P, 10°, CN, PR, RF DB
	100% RETURN	0% LOSS 19.93	100	Is(50) D=1.29 MPa Is(50) A=0.57 MPa Is(50) D=1.66 MPa Is(50) A=1.98	19.0 20.0							DB P, 15°, CN, PR, RF

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:40 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

CORED DRILL HOLE LOG

HOLE NO : BH12

FILE / JOB NO : PS201997
SHEET : 4 OF 4

CLIENT : JQZ
LOCATION : 35 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

POSITION : E: 332639.8, N: 6255620.8 (MGA2020-56) SURFACE ELEVATION : 69.80 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC DRILLER : MY

DATE STARTED : 16/5/2023 DATE COMPLETED : 16/5/2023 DATE LOGGED : 16/5/2023 LOGGED BY : MS CHECKED BY : AK

CASING DIAMETER : 100 mm BARREL (Length) : 1.50 m BIT : 8-step BIT CONDITION : Good

DRILLING						MATERIAL				FRACTURES		
PROGRESS: DRILLING & CASING	PROGRESS: WATER	(CORE LOSS RUN %) / DRILL DEPTH	RQD (%)	SAMPLES & FIELD TESTS	DEPTH (m)	GRAPHIC LOG	DESCRIPTION ROCK TYPE : Colour, Grain size, Structure (texture, fabric, mineral composition, hardness alteration, cementation, etc as applicable)	WEATHERING	ESTIMATED STRENGTH UCS=20·$I_{s(50)}$ ● - Axial ○ - Diametral ■ - UCS VL -2 L -6 M -20 H -60 VH -200 EH	NATURAL FRACTURE (mm) 20 40 100 300 1000	VISUAL	ADDITIONAL DATA (joints, partings, seams, zones, etc) Description, orientation, infilling or coating, shape, roughness, thickness, other
HQ3	100% RETURN	0% LOSS 21.53	100	MPa Is(50) D=1.35 MPa Is(50) A=1.01 MPa	20.0 21.0		SANDSTONE: medium to coarse grained, dark red to brown-grey, very thinly bedded to thinly bedded at 5°-20° *(continued)*	SW				DB DB P, 5°, CN, PR, RF DB
	100% RETURN	0% LOSS 23.00	100	Is(50) D=1.19 MPa Is(50) A=1.59 MPa Is(50) D=1.58 MPa Is(50) A=0.66 MPa	22.0		21.70-23.60m: interbedded with Siltstone (20%)					DB P, 5°, CN, PR, RF J, 40°, CN, CU, RF P, 5°, CN, PR, RF P, 10°, CN, PR, RF
	100% RETURN	0% LOSS 24.54	100	Is(50) D=0.88 MPa Is(50) A=1.37 MPa	23.0 24.0			FR				IS, sand IF, 20 mm
	100% RETURN	0% LOSS 25.21	100	Is(50) D=0.71 MPa Is(50) A=1.04 MPa Is(50) D=1.52 MPa Is(50) A=1.10 MPa	25.0 25.21m 26.0 27.0 28.0 29.0 30.0		Hole Terminated at 25.21 m Target depth					DB DB

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0 LIB GLB Log IS AU CORED BOREHOLE 2A PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 13:40 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0 2023-04-11 Prj: WSP 5.04.0 2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH12

SHEET: 1 OF 3

CLIENT: JQZ
DRILL RIG: GEO205
PROJECT: Park Road St Leonards Development
CONTRACTOR: NUMAC
LOCATION: St Leonards
INCLINATION: -90°
LOGGED: MS DATE: 16/5/23
JOB NO: PS201997
HOLE DIA: 110 mm HOLE DEPTH: 25.21 m
CHECKED: AK DATE: 02/5/23



PointID : BH12 Depth Range: 1.00 - 6.00 m



PointID : BH12 Depth Range: 6.00 - 11.00 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFiles>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

DRAFT REPORT OF CORE PHOTOGRAPHS: BH12

SHEET: 2 OF 3

CLIENT: JQZ
DRILL RIG: GEO205
PROJECT: Park Road St Leonards Development
CONTRACTOR: NUMAC
LOCATION: St Leonards
INCLINATION: -90°
LOGGED: MS DATE: 16/5/23
JOB NO: PS201997
HOLE DIA: 110 mm HOLE DEPTH: 25.21 m
CHECKED: AK DATE: 02/5/23



PointID : BH12 Depth Range: 11.00 - 16.00 m



PointID : BH12 Depth Range: 16.00 - 21.00 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

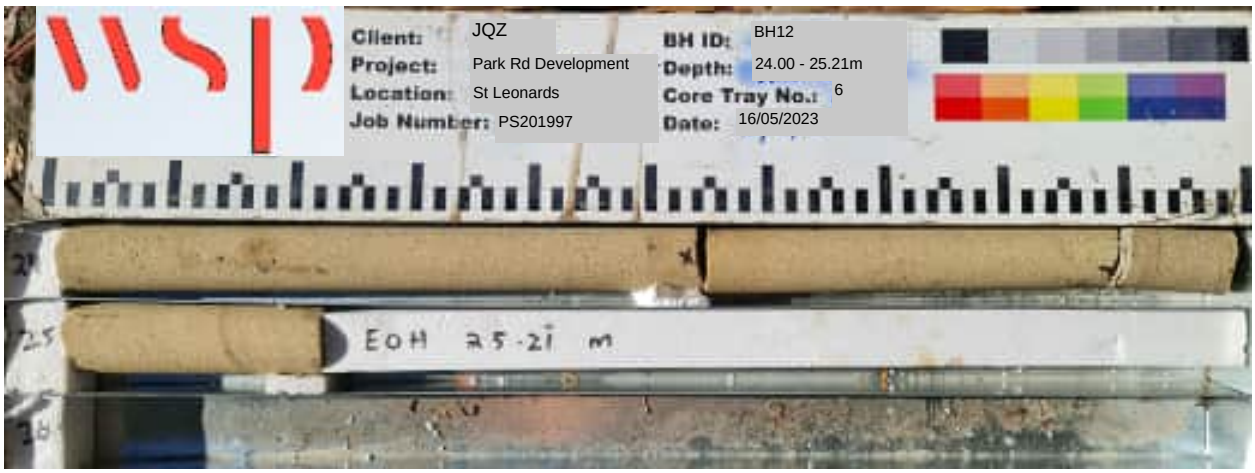
DRAFT REPORT OF CORE PHOTOGRAPHS: BH12

SHEET: 3 OF 3

CLIENT: JQZ
DRILL RIG: GEO205
PROJECT: Park Road St Leonards Development
CONTRACTOR: NUMAC
LOCATION: St Leonards
INCLINATION: -90°
LOGGED: MS DATE: 16/5/23
JOB NO: PS201997
HOLE DIA: 110 mm HOLE DEPTH: 25.21 m
CHECKED: AK DATE: 02/5/23



PointID : BH12 Depth Range: 21.00 - 24.00 m



PointID : BH12 Depth Range: 24.00 - 25.21 m

This report of core photographs must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

WSP-AU 5.04.0.LIB.GLB GrfcTbl GAP CORE PHOTO 2 PER PAGE PS201997 - GINT.GPJ <<DrawingFile>> 1/6/2023 22:58 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

HOLE NO : BH12

CLIENT : JQZ
LOCATION : 35 Berry Rd St Leonards

PROJECT : Park Road St Leonards Development

FILE / JOB NO : PS201997
SHEET : 1 OF 2

POSITION : E: 332639.8, N: 6255620.8 (MGA2020-56) SURFACE ELEVATION : 69.80 (AHD) ANGLE FROM HORIZONTAL : 90°

RIG TYPE : GEO205 MOUNTING : Track CONTRACTOR : NUMAC

DATE STARTED : 16/5/2023 DATE COMPLETED : 16/5/2023 DATE LOGGED : 16/5/2023 LOGGED BY : MS CHECKED BY : AK

PERMIT NUMBER :

DRILLING				MATERIAL			PIEZOMETER CONSTRUCTION DETAILS
PROGRESS: DRILLING & CASING	PROGRESS: WATER	GROUND WATER LEVELS	DEPTH (m)	GRAPHIC LOG	GROUP SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	
			0.0			Silty CLAY: medium to high plasticity, dark grey, with fine grained sand, inferred soft to stiff	ID: BH12 Type: Standpipe Stick Up & RL: 0.00 m 69.80 m AHD Tip Depth & RL: 24.00 m 45.80 m AHD Installation Date: Static Water Level
VE	100% RETURN (NRGWE)				CI-CH		
						1.10m 1.35m	
	100% RETURN		2.0			CORELOSS SANDSTONE: medium to coarse grained, dark red to brown-grey, very thinly bedded to thinly bedded at 5°-20° 2.10m: becoming pale grey stained yellow-red	
	100% RETURN		4.0			3.70m: becoming brown to yellow-grey	
	100% RETURN		6.0			5.40m: becoming pale grey stained yellow-red	
	100% RETURN		8.0			7.50m: becoming fine to coarse grained, pale brown-grey, very thinly bedded to medium bedded at 10°-20° 8.05-8.20m: interbedded with siltstone	
	100% RETURN					9.00m: becoming fine to medium grained	
	100% RETURN		10.0			9.60m: becoming medium to thickly bedded	
	100% RETURN					10.30m: becoming medium to coarse grained, brown, very thinly bedded to medium bedded at 5°-20°	
	100% RETURN		12.0				
HQ3	100% RETURN		14.0				
	100% RETURN		16.0				
	100% RETURN		18.0				18.00 m 18.00 m
	100% RETURN		20.0				
	100% RETURN		22.0			21.70-23.60m: interbedded with Siltstone (20%)	
	100% RETURN		24.0				24.00 m 24.00 m
	100% RETURN					25.21m	
			26.0			Hole Terminated at 25.21 m Target depth	

Gatic Cover
Grout
Bentonite
Gravel
ID: BH12 STICKUP: 0.00 m RL: 69.80 m AHD
Sand

See Explanatory Notes for details of abbreviations & basis of descriptions.

WSP-AU 5.04.0.UB.GLB Log IS AU PIEZOMETER INSTALLATION 2 PS201997 - GINT.GPJ <<DrawingFile>> 6/6/2023 21:36 10.03.00.09 Datgel Lab and In Situ Tool - DGD | Lib: WSP 5.04.0.2023-04-11 Prj: WSP 5.04.0.2023-04-11

Explanatory Notes - Engineering Logs

Engineering logs have been prepared in accordance with AS1726:2017 “Geotechnical Site Investigations” and as defined below.

DRILLING/EXCAVATION METHODS

Symbol	Term
AS	Auger Screwing
EX	Excavation
HA	Hand Auger
NMLC/HMLC	Diamond Core –triple tube
NQ/HQ/PQ	Diamond Core – wireline
PC	Percussion
PCB	Poly Carbonised Diamond Bit
PT	Push Tube
RAB	Rotary Air Blast
RC	Reverse Circulation
S	Sonic drill
VB	Vibrocoring
WB	Washbore with blade
WR	Washbore with roller (tricone)

SUPPORT

C Casing
M Drill mud
Nil No support

WATER

Partial water loss Water inflow

Complete water loss

Water level at date shown

NFGWO No Free Groundwater Observed
The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

NFGWE No Free Groundwater Encountered
The borehole/test pit was dry soon after excavation. Inflow may have been observed had the borehole/test pit been left open for a longer period.

FIELD TEST (Soil borehole and test pit logs)

DM Dilatometer test
HB Hammer bounce
OT Other test (eg. plate load test)
PE Permeability test
PM Pressuremeter test
PP Pocket penetrometer
SPT Standard penetration test
SV Shear vane test

SAMPLE (Soil borehole and test pit logs)

B Bulk disturbed sample
D Disturbed sample
PT Push tube
SPT SPT sample
U50 Undisturbed sample in 50mm diameter tube
U75 Undisturbed sample in 75mm diameter tube

GRAPHIC LOG – see later

TOTAL CORE RECOVERY (Rock logs only)

$$TCR\ (\%) = \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100$$

ROCK QUALITY DESIGNATION (Rock logs only)

$$RQD\ (\%) = \frac{\sum \text{Length of sound core pieces} > 100\text{mm}}{\text{Length of core run}} \times 100$$

GROUP SYMBOL (Soil borehole and test pit logs)

Soils are classified to reflect their primary and significant secondary component/characteristic using the classification symbols described in AS1726-2017, summarised as follows.

Symbol	Major division	Typical names
GW, GP	GRAVEL	Gravel & gravel-sand mixtures, little/no fines
GM		Gravel-silt & gravel-sand-silt mixtures
GC		Gravel-clay & gravel-sand-clay mixtures
SW, SP	SAND	Sand & gravel-sand mixtures, little/no
SM		Sand-silt mixtures
SC		Sand-clay mixtures
ML	SILT & CLAY (low & medium plasticity)	Inorganic silt/clayey fine sand or silt
CL, CI		Inorganic clay, gravelly clay, sandy clay
OL		Organic silt
MH	SILT & CLAY (high plasticity)	Inorganic silt
CH		Inorganic clay, high plasticity
OH		Organic clay, med-high plasticity, organic silt
Pt	Highly organic soil	Peat, highly organic soil

FIELD DESCRIPTION

Soil and rock materials described to AS1726-2017. The description of percentage of cobbles and boulders in a soil may be limited by sample size.

MOISTURE CONDITION

Coarse grained soils and rocks
Dry (D), Moist (M) or Wet (W).
Estimated based on appearance and feel.

Cohesive soils

MC<PL	Moist, dry of plastic limit
MC≈PL	Moist, near plastic limit
MC>PL	Moist, wet of plastic limit
MC≈LL	Wet, near liquid limit
MC>LL	Wet, wet of liquid limit

Estimated based on judgement

COHESIVE SOILS - CONSISTENCY

The consistency of a cohesive soil is assessed by tactile means or field measurement of undrained shear strength.

A Hand Penetrometer may be used in the field or the laboratory to provide approximate assessment of unconfined compressive strength of cohesive soils (kPa) as follows:

Strength	Symbol	Indicative undrained shear strength (kPa)	Hand Penetrometer Reading (kPa)
Very Soft	VS	≤ 12	< 25
Soft	S	>12 and ≤ 25	25 to 50
Firm	F	> 25 and ≤ 50	50 to 100
Stiff	St	>50 and ≤ 100	100 to 200
Very Stiff	VSt	> 100 and ≤ 200	200 to 400
Hard	H	>200	> 400
Friable	Fr	-	-

COHESIONLESS SOILS - RELATIVE DENSITY

Relative density terms are used to describe silty and sandy material, and these are usually based on resistance to drilling penetration or the Standard Penetration Test (SPT) ‘N’ values.

The Standard Penetration Test (SPT) is carried out in accordance with AS 1289, 6.3.1. For completed tests the number of blows required to drive the split spoon sampler 300 mm is recorded as the N value. For incomplete tests the number of blows and the penetration beyond the seating depth of 150 mm are recorded. If the 150 mm seating penetration is not achieved the number of blows to achieve the measured penetration is recorded. SPT correlations may be subject to corrections for overburden pressure and equipment type.

Term	Symbol	Density Index	N Value (blows /0.3 m)	DCP (blows/100 mm)
Very Loose	VL	0 to 15	0 to 4	0 to 1
Loose	L	15 to 35	4 to 10	1 to 2
Medium Dense	MD	35 to 65	10 to 30	2 to 5
Dense	D	65 to 85	30 to 50	5 to 10
Very Dense	VD	>85	>50	>10

SOIL STRUCTURE

Soil structure is described to AS 1726-2017 if visible and present.

SOIL / ROCK ORIGIN

The geological origin of the soil or rock is presented as an interpretation of the geological and geomorphological setting. Origin cannot be deduced on the basis of material appearance and properties alone and is therefore limited by the availability of supporting geological information

ROCK MATERIAL WEATHERING

Rock weathering is described mainly using the following abbreviations and definitions used in AS1726.

Term	Symbol	Definition
Residual soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognizable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition of individual minerals or colour changes.

If differentiation between highly and moderately weathered rock is not practicable, then Distinctly Weathered (DW) is used as defined in AS1726:2017.

INFERRED ROCK STRENGTH

Rock strength is inferred based on field assessment, Point Load Index(AS4133.4.1) or Uniaxial Compressive Strength (AS 4133.4.2.1) as follows:

Term	Symbol	UCS (MPa)	Point Load Index $Is_{(50)}$ (MPa)
Very Low	VL	0.6 to 2	0.03 to 0.1
Low	L	2 to 6	0.1 to 0.3
Medium	M	6 to 20	0.3 to 1
High	H	20 to 60	1 to 3
Very High	VH	60 to 200	3 to 10
Extremely High	EH	>200	>10

● Diametral Point Load Index test

■ Axial Point Load Index test

DEFECT SPACING/BEDDING SPACING (Rock)

Measured at right angles to defects of same set or bedding.

Term	Defect Spacing	Bedding
Extremely closely spaced	<6 mm 6 to 20 mm	Thinly Laminated Laminated
Very closely spaced	20 to 60 mm	Very Thin
Closely spaced	0.06 to 0.2 m	Thin
Moderately widely spaced	0.2 to 0.6 m	Medium
Widely spaced	0.6 to 2 m	Thick
Very widely spaced	>2 m	Very Thick

DEFECT DESCRIPTION (Rock)

Symbol	Term	Symbol	Term
Bg	Bedding	DB	Drill Break
P	Parting	IS	Seam
Cn	Contact	SZ	Sheared Zone
Bd	Boundary	FZ	Fracture Zone
J	Joint	F	Fault
Fo	Foliation	Vn	Vein
C	Cleavage	EW	Extremely Weathered Zone

DEFECT ORIENTATION (Rock)

Dip measured relative to the horizontal plane in vertical boreholes and relative to core axis in inclined boreholes.

DEFECT ROUGHNESS AND SHAPE (Rock)

Roughness	Description	Roughness	Description
SM	Smooth	PO	Polished
RF	Rough	SL	Slickensided
VRo	Very Rough		
Shape	**Description**	**Shape**	**Description**
PR	Planar	CU	Curved
UN	Undulating	VU	Vuggy
IR	Irregular	ST	Stepped

COATING OR INFILLING (Rock)

Abbreviation	Description	Abbreviation	Description
CN	Clean	Co	Coal
CT	Coating	Cr	Crushed rock
IN	infill	Fe	Limonite/ironstone
SN	Stain	Fl	Feldspar
VN	Veneer	Gp	Gypsum
Ca	Calcite	Mn	Manganese
Ch	Chlorite	Py	Pyrite
Cl	Clay	Qz	Quartz

Graphic Symbols — Soils and Rocks

Typical symbols for soils and rocks are as follows. Combinations of these symbols may be used to indicate mixed materials such as clayey sand.

SOIL SYMBOLS

Main components


CLAY


SILT


SAND


GRAVEL


BOULDERS / COBBLES


TOPSOIL


PEAT

Minor components


CLAYEY


SILTY


SANDY


GRAVELLY

OTHER MATERIAL SYMBOLS


FILL


BITUMEN


CONCRETE

ROCK SYMBOLS

Sedimentary Rocks


SANDSTONE


SILTSTONE


CLAYSTONE, MUDSTONE


SHALE


COAL


LIMESTONE


CONGLOMERATE

Igneous rocks


GRANITE


BASALT


UNDIFERENTIATED IGNEOUS

Metamorphic rocks


SLATE, PHYLLITE, SCHIST


GNEISS


QUARTZITE

Appendix B

Borehole imaging

Awaiting full borehole imaging logs

Appendix C

SYDGE304523-1-AA

Park Rd St Leonards

Dewatering management plan

JQZ Pty Ltd



Reference: SYDGE304523-1-AA

6 March 2023

PARK RD ST LEONARDS

Dewatering Management Plan

Report reference number: SYDGE304523-1-AA
6 March 2023

PREPARED FOR

JQZ Pty Ltd
18 Parramatta Rd
Homebush NSW 2140

PREPARED BY

Tetra Tech Coffey
Level 19, Tower B, Citadel Tower, 799 Pacific Highway
Chatswood
NSW 2067 Australia
p: +61 2 9406 1000
f: +61 2 9415 1678
ABN 55 139 460 521

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CONTENTS

1. INTRODUCTION 1

2. BACKGROUND 1

2.1 Site description and proposed development 1

2.2 Previous site investigation information 3

2.3 Rainfall 4

3. SITE HYDROGEOLOGY 5

3.1 Geology 5

3.2 Acid sulfate soils 7

3.3 Regional aquifers 7

3.4 Groundwater levels 7

3.5 Aquifer parameters 10

4. GROUNDWATER INFLOW AND DRAWDOWN ASSESSMENT 12

4.1 Basis of assessment 12

4.1.1 Basement geometry 12

4.1.2 Conceptual cross section 12

4.1.3 Assessment method and boundary conditions 14

4.2 Assessed inflows 15

4.2.1 Total groundwater take 15

4.3 Assessed drawdowns 15

5. RISK ASSESSMENT 17

5.1 Effects on nearby users 17

5.2 Effects on nearby groundwater dependent ecosystems 17

5.3 Risk of increased salinity 17

5.4 Risk of increased contamination in aquifers 17

5.5 Surface settlement 17

5.6 Minimal impact assessment 18

6. GROUNDWATER CHEMISTRY AND DISCHARGE 19

7. DEWATERING AND MONITORING METHODOLOGY 20

7.1 Dewatering methodology 20

7.2 Treatment of discharged water 20

8. MONITORING AND REPORTING REQUIREMENTS 21

8.1 Volume 21

8.2 Quality 21

8.3 Groundwater levels 21
8.4 Reporting 22
9. CONCLUDING REMARKS 22
10. REFERENCES 23

LIST OF TABLES

Table 1: Piezometer details 7
Table 2: Observed groundwater levels at monitoring piezometers 9
Table 3: Rising head test results - Hvorslev (1951) analysis 11
Table 4: Estimated groundwater inflows 15
Table 5: Summary of drawdown distances 16
Table 6: Groundwater induced settlement for a 1 m drawdown in groundwater levels over a 1 m thick compressible soil layer 18
Table 7: Minimal impact consideration – Less Productive – Porous and fractured rock water sources 19

LIST OF FIGURES

Figure 1: Site locality and approximate boundaries 2
Figure 2: Plan of the lowest basement level 3
Figure 3: Previous investigation locations 4
Figure 4: Long-term mean rainfall data 5
Figure 5: Geological boundaries 6
Figure 6: Location of monitoring piezometers 8
Figure 7: Groundwater level contours and inferred groundwater flow direction 10
Figure 8: Cumulative permeability frequency based on packer testing in Sydney Sandstone (after Best and Parker, 2004) 11
Figure 9: Plan view of assumed excavation 13
Figure 10: North-South elevation of conceptual model showing assumed groundwater level and rock properties 13
Figure 11: Section 1 of conceptual site model 14
Figure 12: Section 2 of conceptual site model 14
Figure 13: Drawdown curve for Section 1 16
Figure 14: Drawdown curve for Section 2 16

APPENDICES

APPENDIX A: BOREHOLE LOGS 24
APPENDIX B: RISING HEAD TEST DATA 25
APPENDIX C: SEEP/W RESULTS 26
APPENDIX D: LABORATORY RESULTS 27

1. INTRODUCTION

This report provides a hydrogeological assessment and dewatering management plan for the proposed development of the JQZ Pty Ltd (JQZ) owned Park Road site, located in St Leonards NSW. The site incorporates the properties at 26-52 Park Road, 27-52 Berry Road, and approximately 160m of Berry Lane between these properties, and will be referred to as 'the site'. This assessment was carried out by Tetra Tech Coffey (Coffey) and was commissioned by JQZ.

We understand that the proposed development will comprise the construction of several residential towers over a combined multi-level basement carpark.

The purpose of this report is to provide the following information and assessment in relation to the NSW Aquifer Interference Policy (NSW Department of Primary Industries, 2012) [8]:

- Site hydrogeological information
- Groundwater inflow and drawdown assessment
- Guidance on construction dewatering and monitoring

2. BACKGROUND

2.1 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The proposed development site comprises a rectangular area of approximately 12,700m^2. The site is currently occupied by several one and two storey residential properties with some medium height trees and garden areas. The site also includes approximately 160m of laneway, named Berry Lane, to the rear of these properties, orientated approximately north-south along the site's main axis. The site is bounded by Berry Road to the east, River Road to the south, Park Road to the west and existing residential properties to the north.

The topography of the site slopes from north to south towards River Road, with surface elevation varying from approximately 75m AHD (Australian height Datum) in the north, to 55m AHD to the south, with an average gradient of 1V:8H.

A review of the Architectural drawings indicates that the proposed development involves the demolition of the existing site structures and construction of four separate residential structures between 7 and 12 storeys in height. A combined basement structure will be constructed beneath the towers which will vary between 2 (at the south part of the site) to 6 stories below ground level (at the north). This will include excavations up to approximately 20m below ground level (55m AHD) in the northern part of the site.

A new road will be constructed which will bisect the proposed development from east to west into approximately equal proportions. The basement in the southern part of the site will cover the majority of the site, whereas in the northern part the basement the excavation will extend to two north-south excavations with separation between them.

Figure 1 below illustrates the site locality with the approximate site boundaries shown in red. Figure 2 shows a plan of the lowest basement level.



Figure 1: Site locality and approximate boundaries

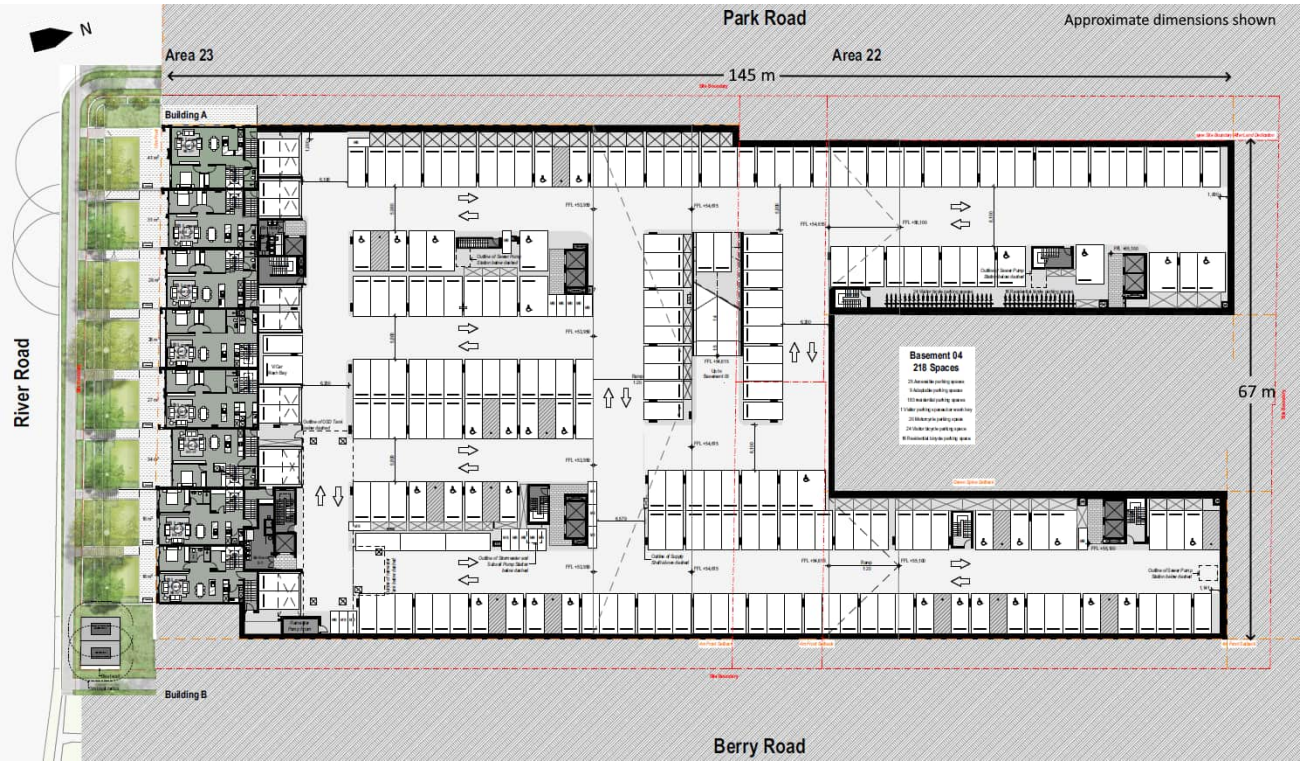


Figure 2: Plan of the lowest basement level

2.2 PREVIOUS SITE INVESTIGATION INFORMATION

Coffey completed a geotechnical investigation for the proposed development in 2018. This included the drilling of 10 boreholes (BH1 to BH9, and BH7A) across the southern portion of proposed development to characterise the site's geotechnical and hydrogeological conditions. The work included installation of five standpipe piezometers boreholes BH1, BH3, BH5, BH7A and BH9 to monitor groundwater levels. A site plan is provided Figure 3 which outlines the borehole locations relative to the site boundaries. It should be noted that this investigation covered the southern portion of the site only. No investigations have been undertaken within the northern half of the site.



Figure 3: Previous investigation locations

Further details of the geotechnical investigations are provided in the Geotechnical Investigation Report (ref: 754-SYDGE219558-GAR-RPT-02, dated 19 October 2018) [1] and a recent desktop study prepared by Coffey (ref: SYDGE304523-AA-01 dated 30 August 2022) [2]. The relevant borehole logs, rock core photographs and well installation logs are attached in Appendix A of this report.

2.3 RAINFALL

Long term average monthly rainfall data has been obtained from the Australian Bureau of Meteorology (BOM) [3] for Sydney Observatory Hill (BOM station no. 066062). This station is located approximately 3 km south-east of the site.

Figure 4 below shows mean monthly rainfall data for Sydney Observatory Hill between 1858 and 2020. The mean annual rainfall is 1,213 mm and the median is 1,164 mm.

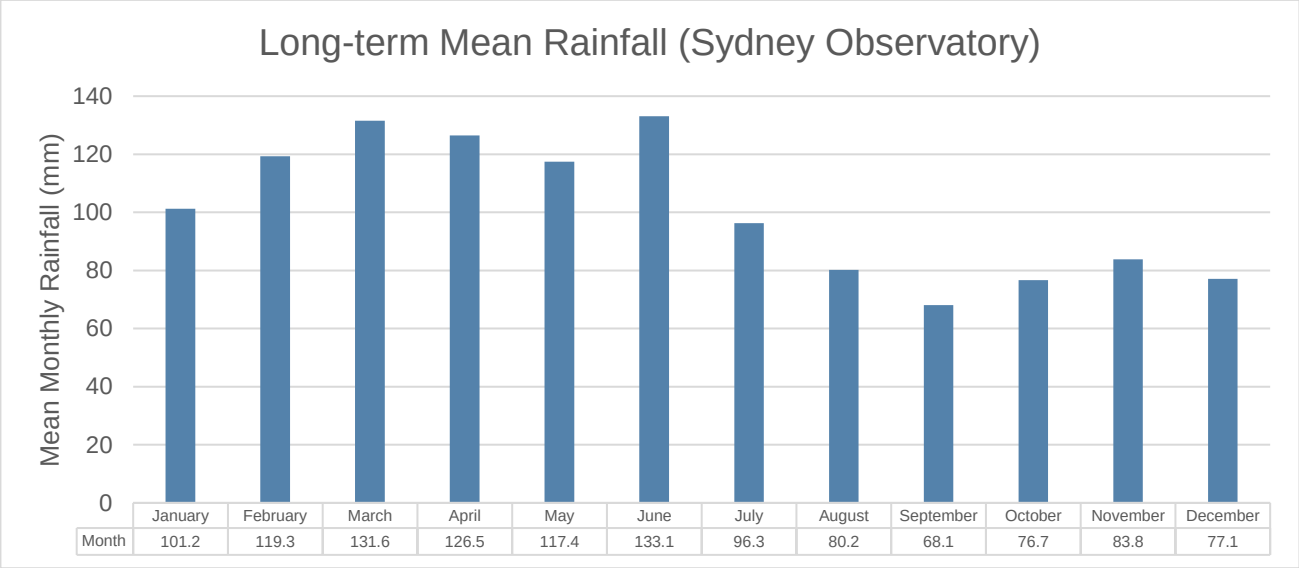


Figure 4: Long-term mean rainfall data

3. SITE HYDROGEOLOGY

3.1 GEOLOGY

A review of the NSW Seamless Geology database [4] indicates the site is bisected by the boundary between the Ashfield Shale and the underlying Hawkesbury Sandstone. This boundary is located near the junction between the Coffey 2018 investigation [1] and the newly acquired land. This is illustrated in Figure 5 below.

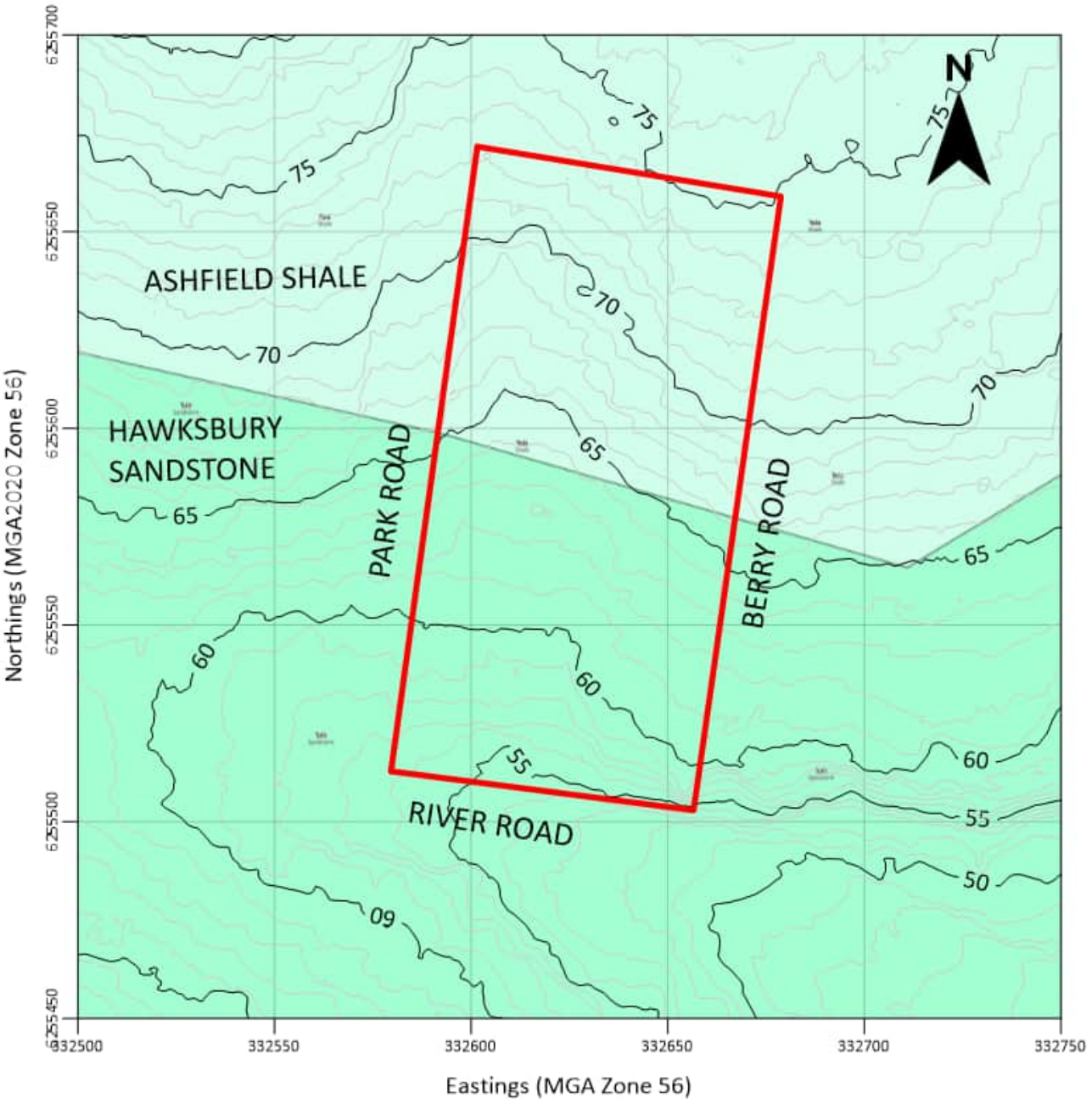


Figure 5: Geological boundaries

The bedrock units are summarised below.

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

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

The site subsurface generally consists of up to about 3 m of soil strength materials (fill or residual soil) overlying bedrock.

Further details on the site geology are presented in the recent desktop study [2] of the site.

3.2 ACID SULFATE SOILS

Reference to Department of Land and Water Conservation, Acid Sulfate Soil Risk Map for Prospect/Parramatta [5] indicates that the site is in an area of no known occurrence of acid sulfate soils.

3.3 REGIONAL AQUIFERS

Groundwater at the site is located within the fractured rock aquifer of the Hawkesbury Sandstone and potentially a small part of the overlying Ashfield Shale. Surface water drains via Berrys Creek to Sydney Harbour at Gore Cove, approximately 800 m south of the site.

The site is located in the Sydney Basin Central Groundwater Source as defined in the NSW Government (2011) Water sharing plan for the greater metropolitan region groundwater sources

3.4 GROUNDWATER LEVELS

Groundwater levels from piezometers previously installed by Coffey have been measured on several occasions. Table 1 provides the coordinates and screen elevations for these piezometers. Figure 6 shows their location on the site along with approximate surface elevation contours.

Table 1: Piezometer details

Piezometer ID	Easting (GDA2020)	Northing (GDA2020)	Surface elevation (mAHD)	Top of screen (m below ground level)	Base of screen (m below ground level)
BH1	332593.62	6255594.30	66.20	4.02	10.02
BH3	332664.31	6255580.56	66.20	4.08	10.08
BH5	332632.44	6255545.67	60.15	1.00	10.00
BH7A	332584.89	6255513.82	56.85	4.26	10.26
BH9	332667.23	6255517.90	60.16	4.48	10.48



Figure 6: Location of monitoring piezometers

A Coffey engineer visited the site on 14 and 21 February to record the depth to groundwater at piezometers using an electronic dip meter. Groundwater levels were previously recorded by a Coffey engineer on 4 September 2018. Table 2 presents the observed groundwater levels on these dates.

Table 2: Observed groundwater levels at monitoring piezometers

Piezometer ID	04-Sep-18 Site Visit		14-Feb-23 Site Visit		21-Feb-23 Site Visit	
	Groundwater elevation (mAHD)	Groundwater depth (m below ground)	Groundwater elevation (m below ground)	Groundwater depth (m below ground)	Groundwater elevation (m below ground)	Groundwater depth (m below ground)
BH1	61.73	4.47	62.31	3.89	-	-
BH3	62.38	3.82	-	-	63.19	3.01
BH5	55.85	4.3	56.24	3.91	-	-
BH7A	52.95	3.9	53.42	3.43	-	-
BH9	54.99	5.17	55.61	4.55	-	-

The groundwater levels measured in 2018 and 2023 are generally consistent, with the groundwater level readings in 2023 typically 0.4m to 0.8m higher in elevation than 2018. This is consistent with the above average rainfall recorded in Sydney during 2022.

Groundwater levels are relatively consistent with regards to depth below ground level across the site, generally varying between 3 to 4.5m below ground level. This infers a groundwater flow direction across the site from north to south at a gradient of approximately 1V:8H, similar to the topography. It should be noted that the groundwater level measurements have only been taken from piezometers on the southern half of the site.

Based on the groundwater levels measured in February 2023, a groundwater contour plan for the southern portion of the site is shown in Figure 7 below, along with the inferred direction of groundwater flows.



Figure 7: Groundwater level contours and inferred groundwater flow direction

3.5 AQUIFER PARAMETERS

Three rising head tests were carried out by Coffey in February 2023 at piezometers BH1, BH7A and BH9. These tests provide an assessment of hydraulic conductivity near these wells. The rising head tests were conducted as follows:

- Groundwater levels were initially measured using an electronic dip meter to record the standing groundwater level.
- The wells were then bailed using a plastic bailer to lower the groundwater level in the wells by at least 2m.

- The recovery of the groundwater level was then measured using the electronic dip meter with levels recorded at regular intervals.

The results of the rising head test were then analysed using the Hvorslev Method (1951) and results presented in Table 3 below. The test reports are provided in Appendix B.

Table 3: Rising head test results - Hvorslev (1951) analysis

Piezometer ID	Hydraulic Conductivity (m/s)
BH1	1.5×10^{-7}
BH7A	1.2×10^{-7}
BH9	0.6×10^{-7}

The tests yielded reasonably consistent values, with an average hydraulic conductivity of 1.1×10^{-7} m/s and a maximum of 1.5×10^{-7} m/s.

These assessed values are above the median values for Hawksbury Sandstone reported by Best and Parker (2004) [6] based on test results for over 900 packer tests, as shown in Figure 8. It can be assumed that one Lugeon is approximately equal to a hydraulic conductivity of 1×10^{-7} m/s

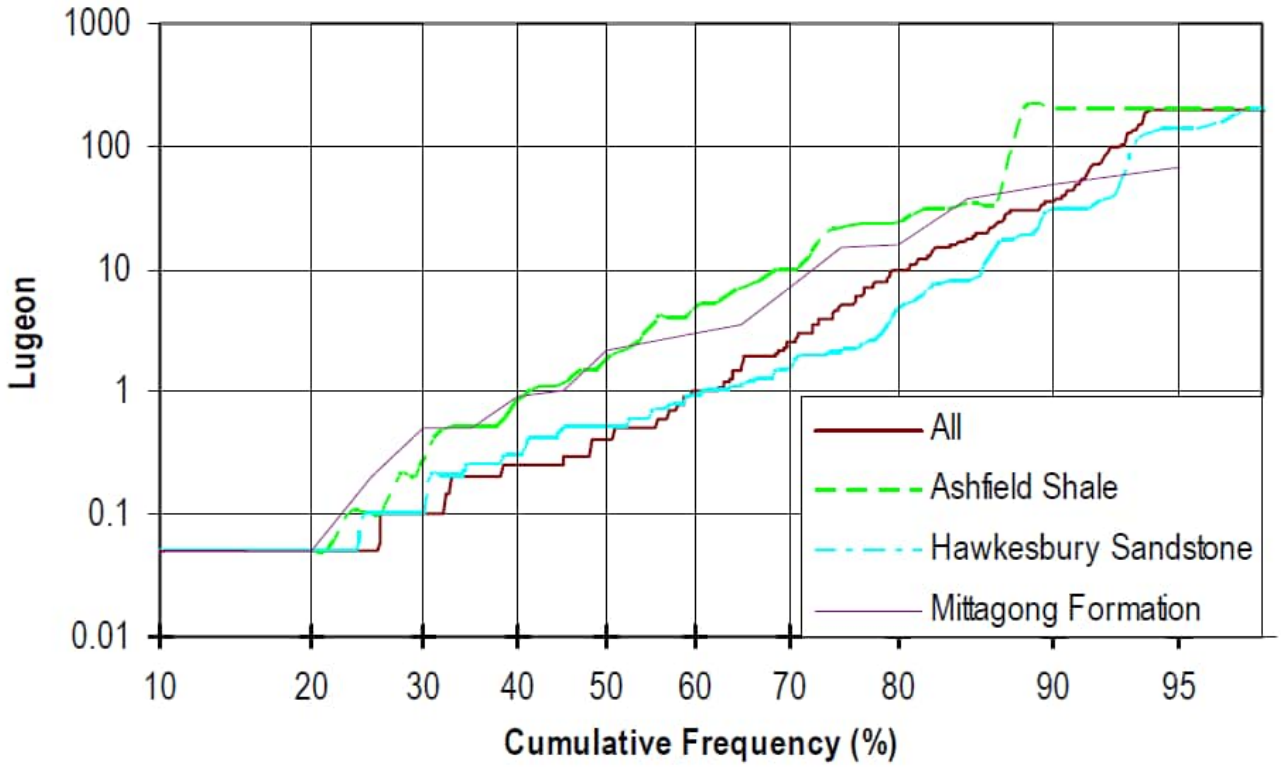


Figure 8: Cumulative permeability frequency based on packer testing in Sydney Sandstone (after Best and Parker, 2004)

The base of the excavation will be approximately 10 m below the top of the Hawkesbury Sandstone, and a hydraulic conductivity of 1.5×10^{-7} m/s is considered as reasonable to adopt for the underlying bedrock units for the purposes of inflow assessment.

4. GROUNDWATER INFLOW AND DRAWDOWN ASSESSMENT

4.1 BASIS OF ASSESSMENT

It is assumed that the basement levels for the development will be drained with groundwater inflows occurring from seepage through the bedrock. It is assumed that dewatering will be carried out for the permanent design life of the basement.

The assessment assumes a steady-state analysis.

4.1.1 Basement geometry

For the purpose of this inflow assessment the basement geometry can be summarised as follows:

- The basement can be described as a horseshoe shape, with a rectangular area in the southern portion of the site and two peninsula basement sections in the north. For modelling the inflow assessment, the basement structure is treated as a rectangular excavation with approximate dimensions of 72m x 144m in plan.
- The excavation is cut into the hillside with a bulk excavation level of between 54m and 55m AHD. For this analysis a consistent bulk excavation of 54m AHD has been assumed across the site.
- The ground surface is sloped such that the surface levels range from 55m AHD in the south to 74m AHD in the north.

4.1.2 Conceptual cross section

Figure 9 provides a simplified site plan of the proposed development. The site has been divided into a northern and southern area for the assessment. Two Sections have been selected for inflow analysis for each area. The sections are located in the deeper (in terms of excavation below groundwater table) half of each of the areas.

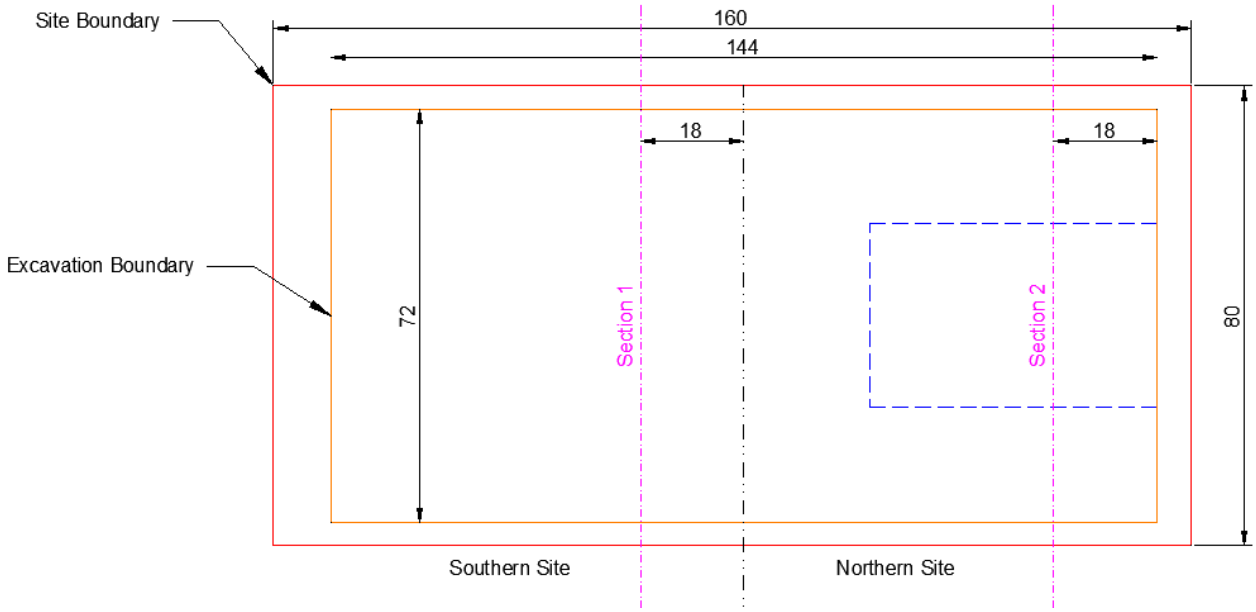


Figure 9: Plan view of assumed excavation

Figure 10 to Figure 12 below present conceptual cross sections of the site, showing the proposed excavation in relation to the current groundwater level and underlying bedrock (Hawksbury Sandstone/Ashfield Shale) aquifer.

The maximum drawdown to achieve dry conditions in the excavation is approximately 16.5 m in the northern part of the site, assuming groundwater to be at between 3.5 m and 4 m below ground in that area.

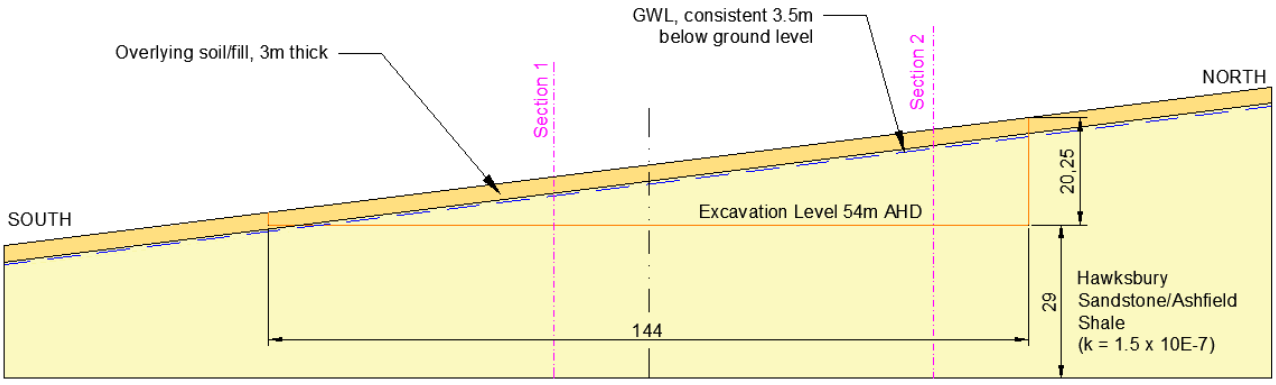


Figure 10: North-South elevation of conceptual model showing assumed groundwater level and rock properties

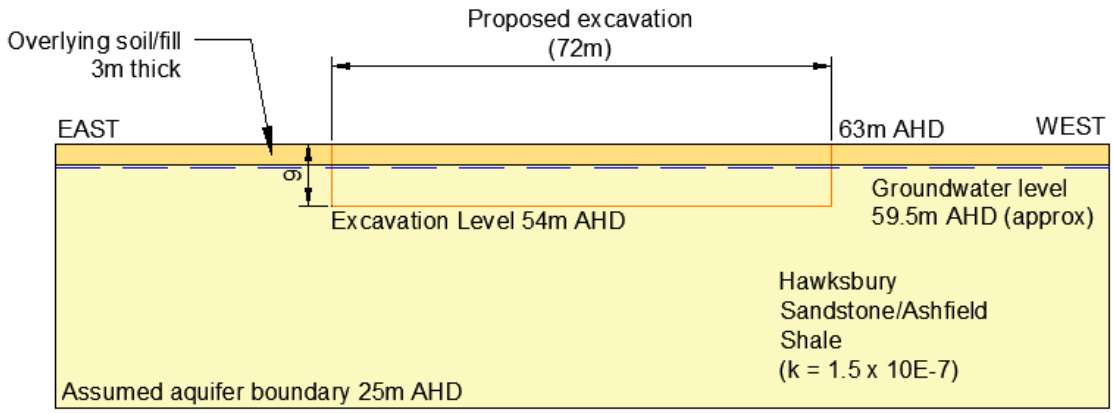


Figure 11: Section 1 of conceptual site model

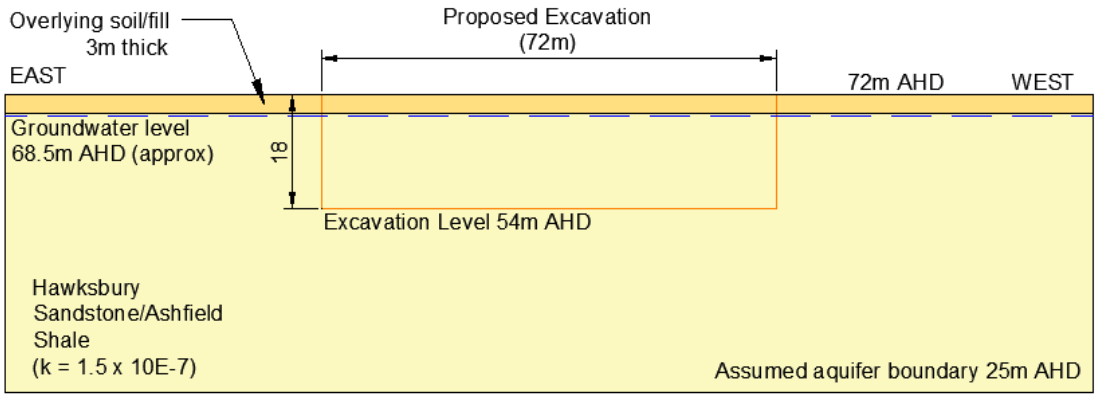


Figure 12: Section 2 of conceptual site model

4.1.3 Assessment method and boundary conditions

An estimation of steady state groundwater inflow rates to the proposed excavation was carried out using the proprietary software Geostudio SEEP/W R18 Version 9.

The following assumptions were adopted for the inflow assessment:

- The flow to the excavation is unconfined and predominantly in the horizontal section.
- The initial groundwater level is 59.5m AHD for Section 1 and 68.5m AHD for Section 2.
- The base of the aquifer is set at 25m AHD and defined as a no-flow boundary.
- The hydraulic conductivity of the bedrock is k = 1.5 x 10^{-7} m/s with a kv/kh ratio of 0.2.
- The excavation face is a seepage face which allows water to flow out of the model.
- An estimated rainfall infiltration rate 7.6 x 10^{-10} m/sec is applied to the ground surface. This is approximately equal to 2% of annual rainfall.
- An estimated zone of influence or distance to lateral fixed head boundaries of 275m from the edge of excavation has been adopted.
- Due to symmetry across the conceptual cross sections presented in Section 4.1.2, only half the excavation has been modelled.

4.2 ASSESSED INFLOWS

The results of the SEEP/W models are presented in Appendix C of this report. The results of the SEEP/W analysis provide an inflow of m^3/s per linear meter of excavation face of each section. To calculate the total inflow rate from the excavation, the inflow rates from the SEEP/W results need to be multiplied by the perimeter of each portion of the site.

Table 4 below summarises the estimated groundwater inflows for each section.

Table 4: Estimated groundwater inflows

	Groundwater inflow rate (m^3/s per m excavation perimeter)	Site perimeter (m)	Groundwater inflow rate Q (m^3/sec)	
			m^3/s	m^3/day
Southern part of site (Section 1)	1.8×10^{-7}	216	3.9×10^{-5}	3.4
Northern part of site (Section 2)	4.0×10^{-7}	216	8.6×10^{-5}	7.5
Total		432	12.5×10^{-5}	10.8

Based on the SEEP/W analysis, an inflow rate of 10.8 m^3/day (0.125 L/s) into the excavation was assessed. Considering the uncertainty in the predictions of inflow, we consider a reasonable estimate of inflows during construction to be between 5 and 20 m^3/day.

4.2.1 Total groundwater take

The estimated groundwater take during and following construction works from groundwater seeping through the excavation faces is between 2 ML and 8 ML a year, based on groundwater inflow rates of between 5 and 20 m^3/day.

An assessment of groundwater within excavated soil/rock has also been considered based on the following information:

- An excavated volume of rock below groundwater table of 58,800m^3 and;
- A rock porosity of 0.17.

For this excavation, it is expected that an additional approximately 10ML of groundwater take will be required during excavation.

The assessed groundwater inflow rates are for working conditions based on information available at the time of writing this report prior to excavation of the proposed basement. Unforeseen ground conditions may result in inflows different to those assessed here.

4.3 ASSESSED DRAWDOWNS

Figure 13 and Figure 14 presents the assessed groundwater drawdown versus distance from the excavation face based on the SEEP/W analysis for Sections 1 and 2. Table 5 summarises the estimated distances from excavation face for the 1m and 2m drawdown levels.

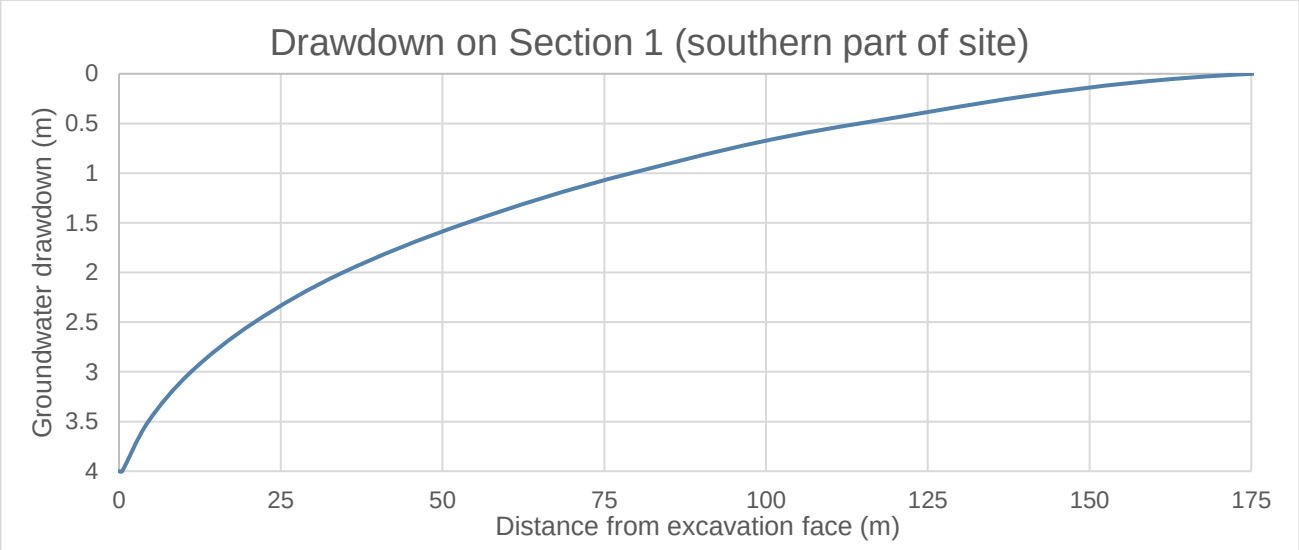


Figure 13: Drawdown curve for Section 1

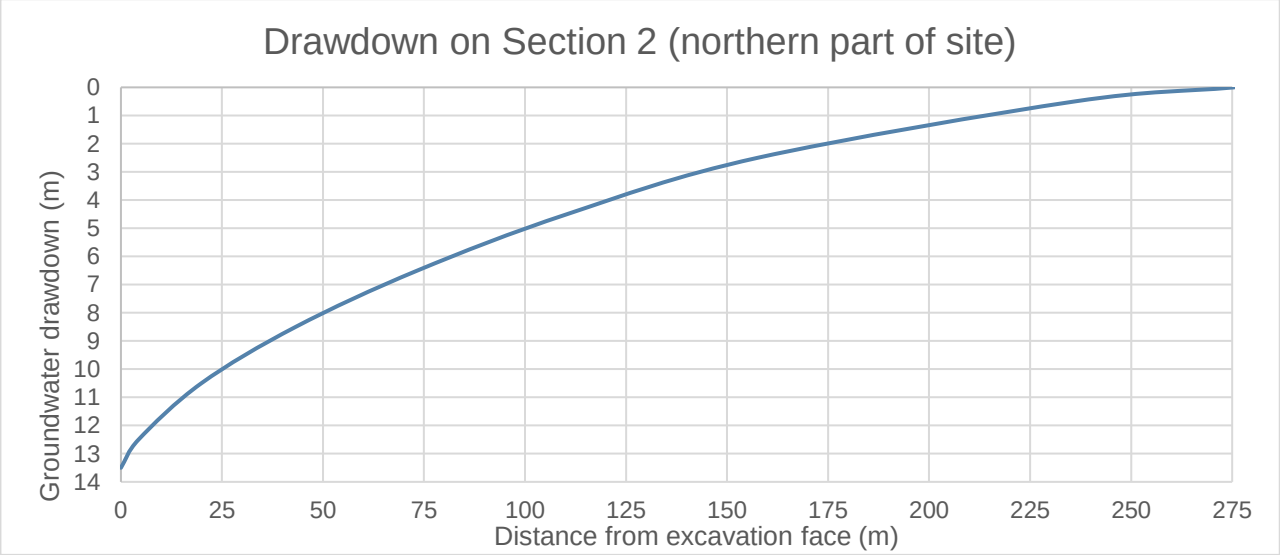


Figure 14: Drawdown curve for Section 2

Table 5: Summary of drawdown distances

	Distance from excavation face (m)	
	1m drawdown	2m drawdown
Section 1 - South	75	30
Section 2 - North	215	175

These assessed drawdowns are based on the analysis presented above and assumptions related to the zone of influence and rainfall infiltration. We consider the assessed drawdowns represent a reasonable assessment at the pre-construction stage of the site, noting that there is an unavoidable degree of uncertainty in predictions of drawdown prior to construction observations becoming available.

This assessment considers drawdown related to the site excavation and dewatering only. Should dewatering occur simultaneously at other locations, by other proponents, the effects may result in wider cumulative drawdowns.

5. RISK ASSESSMENT

5.1 EFFECTS ON NEARBY USERS

A search for nearby registered bores was made on 23 February 2023 using the Bureau of Meteorology Australian Groundwater Explorer database [7]. Based on the search results, no registered groundwater bores were found within 500m of the site. Registered bores outside this range are not expected to be influenced by drawdown effects from the proposed development.

Based on the assessed drawdowns shown in Figure 13 and Figure 14 the risk to nearby groundwater users is assessed to be negligible.

5.2 EFFECTS ON NEARBY GROUNDWATER DEPENDENT ECOSYSTEMS

The closest high priority groundwater dependent ecosystems (GDE) shown on the Bureau of Meteorology Groundwater Dependent Ecosystems Atlas [8] are the Coastal Sandstone Gulley Forest which is located approximately 2km to the south-west of the site and situated at a much lower elevation adjacent to the Woodford Bay area.

Due to the distance and elevation difference, the risk to this GDE is assessed to be negligible.

5.3 RISK OF INCREASED SALINITY

The closest saltwater source to the site is approximately 800 m away to the south at Gore Cove at an elevation of approximately 55 m below the base of the proposed excavation.

Based on the assessments presented in this report and the distance to the nearest saltwater source, the risk of saltwater intrusion into the aquifer as a result of the proposed development is considered to be negligible.

5.4 RISK OF INCREASED CONTAMINATION IN AQUIFERS

The development will act as a groundwater sink. A review of the preliminary contamination report prepared of the site by Tetra Tech Coffey (Ref. SYDGE304523, dated 19 July 2022) [9] indicates that there are no known sources of contamination within the site or in the surrounding area.

Therefore, the risk of increased contamination in aquifers is considered negligible.

5.5 SURFACE SETTLEMENT

A decrease in groundwater pressure in the soil due to drawdown results in an increase in effective stress, which may result in surface settlement due to compression of the soil. The magnitude of settlement depends on the soil/rock stiffness in one-dimensional compression E'_0, the magnitude of drawdown in groundwater levels, and the saturated thickness of the compressible layer. Table 6 (after Preene, Roberts and Powrie, 2016 [14]) shows the groundwater induced settlement for a 1 m drawdown in groundwater levels over a 1 m thick compressible layer.

Table 6: Groundwater induced settlement for a 1 m drawdown in groundwater levels over a 1 m thick compressible soil layer

The basic settlement is defined as the compression of a soil layer 1 m thick from an increase in vertical effective stress corresponding to a drawdown of 1 m. For a given situation, the total settlement in mm may be obtained by multiplying the basic settlement by the drawdown and the thickness of the soil layer (both in metres)

One-dimensional soil stiffness, E'_o (MPa)	1	5	10	15	20	25
Basic settlement (mm)	10.0	2.0	1.0	0.667	0.5	0.4
One-dimensional soil stiffness, E'_o (MPa)	40	50	75	100	150	200
Basic settlement (mm)	0.25	0.20	0.133	0.10	0.067	0.05

Considering there is expected to be approximately 3m of soil-like material across the site, and groundwater levels are generally at 3.5m or deeper below surface level, drawdown of the groundwater table is not expected to cause settlement of the overlying soil. In addition the underlying weathered rock material typically has a one-dimensional stiffness of over 1 Gpa (not shown in Table 6).

If we assume a drawdown of 10 m, a saturated thickness of 44m (refer to Figure 12), and a one-dimensional soil stiffness of 1 GPa for sandstone bedrock, then the assessed groundwater induced surface settlement is less than 10 mm.

Based on this assessment, the potential for adverse groundwater drawdown induced surface settlement outside the site due to the construction dewatering is assessed to be low.

5.6 MINIMAL IMPACT ASSESSMENT

According to the NSW Aquifer Interference Policy [10] the fractured rock groundwater source from which the site will be extracting water for the purposes of construction dewatering is classed as ‘less productive’ considering it does not contain water supply works that can yield water at a rate greater than 5 L/sec. Table 7 presents a ‘Minimal Impact Consideration’ for Aquifer Interference Activities for porous and fractured rock water sources following the NSW Aquifer Interference Policy [10]. Based on this we conclude that the development is a low risk for groundwater impacts.

Table 7: Minimal impact consideration – Less Productive – Porous and fractured rock water sources

Consideration	Response
WATER TABLE 1. Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan"(2) variations, 40m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan; or A maximum of a 2m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies(5) will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2m decline cumulatively at any water supply work then make good provisions should apply.	Refer to Section 5.2: Negligible water level decline is predicted within 40 m of any high priority groundwater dependent ecosystem. There is not known to be a high priority culturally significant site within 40 m from the site Refer to Section 5.1: No registered bores with the listed purpose of water supply are located within the predicted 2 m drawdown contour around the site.
WATER PRESSURE 1. A cumulative pressure head decline of not more than 2m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1. above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	Refer to Section 5.1: No registered bores with the listed purpose of water supply are located within the predicted 2 m drawdown contour around the site.
WATER QUALITY 1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 2. If condition 1. is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.	Refer to Section 5.4: The development will act as a groundwater sink, and injection/recharge of water to the groundwater system is not proposed. Therefore the risk of increased contamination in aquifers is considered negligible. Refer to Section 5.3: The closest salt water source to the site is over 1.0km away at a much lower elevation (Greenwich Bay) Based on the assessments presented in this report and the distance to the nearest salt water source, the risk of salt water intrusion into the aquifer as a result of the proposed development is considered to be negligible.

6. GROUNDWATER CHEMISTRY AND DISCHARGE

Groundwater samples were collected from two site piezometers (BH1 and BH9) along with a duplicate sample of BH9 for QA purposes on 21 February 2023 and were sent to the NATA accredited laboratory ALS for the following analyses:

- pH
- Electrical conductivity (EC);
- Total dissolved solids (TDS);
- Suspended Solids
- Dissolved metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc;

- Total Organic Carbon (TOC)
- Anions (chloride, sulfate) and cations (calcium, magnesium, potassium and sodium);
- Total Nitrogen including NO_2, NO_3, NH_3;
- Hydrocarbons (total recoverable hydrocarbons (TRH) and Polycyclic Aromatic Hydrocarbons).

The laboratory results and summary table are presented in Appendix D.

Based on stormwater catchment mapping provided by Sydney Water [11] stormwater from the site would drain to the south-east entering Berry Creek through a series of stormwater pipes and culverts which flows to the Gore Cove reserve wetland. As a result, groundwater released from the site to the stormwater system intersect estuary and marine habitat which may impact the marine water quality along the river.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) have been published as an interactive website [12]. The groundwater chemistry laboratory test results were evaluated against the ANZG 2018 default guideline values (DGVs) for protection of 95% of species within a marine receiving environment. The results of this are summarised below:

- Laboratory pH measurements indicated that the groundwater collected was acidic with a pH ranging from 4.9 to 5.5, a similar pH to slightly acidic rain.
- Laboratory EC ranged from 370 µS/cm to 590 µS/cm and TDS results ranged from 264 mg/L to 430 mg/L.
- Hydrocarbons including TRH, BTEX and PAHs were below laboratory detection limits at all samples.
- Concentrations of two metals (copper and zinc) exceeded the ANZG 2018 DGVs.

The reported metal concentrations are reflective of the regional urban groundwater quality in the area.

With reference to the laboratory test results and expected point of stormwater discharge from the site, it is considered that only routine groundwater treatment measures such as pH adjustment and sediment reduction will be necessary prior to groundwater being released directly to the stormwater system.

7. DEWATERING AND MONITORING METHODOLOGY

7.1 DEWATERING METHODOLOGY

Temporary groundwater containment during construction is required for the excavation works. Considering the size of the site, it is expected that a system of sump pits would be used to contain and direct collected groundwater from the site to temporary detention basins within the southern portion of the site during the excavation process. These basins would allow for storage of the collected groundwater with an aggregate capacity equal to the assessed inflow rate plus adequate redundancy to allow for settlement and treatment prior to discharge.

Temporary and permanent excavation support will be required for the excavation. The excavation support designs are currently in development and beyond the scope of this hydrogeological report.

7.2 TREATMENT OF DISCHARGED WATER

The quality of the groundwater prior to discharge to the stormwater network shall conform to the Protection of the Environment Operations Act 1997 (POEO Act) and ANZG (2018) guidelines.

Based on the identified groundwater quality presented in Appendix D, the groundwater may require treatment to increase pH levels and reduce turbidity prior to discharge. The following possible treatment measures are suggested, and should be installed and operational prior to the commencement of any excavation:

A groundwater filtration and pH buffering treatment system, which could comprise:

- A baffled treatment tank;
- Automated in-line chemical dosing systems for the addition of buffering solutions and coagulants;
- A flow metre to record extraction volumes and total flows;
- Emergency response alarms for non-routine situations; and
- A sedimentation tank to provide additional residence time and sedimentation.

Pumping to the stormwater system will be subject to the approval of the relevant authority, either Council or Sydney Water depending on the stormwater pits used.

8. MONITORING AND REPORTING REQUIREMENTS

8.1 VOLUME

The volume of water removed from site must be recorded daily using calibrated flow meters or records from appropriate waste disposal contractors. This information is to be recorded either in hard copy or in electronic format.

8.2 QUALITY

The discharge water must be tested onsite for pH and Turbidity (NTU) using a handheld or other testing meter prior to release into the stormwater system. This information is to be recorded either in hard copy or in electronic format.

At monthly intervals during construction, a sample of discharge water should be sampled and sent for testing at a NATA registered laboratory for the following:

- Turbidity
- Total suspended solids;
- Total dissolved solids;
- Metals: arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc;
- Total recoverable hydrocarbons;
- Benzene, toluene, ethylbenzene, xylene.

8.3 GROUNDWATER LEVELS

It is anticipated that any groundwater wells that have been installed or will be installed within the basement plan area are likely to be removed during the excavation process. Currently this only comprises BH5, however BH1, BH3 and BH7A may be affected and removed as part of the basement excavation process. BH9 which is installed outside of the site compound is expected to still be accessible for monitoring.

It is recommended that at least 2 additional groundwater wells are installed particularly within the northern portion of the site to understand the groundwater levels in this area. If there is insufficient space to install additional wells within the site boundary and outside of the excavation zone, these wells should be installed to the north of the proposed development, likely placed within the Council roadway or parking bays to allow for assessment of groundwater level upstream of the development site.

Continuous water level monitoring of installed wells could be completed using electronic data loggers installed in these boreholes. If electronic data loggers are not used, water levels at these bores must be manually measured at a minimum of once per month during construction.

8.4 REPORTING

During construction, a groundwater monitoring report should be prepared every three months by an experienced hydrogeologist providing factual data on the recorded inflow volumes, quality of discharged water, and groundwater levels at monitoring piezometers. The monitoring report must also comment on a comparison of observations versus the predictions in this report, in particular highlighting, where applicable:

- Whether observed groundwater discharge volumes are exceeding the predictions in this report
- Any increase in risk to existing groundwater users due to higher-than-expected drawdowns

9. CONCLUDING REMARKS

Based on our site observations, the site hydrogeological model and experience on similar projects, it is considered that a drained basement for the proposed development is feasible and presents a low risk to the groundwater system, provided that appropriate monitoring of groundwater discharge volumes and groundwater levels is carried out during construction.

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

10. REFERENCES

[1] Coffey Services Australia Pty Ltd, (2018) “Country Garden Australia - St Leonards Development - Geotechnical Assessment Report (SYDGE219558-GET-RPT-02),” Sydney, 19 October 2018.

[2] Tetra Tech Coffey, (2022) “Area 22 Proposed Residential Development, 26-36 Park Road, 27-47 Berry Road and 48-52 River Road, St Leonards (SYDGE304523-AA-01),” Sydney, August 2022.

[3] Bureau of Meteorology, “Climate Data Online Tool,” Australian Government, [Online]. Available: http://www.bom.gov.au/climate/data/.

[4] NSW Government, (2019) “NSW Seamless Geology,” Department of Regional New South Wales, 01 05 2019. [Online]. Available: https://data.nsw.gov.au/data/dataset/nsw-seamless-geology.

[5] NSW Government, (1997) “Department of Land and Water Conservation - Acid Sulfate Soil Risk Map - Prospect/Parramatta,” Department of Land and Water Conservation, Sydney, 1997.

[6] Bureau of Meteorology, “Australian Groundwater Explorer,” Australian Government, [Online]. Available: http://www.bom.gov.au/water/groundwater/explorer/map.shtml.

[7] Bureau of Meteorology, “Groundwater Dependent Ecosystem Atlas,” Australian Government, [Online]. Available: http://www.bom.gov.au/water/groundwater/gde/map.shtml.

[8] NSW Department of Primary Industries, (2012) “NSW Aquifer Interference Policy”, Sydney, September 2012.

[9] Sydney Water, (2022) “Stormwater catchment map,” 2022. [Online]. Available: https://www.sydneywater.com.au/water-the-environment/how-we-manage-sydneys-water/stormwater-network/stormwater-catchment-map.html.

[10] Water Quality Australia, (2018) “Australian and New Zealand Guidelines for Fresh and Marine Water Quality,” 2018. [Online]. Available: https://www.waterquality.gov.au/anz-guidelines.

[11] Best R.J. and Parker C.J. (2004) Groundwater in Sydney, tunnel inflows and settlement – theory and experience

[12] Hvorslev, M J (1951) Time lag and soil permeability in ground-water observations, Waterways Experiment Station, Corps of Engineers, US Army, Bulletin No 36

[13] NSW Government (2011) Water sharing plan for the greater metropolitan region groundwater sources 2011 Groundwater sources, management zones & groundwater dependent ecosystems, Map No: WSP015

[14] Preene, M, Roberts, T O L, Powrie, W (2016), Groundwater control: design and practice, second edition, CIRIA C750

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

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

Your report is based on project specific criteria

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

Subsurface conditions can change

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

Interpretation of factual data

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

Your report will only give preliminary recommendations

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

Your report is prepared for specific purposes and persons

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

Interpretation by other design professionals

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

Data should not be separated from the report

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

Geoenvironmental concerns are not at issue

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

Rely on Tetra Tech Coffey for additional assistance

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

Responsibility

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

APPENDIX A: BOREHOLE LOGS

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Engineering Log - Borehole

Borehole ID.	***BH1***
sheet:	1 of 3
project no.	***754-SYDGE219558***
date started:	***28 Aug 2018***
date completed:	***28 Aug 2018***
logged by:	***AM***
checked by:	***AB***

client: ***Country Garden Australia Pty Ltd***

principal:

project: ***St Leonards Development***

location: ***St Leonards, NSW***

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

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

drilling information | **material substance**

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

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

consistency / relative density

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

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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BH1 1.75 - 6.00 m

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

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client: Country Garden Australia Pty Ltd

project: St Leonards Development
St Leonards

title: **CORE PHOTOGRAPH**
BH1

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

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BH1 6.00 - 10.02 m

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

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client:	Country Garden Australia Pty Ltd
project:	St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH1**
project no: 754-SYDGE219558	fig no: **FIGURE 2** rev:

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Piezometer Installation Log

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

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

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

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

method & support	water	RL (m)	depth (m)	graphic log	material name
AD/T		66	0		**TOPSOIL**
					FILL
			1		**RESIDUAL SOIL**
		64	2		**HAWKESBURY SANDSTONE**
			3		
		62	4		
N	04/09/18		5		
			6		
NMLC		60			
			7		
		58	8		
			9		
			10		
		56			
			11		

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

BH1

Grout

3.00 m

Bentonite

3.50 m

4.02 m

Sand

10.02 m

method & support
see engineering log for details

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

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

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

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

consistency / relative density

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

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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BH2 3.00 - 8.00 m

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

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client: Country Garden Australia Pty Ltd

project: St Leonards Development
St Leonards

title: **CORE PHOTOGRAPH**
BH2

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

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BH2 8.00 - 10.11 m

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

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client: Country Garden Australia Pty Ltd

project: St Leonards Development
St Leonards

title: **CORE PHOTOGRAPH**
BH2

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

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Engineering Log - Borehole

Borehole ID.	***BH3***
sheet:	1 of 3
project no.	***754-SYDGE219558***
date started:	***27 Aug 2018***
date completed:	***27 Aug 2018***
logged by:	***AM***
checked by:	***AB***

client: ***Country Garden Australia Pty Ltd***

principal:

project: ***St Leonards Development***

location: ***St Leonards, NSW***

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

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

drilling information						material substance						
method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA			E	66				**FILL: SILTY SAND**: dark brown.	D			**FILL**
HA			E					**CLAY**: medium plasticity, orange brown.	<Wp	F		**RESIDUAL SOIL**
AD/T			SPT 3,3,3 N=6	65	1.0			1.0 m: trace sandstone gravels		VSt	>>X	
			SPT 7,10,9 N=19						>Wp			
				64	2.0			Borehole BH3 continued as cored hole				
				63	3.0							
				62	4.0							
				61	5.0							
				60	6.0							
				59	7.0							

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating



BH3 1.90 - 6.00 m

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

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

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BH3 6.00 - 10.08 m

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

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

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Piezometer Installation Log

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

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

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

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

method & support	water	RL (m)	depth (m)	graphic log	material name
HA		66	0		
			1		**FILL**
AD/T					**RESIDUAL SOIL**
		64	2		**HAWKESBURY SANDSTONE**
	04/09/18		3		
		62	4		
			5		
NMLC		60	6		
			7		
		58	8		
			9		
			10		
		56	11		

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

BH3

Grout

2.96 m

Bentonite

3.48 m

4.08 m

Sand

10.08 m

method & support
see engineering log for details

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

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

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

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Engineering Log - Borehole

Borehole ID.	***BH4***
sheet:	1 of 3
project no.	***754-SYDGE219558***
date started:	***23 Aug 2018***
date completed:	***23 Aug 2018***
logged by:	***AM***
checked by:	***AB***

client: ***Country Garden Australia Pty Ltd***

principal:

project: ***St Leonards Development***

location: ***St Leonards, NSW***

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

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

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

consistency / relative density

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

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

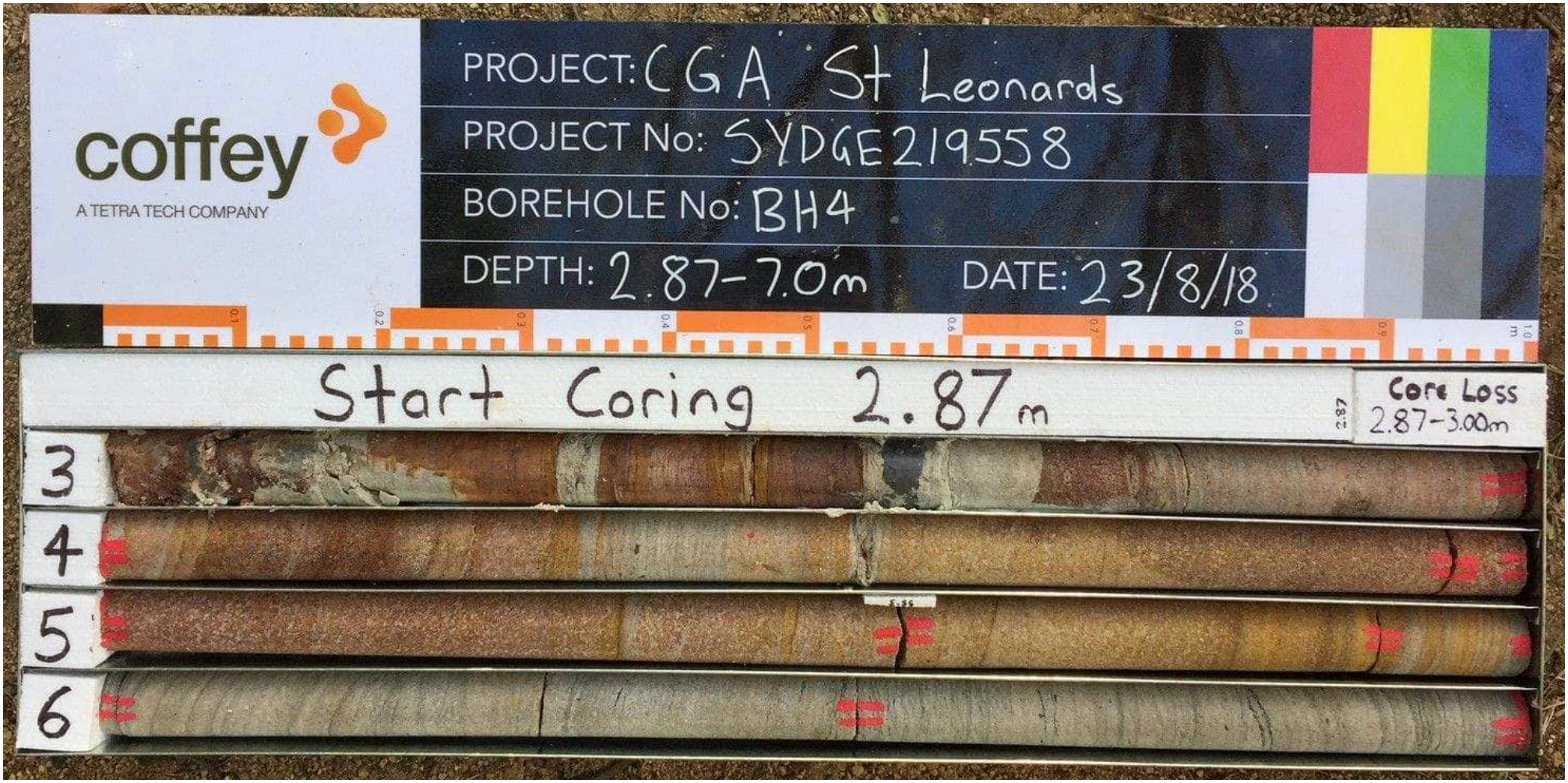
strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating



BH4 2.87 - 7.00 m

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

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

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BH4 7.00 - 10.42 m

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

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

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Engineering Log - Borehole

Borehole ID.	***BH5***
sheet:	1 of 3
project no.	***754-SYDGE219558***
date started:	***21 Aug 2018***
date completed:	***21 Aug 2018***
logged by:	***AM***
checked by:	***AB***

client: ***Country Garden Australia Pty Ltd***

principal:

project: ***St Leonards Development***

location: ***St Leonards, NSW***

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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BH5 0.57 - 5.00 m

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

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

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BH5 5.00 - 10.00 m

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

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH5**

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

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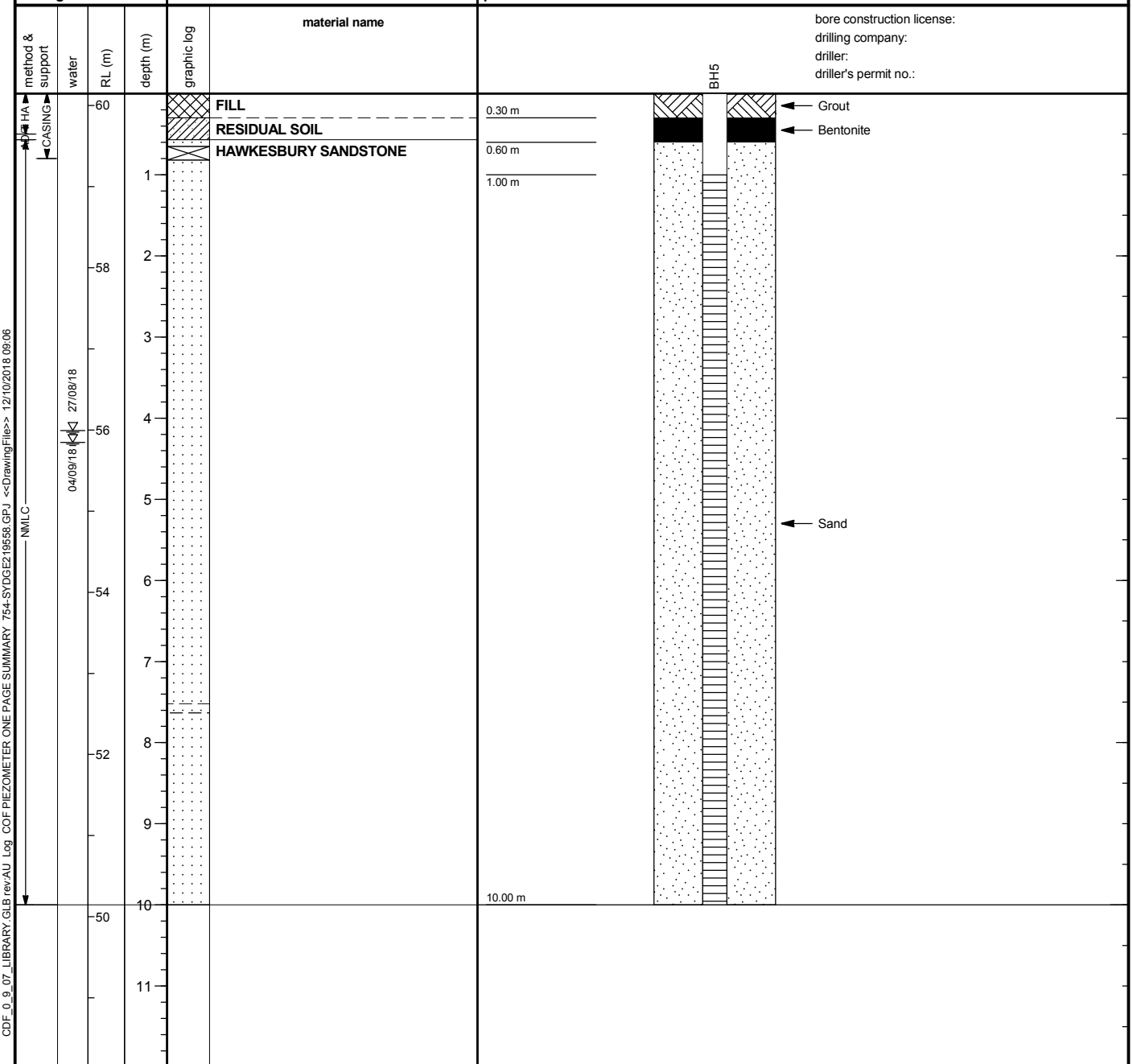
Piezometer Installation Log

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

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

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

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



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method & support
see engineering log for details

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

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

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

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Engineering Log - Borehole

Borehole ID.	***BH6***
sheet:	1 of 3
project no.	***754-SYDGE219558***
date started:	***20 Aug 2018***
date completed:	***21 Aug 2018***
logged by:	***AM***
checked by:	***AB***

client: ***Country Garden Australia Pty Ltd***

principal:

project: ***St Leonards Development***

location: ***St Leonards, NSW***

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating



BH6 1.00 - 6.00 m

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

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A TETRA TECH COMPANY

client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH6**

project no:	fig no:	rev:
754-SYDGE219558		

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BH6 6.00 - 10.07 m

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

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH6**

project no:	fig no:	rev:
754-SYDGE219558		

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

consistency / relative density

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

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

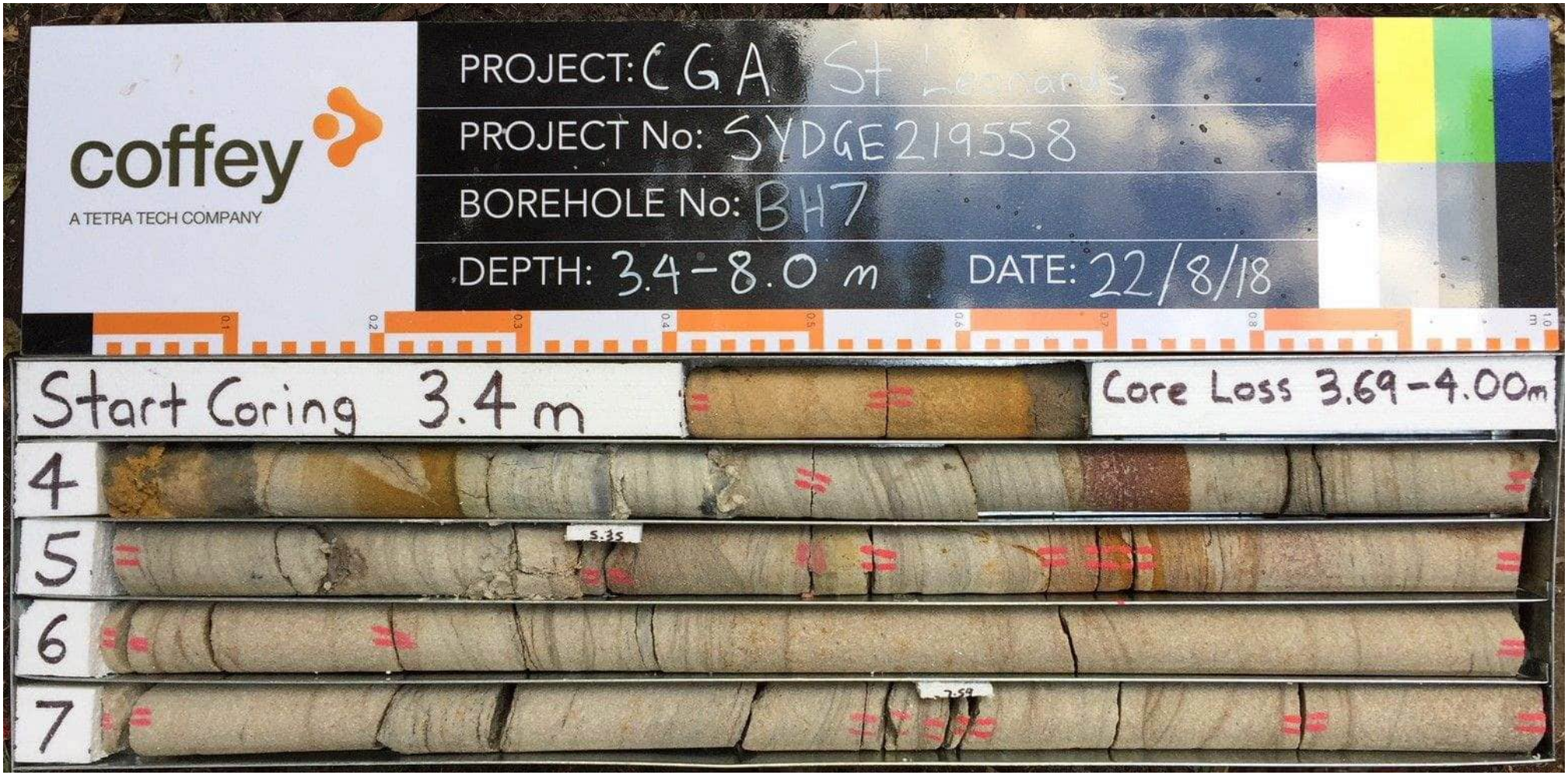
strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating



BH7A 3.40 - 8.00 m

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

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

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BH7A 8.00 - 10.26 m

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

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

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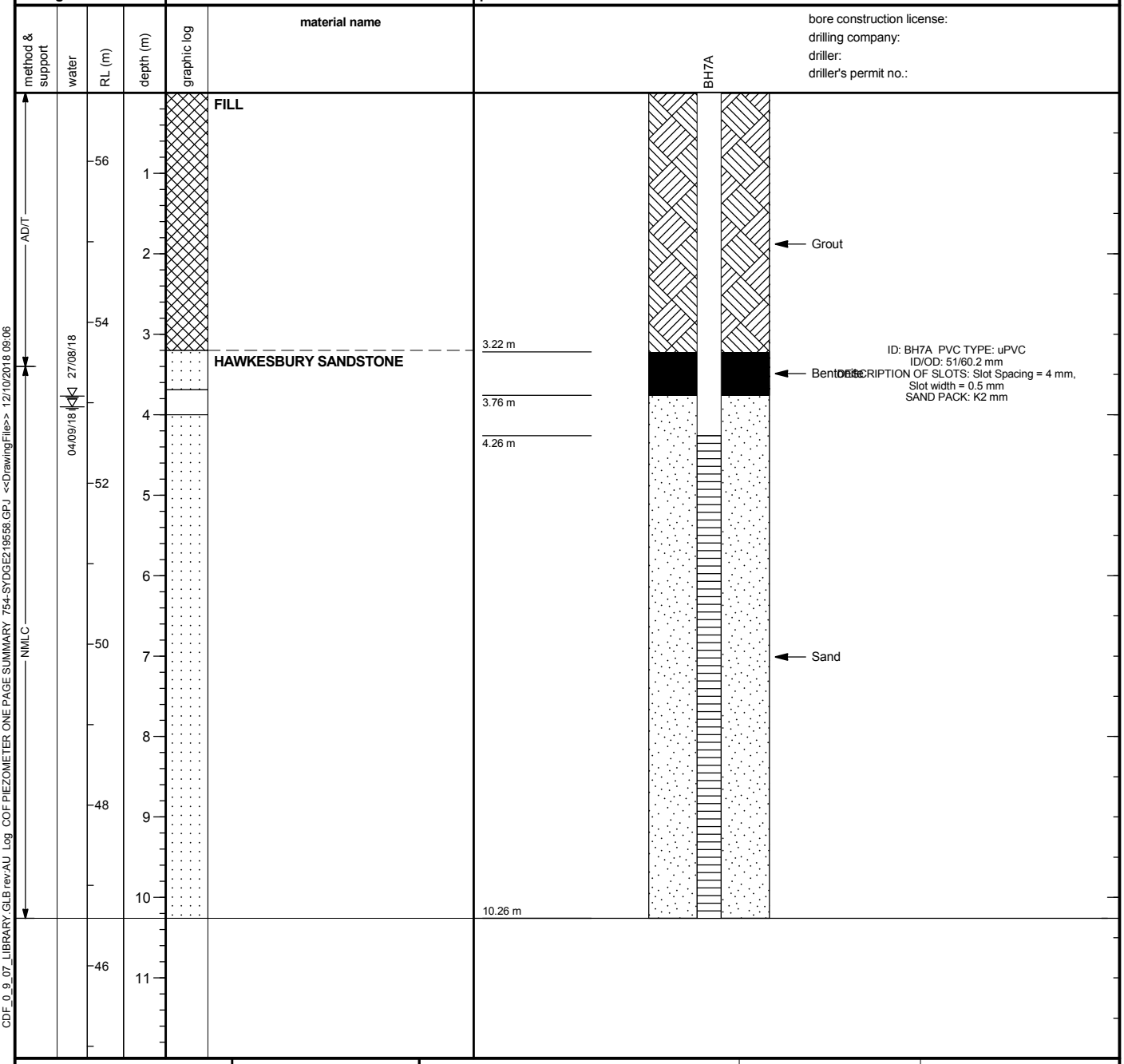
Piezometer Installation Log

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

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

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

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



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method & support
see engineering log for details

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

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

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

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Engineering Log - Borehole

Borehole ID.	***BH8***
sheet:	1 of 3
project no.	***754-SYDGE219558***
date started:	***21 Aug 2018***
date completed:	***22 Aug 2018***
logged by:	***AM***
checked by:	***AB***

client: ***Country Garden Australia Pty Ltd***

principal:

project: ***St Leonards Development***

location: ***St Leonards, NSW***

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

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

drilling information | **material substance**

method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (SOIL NAME: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA AD/T CASING								**BRICK PAVERS**.	D			**PAVEMENT**
								FILL: SAND: pale brown.				**FILL**
								FILL: SAND: dark brown, with coarse gravels.				
				54	1.0			**CLAY**: low plasticity, orange-brown, with fine grained sand.	<Wp	St		**RESIDUAL SOIL**
								Borehole BH8 continued as cored hole				
				53	2.0							
				52	3.0							
				51	4.0							
				50	5.0							
				49	6.0							
				48	7.0							
				47								

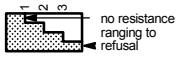
CDF_0_9_07_LIBRARY.GLB rev:AU Log COF BOREHOLE: NON CORED 754-SYDGE219558.GPJ <<DrawingFile>> 12/10/2018 09:03

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

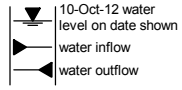
* bit shown by suffix, e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration



water



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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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BH8 1.33 - 6.00 m

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

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

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BH8 6.00 - 10.00 m

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

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

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Engineering Log - Borehole

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

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

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

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

consistency / relative density

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

coffey
A TETRA TECH COMPANY

Engineering Log - Cored Borehole

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

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

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating



BH9 1.18 - 6.00 m

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

coffey
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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH9**

project no:	fig no:	rev:
754-SYDGE219558		

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BH9 6.00 - 10.48 m

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

coffey
A TETRA TECH COMPANY

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

CDF_0_9_07_LIBRARY.GLB GrfcTbl COF PHOTO CORE PHOTO 1 PER PAGE 754-SYDGE219558.GPJ <<DrawingFile>> 27-08-2018 12:08

coffey
A TETRA TECH COMPANY

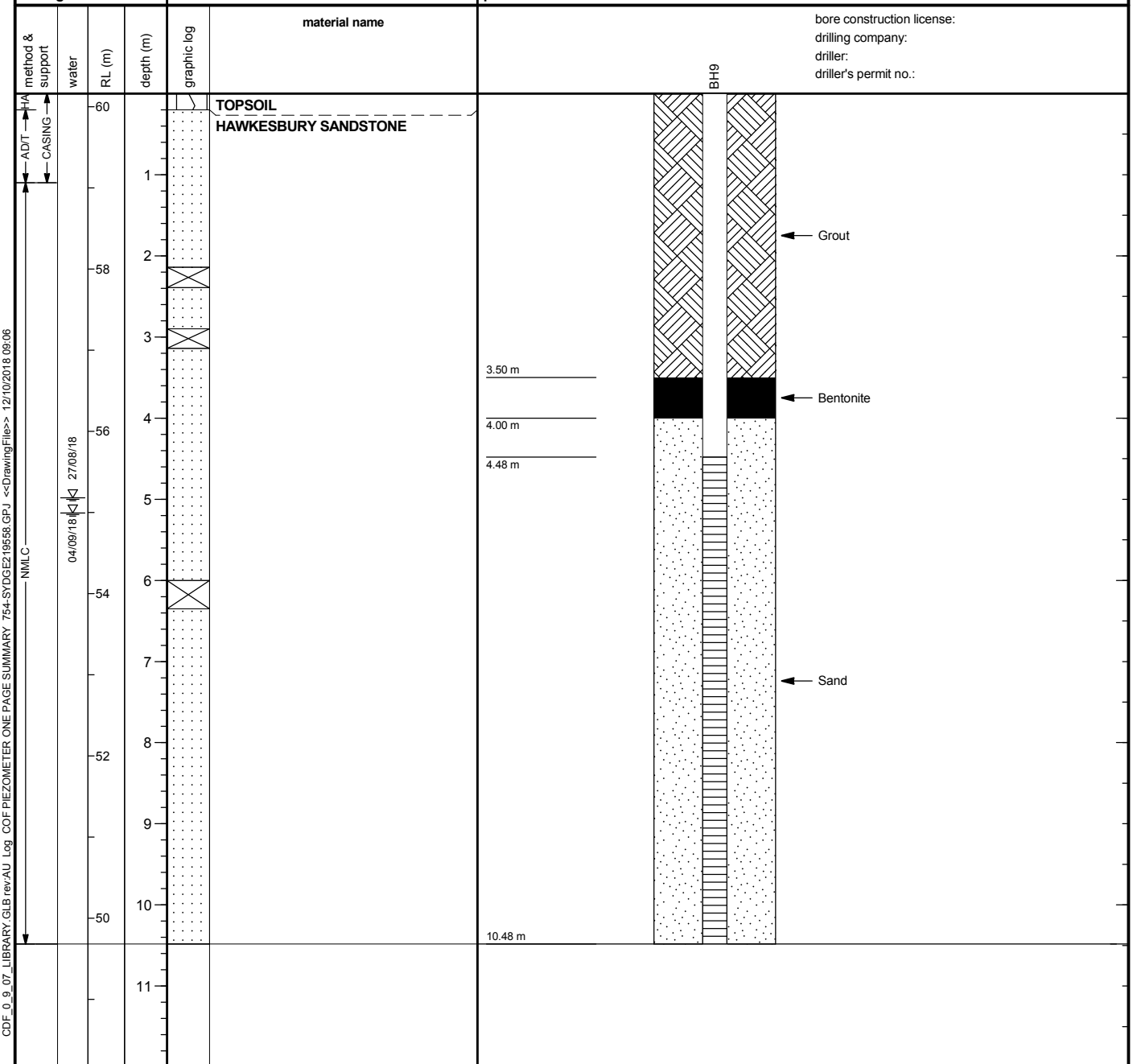
Piezometer Installation Log

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

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

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

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



method & support
see engineering log for details

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

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

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

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APPENDIX B: RISING HEAD TEST DATA

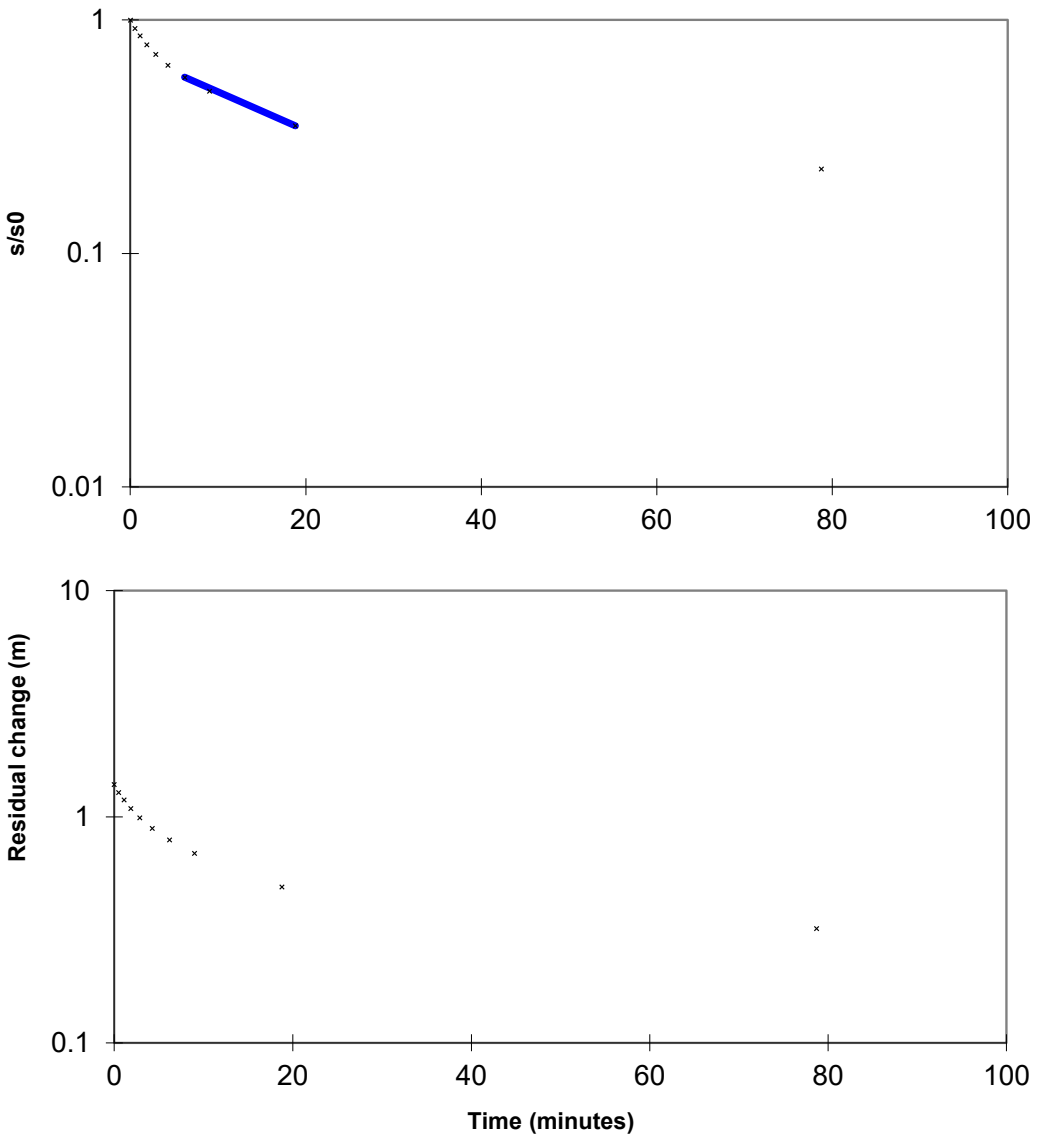
RISING OR FALLING HEAD TEST ANALYSIS

Bore Data	Units	Value
Initial groundwater level	m	3.81
Groundwater level at t=0	m	5.20
Casing radius (r)	m	0.025
Bore radius (R)	m	0.05
Screened interval length (L)	m	6
Match time start	min	5
Match time end	min	15
Characteristic Time (t_0)	**min**	**26.93**
Hydraulic Conductivity (K)	**m/day**	**0.01333**

Piezometer: BH1

Method Developed by Hvorslev (1951)

$$K = \frac{r^2 \ln(L/R)}{2Lt_0}$$



Reference: Hvorslev, M.J. (1951), Time lag and soil permeability in ground water observations. U.S. Army Corps of Engineers Waterway Experimentation Station, Bulletin 36.

drawn	BS		client:	JQZ
approved	AO	TETRA TECH COFFEY	project:	Park Road St Leonards
date	21 Feb 2023		title:	RISING HEAD TEST - BH1
scale	AS SHOWN		project no:	754-SYDGE304523-1
original size	A4			

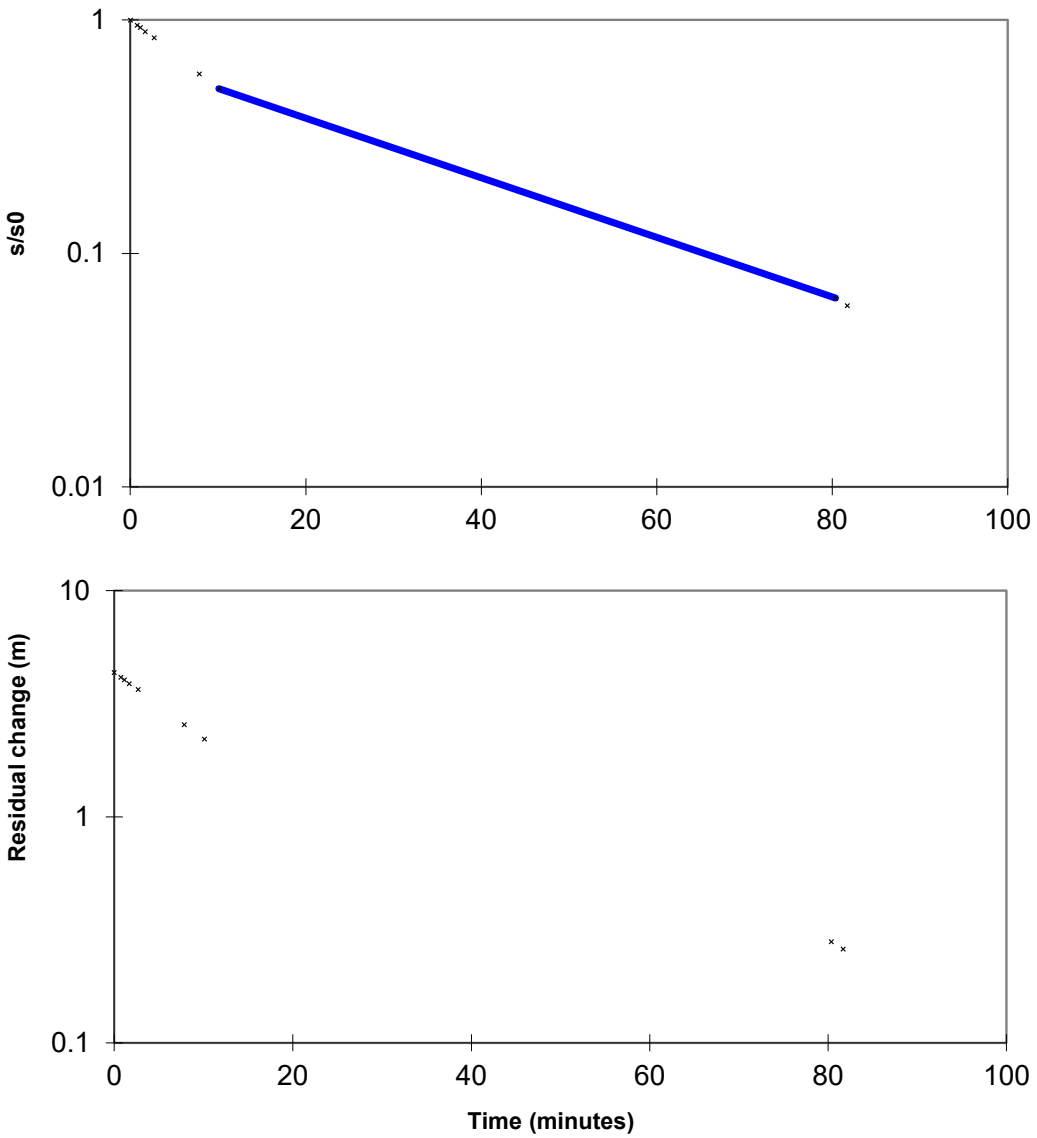
RISING OR FALLING HEAD TEST ANALYSIS

Bore Data	Units	Value
Initial groundwater level	m	3.34
Groundwater level at t=0	m	7.69
Casing radius (r)	m	0.025
Bore radius (R)	m	0.05
Screened interval length (L)	m	6
Match time start	min	10
Match time end	min	80
Characteristic Time (t_0)	**min**	**34.00**
Hydraulic Conductivity (K)	**m/day**	**0.01056**

Piezometer: BH7A

Method Developed by Hvorslev (1951)

$$K = \frac{r^2 \ln(L/R)}{2Lt_0}$$



Reference: Hvorslev, M.J. (1951), Time lag and soil permeability in ground water observations. U.S. Army Corps of Engineers Waterway Experimentation Station, Bulletin 36.

drawn	BS		client:	JQZ
approved	AO	TETRA TECH COFFEY	project:	Park Road St Leonards
date	14 Feb 2023		title:	RISING HEAD TEST - BH7A
scale	AS SHOWN		project no:	754-SYDGE304523-1
original size	A4			

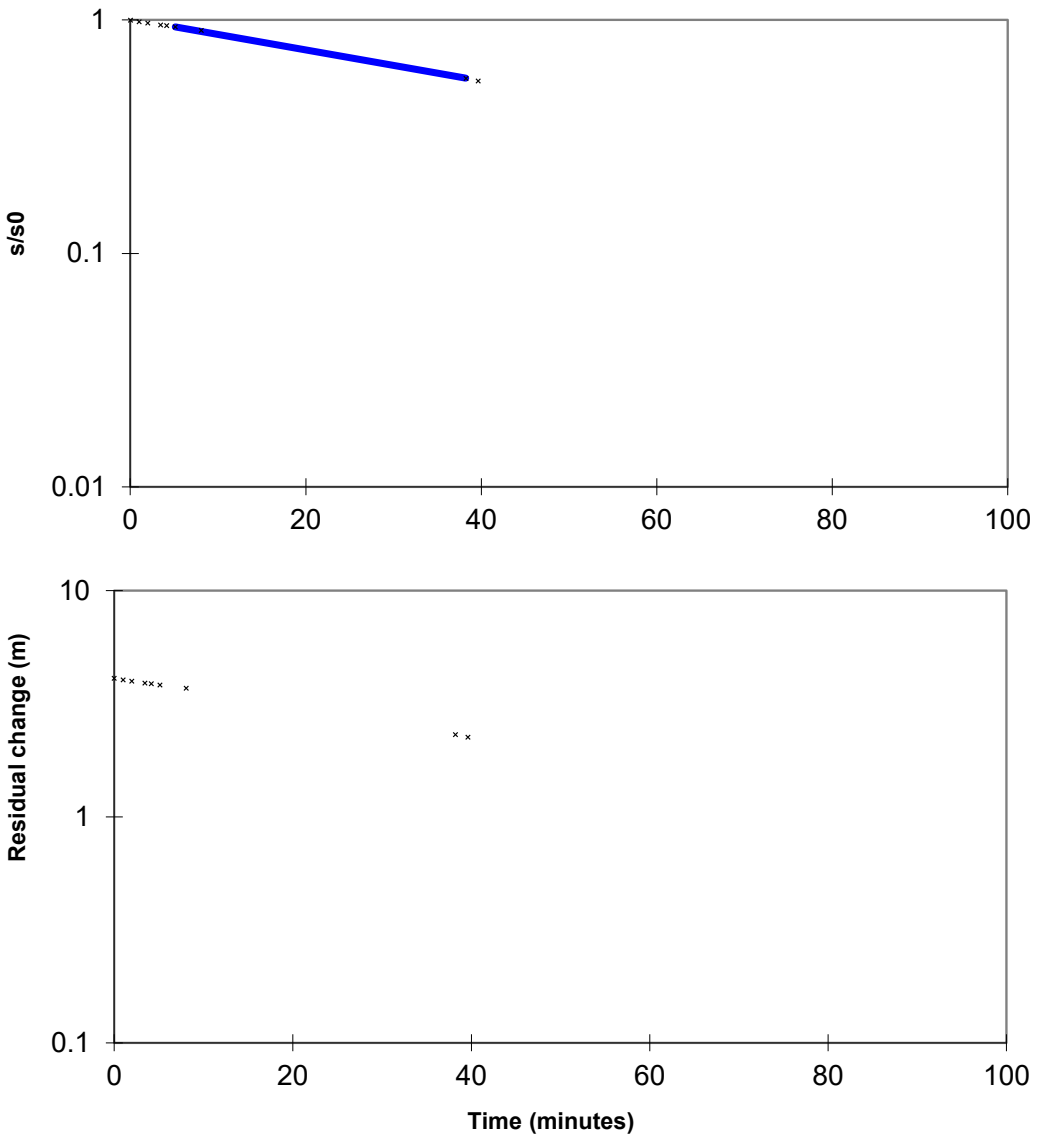
RISING OR FALLING HEAD TEST ANALYSIS

Bore Data	Units	Value
Initial groundwater level	m	4.42
Groundwater level at t=0	m	8.52
Casing radius (r)	m	0.025
Bore radius (R)	m	0.05
Screened interval length (L)	m	6
Match time start	min	5
Match time end	min	30
Characteristic Time (t_0)	**min**	**64.76**
Hydraulic Conductivity (K)	**m/day**	**0.00554**

Piezometer: BH9

Method Developed by Hvorslev (1951)

$$K = \frac{r^2 \ln(L/R)}{2Lt_0}$$



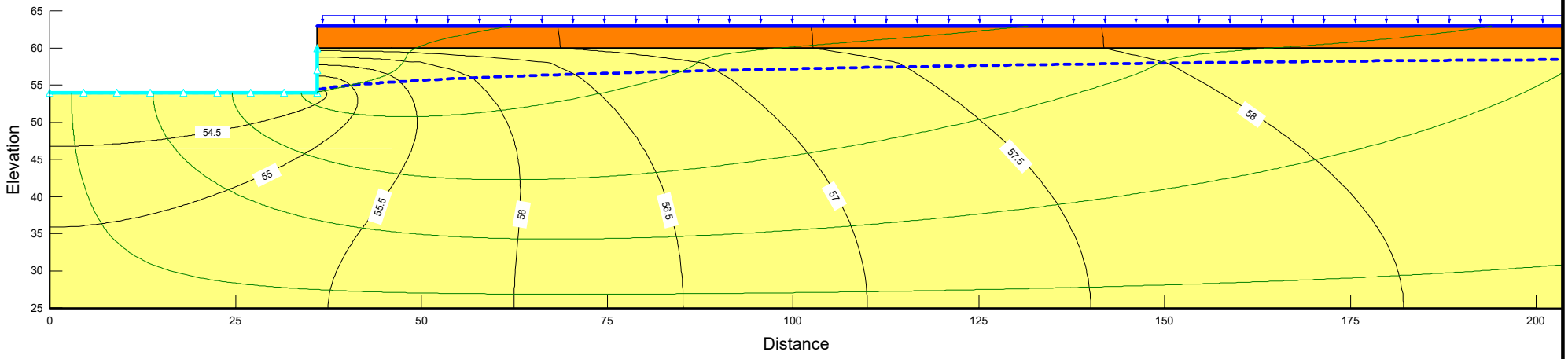
Reference: Hvorslev, M.J. (1951), Time lag and soil permeability in ground water observations. U.S. Army Corps of Engineers Waterway Experimentation Station, Bulletin 36.

drawn	BS	TETRA TECH COFFEY	client:	JQZ
approved	AO		project:	Park Road St Leonards
date	14 Feb 2023		title:	RISING HEAD TEST - BH9
scale	AS SHOWN		project no:	754-SYDGE304523-1
original size	A4			

APPENDIX C: SEEP/W RESULTS

Color	Name	Ky'/Kx' Ratio
	Fill	1
	Hawksbury Sandstone	0.2

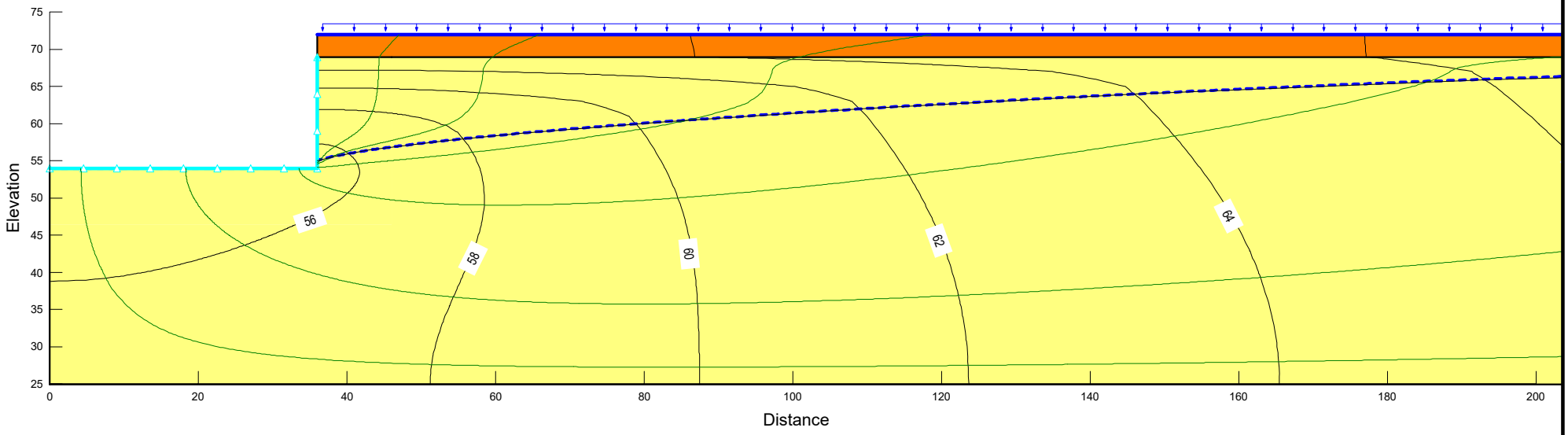
Color	Name	Kind	Parameters
	Head - 58.5 mAHD	Water Total Head	58.5 m
	Rainfall infiltration	Water Flux	7.6e-10 m/sec
	Seepage face	Water Rate	0 m³/sec



Section 1	
Section 1.gsz	
28/02/2023	1:800

Color	Name	Ky'/Kx' Ratio
	Fill	1
	Hawksbury Sandstone	0.2

Color	Name	Kind	Parameters
	Head - 68.5 mAHD	Water Total Head	68.5 m
	Rainfall infiltration	Water Flux	7.6e-10 m/sec
	Seepage face	Water Rate	0 m³/sec



Section 2	
Section 2.gsz	
28/02/2023	1:800

APPENDIX D: LABORATORY RESULTS

Analytes	Units	Limit of reporting (LOR)	ANZG 2018 DGVs	Notes	Sample IDs and Sampling date		
					BH1 (ALS)	BH9 (ALS)	BH9 Duplicate (ALS)
					21/02/2023	21/02/2023	21/02/2023
Physical Parameters							
Lab pH	pH	0.01	6.5 - 8	1	**4.9**	**5.5**	**5.5**
Lab Electrical Conductivity	µS/cm	1	-		590	376	370
Total Dissolved Solids	mg/L	10	-		430	264	293
Total Suspended Solids	mg/L	5	-		367	6080	4060
Cations							
Calcium	mg/L	1	-		1	13	13
Magnesium	mg/L	1	-		10	5	5
Potassium	mg/L	1	-		1	< LOR	< LOR
Sodium	mg/L	1	-		101	53	54
Anions							
Bicarbonate Alkalinity (as CaCO3)	mg/L	1	-		< LOR	20	12
Total Alkalinity (as CaCO3)	mg/L	1	-		< LOR	20	12
Chloride	mg/L	1	-		154	66	68
Sulfate (as SO4)	mg/L	1	-		73	62	61
Metals (total)							
Arsenic	mg/L	0.001	-		< LOR	0.003	0.003
Cadmium	mg/L	0.0001	0.0055		0.0002	< LOR	< LOR
Chromium	mg/L	0.001	0.0044	2	< LOR	0.001	0.001
Copper	mg/L	0.001	0.003		**0.009**	0.002	0.002
Lead	mg/L	0.001	0.0044		< LOR	< LOR	< LOR
Mercury	mg/L	0.0001	0.0004		< LOR	< LOR	< LOR
Nickel	mg/L	0.001	0.07		0.014	0.002	0.002
Zinc	mg/L	0.005	0.008		**0.089**	**0.03**	**0.027**
BTEX							
Benzene	µg/L	1	700		< LOR	< LOR	< LOR
Toluene	µg/L	2	180		< LOR	< LOR	< LOR
Ethylbenzene	µg/L	2	80		< LOR	< LOR	< LOR
m&p-Xylenes	µg/L	2	-		< LOR	< LOR	< LOR
o-Xylene	µg/L	2	-		< LOR	< LOR	< LOR
Xylenes - Total	µg/L	2	-		< LOR	< LOR	< LOR
Total Recoverable Hydrocarbons-1999 NEPM Fractions							
TRH C6-C9	mg/L	0.02	-		< LOR	< LOR	< LOR
TRH C10-C14	mg/L	0.05	-		< LOR	< LOR	< LOR
TRH C15-C28	mg/L	0.1	-		< LOR	< LOR	< LOR
TRH C29-C36	mg/L	0.05	-		< LOR	< LOR	< LOR
TRH C10-C36 (Total)	mg/L	0.05	-		< LOR	< LOR	< LOR
Total Recoverable Hydrocarbons-2013 NEPM Fractions							
TRH C6-C10	mg/L	0.02	-		< LOR	< LOR	< LOR
TRH >C10-C16	mg/L	0.1	-		< LOR	< LOR	< LOR
TRH >C16-C34	mg/L	0.1	-		< LOR	< LOR	< LOR
TRH >C34-C40	mg/L	0.1	-		< LOR	< LOR	< LOR
TRH >C10-C40 (Total)	mg/L	0.1	-		< LOR	< LOR	< LOR
Polycyclic Aromatic Hydrocarbons (Trace level)							
Acenaphthene	mg/L	0.001	-		< LOR	< LOR	< LOR
Acenaphthylene	mg/L	0.001	-		< LOR	< LOR	< LOR
Anthracene	mg/L	0.001	0.0004		< LOR	< LOR	< LOR
Benz(a)anthracene	mg/L	0.001	-		< LOR	< LOR	< LOR
Benzo(a)pyrene	mg/L	0.0005	0.0002		< LOR	< LOR	< LOR
Benzo(b&j)fluoranthene	mg/L	0.001	-		< LOR	< LOR	< LOR
Benzo(g.h.i)perylene	mg/L	0.001	-		< LOR	< LOR	< LOR
Benzo(k)fluoranthene	mg/L	0.001	-		< LOR	< LOR	< LOR
Chrysene	mg/L	0.001	-		< LOR	< LOR	< LOR
Dibenz(a.h)anthracene	mg/L	0.001	-		< LOR	< LOR	< LOR
Fluoranthene	mg/L	0.001	0.0014		< LOR	< LOR	< LOR
Fluorene	mg/L	0.001	-		< LOR	< LOR	< LOR
Indeno(1.2.3-cd)pyrene	mg/L	0.001	-		< LOR	< LOR	< LOR
Naphthalene	mg/L	0.005	0.07		< LOR	< LOR	< LOR
Phenanthrene	mg/L	0.001	0.002		< LOR	< LOR	< LOR
Pyrene	mg/L	0.001	-		< LOR	< LOR	< LOR
Total PAH	mg/L	0.0005	-		< LOR	< LOR	< LOR

ANZG. 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. ANZG 2018 default guideline values (DGVs) remain the same as the ANZECC 2000 trigger values for protection of 95% of species within a freshwater ecosystem.

Values exceeds ANZG 2018 DGVs

Notes:
1. pH range are values for lowland rivers
2. Guideline for chromium (Cr VI) in marine water

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2305718**	Page	: 1 of 7
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: ANTONY ORTON	Contact	: Khaleda Ataei
Address	: LEVEL 19, TOWER B- CITADEL TOWER 799 PACIFIC HIGHWAY CHATSWOOD NSW, AUSTRALIA 2067	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: + 61 2 8784 8555
Project	: SYDGE304523-1 Park Rd St Leonards	Date Samples Received	: 21-Feb-2023 17:00
Order number	: 304523	Date Analysis Commenced	: 22-Feb-2023
C-O-C number	: ----	Issue Date	: 27-Feb-2023 13:22
Sampler	: ANTONY ORTON		
Site	:		
Quote number	: EN/222		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

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

General Comments

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

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

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

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

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

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

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

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

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH1	BH9	DUP	----	----
			Sampling date / time	21-Feb-2023 15:30	21-Feb-2023 15:30	21-Feb-2023 15:30	----	----
Compound	CAS Number	LOR	Unit	ES2305718-001	ES2305718-002	ES2305718-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**4.85**	**5.53**	**5.51**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**590**	**376**	**370**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**430**	**264**	**293**	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**367**	**6080**	**4060**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	**20**	**12**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	<1	**20**	**12**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**73**	**62**	**61**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**154**	**66**	**68**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**1**	**13**	**13**	----	----
Magnesium	7439-95-4	1	mg/L	**10**	**5**	**5**	----	----
Sodium	7440-23-5	1	mg/L	**101**	**53**	**54**	----	----
Potassium	7440-09-7	1	mg/L	**1**	<1	<1	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.003**	**0.003**	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0002**	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.001**	**0.001**	----	----
Copper	7440-50-8	0.001	mg/L	**0.009**	**0.002**	**0.002**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.406**	**0.018**	**0.017**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.014**	**0.002**	**0.002**	----	----
Zinc	7440-66-6	0.005	mg/L	**0.089**	**0.030**	**0.027**	----	----
Iron	7439-89-6	0.05	mg/L	**0.08**	**1.17**	**1.16**	----	----
EG020T: Total Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	**0.414**	**0.030**	**0.027**	----	----
Iron	7439-89-6	0.05	mg/L	**5.75**	**10.0**	**7.38**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH1	BH9	DUP	----	----
			Sampling date / time	21-Feb-2023 15:30	21-Feb-2023 15:30	21-Feb-2023 15:30	----	----
Compound	CAS Number	LOR	Unit	ES2305718-001	ES2305718-002	ES2305718-003	--------	--------
				Result	Result	Result	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.07**	**0.18**	**0.17**	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**1.26**	**0.02**	**0.06**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.26**	**0.02**	**0.06**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**2.9**	**2.2**	**2.1**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**4.2**	**2.2**	**2.2**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.22**	**0.55**	**0.53**	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**5.86**	**3.55**	**3.43**	----	----
ø Total Cations	----	0.01	meq/L	**5.50**	----	----	----	----
ø Total Cations	----	0.01	meq/L	----	**3.36**	**3.41**	----	----
ø Ionic Balance	----	0.01	%	**3.21**	----	----	----	----
ø Ionic Balance	----	0.01	%	----	**2.70**	**0.28**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**5**	**8**	**8**	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	<1.0	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH1	BH9	DUP	----	----
			Sampling date / time	21-Feb-2023 15:30	21-Feb-2023 15:30	21-Feb-2023 15:30	----	----
Compound	CAS Number	LOR	Unit	ES2305718-001	ES2305718-002	ES2305718-003	--------	--------
				Result	Result	Result	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	<0.5	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	----	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	----	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	----	----
Toluene	108-88-3	2	µg/L	<2	<2	<2	----	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	----	----
^ Total Xylenes	----	2	µg/L	<2	<2	<2	----	----
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	----	----
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	BH1	BH9	DUP	----	----
				Sampling date / time	21-Feb-2023 15:30	21-Feb-2023 15:30	21-Feb-2023 15:30	----	----
Compound	CAS Number	LOR	Unit		ES2305718-001	ES2305718-002	ES2305718-003	--------	--------
					Result	Result	Result	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		30.8	26.1	29.7	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		56.8	62.6	55.6	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		63.9	71.8	63.0	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		58.2	65.2	61.7	----	----
Anthracene-d10	1719-06-8	1.0	%		75.4	80.2	74.0	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		90.5	94.4	86.6	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		117	118	123	----	----
Toluene-D8	2037-26-5	2	%		111	110	113	----	----
4-Bromofluorobenzene	460-00-4	2	%		104	103	106	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES2305718**	Page	: 1 of 10
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: ANTONY ORTON	Contact	: Khaleda Ataei
Address	: LEVEL 19, TOWER B- CITADEL TOWER 799 PACIFIC HIGHWAY CHATSWOOD NSW, AUSTRALIA 2067	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: + 61 2 8784 8555
Project	: SYDGE304523-1 Park Rd St Leonards	Date Samples Received	: 21-Feb-2023
Order number	: 304523	Date Analysis Commenced	: 22-Feb-2023
C-O-C number	: ----	Issue Date	: 27-Feb-2023
Sampler	: ANTONY ORTON		
Site	:		
Quote number	: EN/222		
No. of samples received	: 3		
No. of samples analysed	: 3		

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

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

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

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

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

General Comments

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

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

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
= Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EA005P: pH by PC Titrator (QC Lot: 4888652)									
ES2305482-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	4.90	4.71	4.0	0% - 20%
ES2305752-003	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.52	6.53	0.2	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 4888650)									
ES2305652-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	179	179	0.0	0% - 20%
ES2305838-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	2200	2200	0.1	0% - 20%
ES2305482-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	131	129	1.6	0% - 20%
ES2305832-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	27200	27500	0.8	0% - 20%
EW2300879-006	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	131	130	0.9	0% - 20%
ES2305752-003	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	18700	18900	1.3	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 4888503)									
ES2305482-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	123	114	7.6	0% - 50%
ES2305752-004	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	2810	2780	1.1	0% - 20%
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 4888504)									
ES2305482-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	<5	0.0	No Limit
ES2305752-004	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	118	123	3.5	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 4888651)									
ES2305651-008	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	34	34	0.0	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	34	34	0.0	0% - 20%
ES2305482-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	1	<1	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
ED037P: Alkalinity by PC Titrator (QC Lot: 4888651) - continued									
ES2305482-001	Anonymous	ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	1	<1	0.0	No Limit
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 4887523)									
ES2305626-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2950	2910	1.4	0% - 20%
EW2300879-004	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	7	7	0.0	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 4887524)									
ES2305655-002	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	1060	1080	1.3	0% - 20%
ES2305626-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	17700	17700	0.4	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 4887557)									
ES2305718-001	BH1	ED093F: Calcium	7440-70-2	1	mg/L	1	1	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	10	10	0.0	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	101	99	2.6	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	1	1	0.0	No Limit
EW2300878-003	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	2	2	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	<1	<1	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	10	10	0.0	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.0	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 4887555)									
ES2305718-001	BH1	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0001	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.009	0.012	23.8	0% - 50%
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.406	0.407	0.2	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.014	0.015	0.0	0% - 50%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.089	0.101	13.0	0% - 20%
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.08	0.12	44.3	No Limit
EW2300878-003	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0002	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.004	0.004	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.016	0.016	0.0	0% - 50%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.108	0.106	1.0	0% - 20%
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 4888268)									
ME2300253-026	Anonymous	EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.368	0.365	0.6	0% - 20%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	10.3	10.4	0.7	0% - 20%
ME2300253-014	Anonymous	EG020A-T: Manganese	7439-96-5	0.001	mg/L	2.13	2.14	0.1	0% - 20%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EG020T: Total Metals by ICP-MS (QC Lot: 4888268) - continued									
ME2300253-014	Anonymous	EG020A-T: Iron	7439-89-6	0.05	mg/L	15.4	15.2	1.5	0% - 20%
EG035F: Dissolved Mercury by FIMS (QC Lot: 4887556)									
EW2300878-004	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	0.0005	0.0005	0.0	No Limit
ES2305718-001	BH1	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 4888467)									
ES2305088-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	7.14	7.07	0.9	0% - 20%
ES2305324-011	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.33	0.30	10.5	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 4887521)									
ES2305626-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EW2300879-004	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 4888466)									
ES2305088-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.04	<0.01	126	No Limit
ES2305324-011	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.01	0.01	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 4888456)									
ES2305088-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	12.8	13.2	2.8	0% - 20%
ES2305359-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.3	2.0	45.9	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 4888458)									
ES2305718-001	BH1	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.22	0.20	6.6	No Limit
ES2305766-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 4889507)									
ES2305718-001	BH1	EP005: Total Organic Carbon	----	1	mg/L	5	4	0.0	No Limit
EW2300879-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	3	3	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 4888810)									
ES2305482-001	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
ES2305718-001	BH1	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 4888810)									
ES2305482-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.0	No Limit
ES2305718-001	BH1	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.0	No Limit
EP080: BTEXN (QC Lot: 4888810)									
ES2305482-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.0	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.0	No Limit
ES2305718-001	BH1	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EP080: BTEXN (QC Lot: 4888810) - continued									
ES2305718-001	BH1	EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.0	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 4888652)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	100	98.8	101
				----	7 pH Unit	99.7	99.2	101
EA010P: Conductivity by PC Titrator (QCLot: 4888650)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	220 µS/cm	90.6	89.9	110
				<1	2100 µS/cm	92.5	90.2	111
				<1	58301 µS/cm	100	93.3	106
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 4888503)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	91.1	87.0	109
				<10	293 mg/L	107	75.2	126
				<10	2340 mg/L	102	83.0	124
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 4888504)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	94.3	83.0	129
				<5	1000 mg/L	96.2	82.0	110
				<5	987 mg/L	98.0	83.0	118
ED037P: Alkalinity by PC Titrator (QCLot: 4888651)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	98.1	81.0	111
				----	50 mg/L	106	80.0	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 4887523)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	108	82.0	122
				<1	500 mg/L	113	82.0	122
ED045G: Chloride by Discrete Analyser (QCLot: 4887524)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	50 mg/L	107	80.9	127
				<1	1000 mg/L	101	80.9	127
ED093F: Dissolved Major Cations (QCLot: 4887557)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	99.6	80.0	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	99.2	90.0	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	100	82.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	96.7	85.0	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 4887555)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.9	85.0	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	100	84.0	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	93.8	85.0	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	97.0	81.0	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.4	83.0	111

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
				Result	Concentration	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 4887555) - continued								
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	95.9	82.0	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	97.8	82.0	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	99.7	81.0	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	94.8	82.0	112
EG020T: Total Metals by ICP-MS (QCLot: 4888268)								
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	98.6	85.0	113
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	85.0	117
EG035F: Dissolved Mercury by FIMS (QCLot: 4887556)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	98.4	83.0	105
EK055G: Ammonia as N by Discrete Analyser (QCLot: 4888467)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	99.8	90.0	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4887521)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	97.7	82.0	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 4888466)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	101	91.0	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4888456)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	87.5	69.0	101
				<0.1	1 mg/L	115	70.0	118
				<0.1	5 mg/L	103	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 4888458)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	92.8	71.3	126
				<0.01	0.442 mg/L	123	71.3	126
				<0.01	1 mg/L	103	71.3	126
EP005: Total Organic Carbon (TOC) (QCLot: 4889507)								
EP005: Total Organic Carbon	----	1	mg/L	<1	10 mg/L	96.6	72.0	120
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 4887384)								
EP075(SIM): Naphthalene	91-20-3	1	µg/L	<1.0	5 µg/L	68.2	50.0	94.0
EP075(SIM): Acenaphthylene	208-96-8	1	µg/L	<1.0	5 µg/L	67.2	63.6	114
EP075(SIM): Acenaphthene	83-32-9	1	µg/L	<1.0	5 µg/L	68.9	62.2	113
EP075(SIM): Fluorene	86-73-7	1	µg/L	<1.0	5 µg/L	73.7	63.9	115
EP075(SIM): Phenanthrene	85-01-8	1	µg/L	<1.0	5 µg/L	80.9	62.6	116
EP075(SIM): Anthracene	120-12-7	1	µg/L	<1.0	5 µg/L	78.9	64.3	116
EP075(SIM): Fluoranthene	206-44-0	1	µg/L	<1.0	5 µg/L	87.5	63.6	118
EP075(SIM): Pyrene	129-00-0	1	µg/L	<1.0	5 µg/L	89.2	63.1	118
EP075(SIM): Benz(a)anthracene	56-55-3	1	µg/L	<1.0	5 µg/L	92.0	64.1	117
EP075(SIM): Chrysene	218-01-9	1	µg/L	<1.0	5 µg/L	88.5	62.5	116
EP075(SIM): Benzo(b+j)fluoranthene	205-99-2	1	µg/L	<1.0	5 µg/L	88.6	61.7	119
	205-82-3							

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Acceptable Limits (%): Low	Acceptable Limits (%): High
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 4887384) - continued								
EP075(SIM): Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	5 µg/L	100	63.0	115
EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	5 µg/L	98.4	63.3	117
EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	5 µg/L	94.0	59.9	118
EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	5 µg/L	94.3	61.2	117
EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	5 µg/L	92.8	59.1	118
EP080/071: Total Petroleum Hydrocarbons (QCLot: 4887383)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	400 µg/L	78.3	53.7	97.0
EP071: C15 - C28 Fraction	----	100	µg/L	<100	600 µg/L	89.3	63.3	107
EP071: C29 - C36 Fraction	----	50	µg/L	<50	400 µg/L	96.8	58.3	120
EP080/071: Total Petroleum Hydrocarbons (QCLot: 4888810)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	260 µg/L	87.2	75.0	127
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4887383)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	500 µg/L	81.3	53.9	95.5
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	700 µg/L	93.9	57.8	110
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	300 µg/L	98.7	50.5	115
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4888810)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	310 µg/L	88.2	75.0	127
EP080: BTEXN (QCLot: 4888810)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	80.5	70.0	122
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	84.2	69.0	123
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	81.3	70.0	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	10 µg/L	84.0	69.0	121
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	84.0	72.0	122
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	86.8	70.0	120

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Acceptable Limits (%): Low	Acceptable Limits (%): High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 4887523)							
ES2305626-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 4887524)							
ES2305626-001	Anonymous						

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 4887524) - continued							
ES2305626-001	Anonymous	ED045G: Chloride	16887-00-6	50 mg/L	# Not Determined	70.0	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 4887555)							
ES2305686-001	Anonymous	EG020A-F: Arsenic	7440-38-2	1 mg/L	99.1	70.0	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	100	70.0	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	98.6	70.0	130
		EG020A-F: Copper	7440-50-8	1 mg/L	100	70.0	130
		EG020A-F: Lead	7439-92-1	1 mg/L	99.4	70.0	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	101	70.0	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	96.8	70.0	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	99.0	70.0	130
EG020T: Total Metals by ICP-MS (QCLot: 4888268)							
ES2305718-002	BH9	EG020A-T: Manganese	7439-96-5	1 mg/L	99.8	70.0	130
EG035F: Dissolved Mercury by FIMS (QCLot: 4887556)							
ES2305686-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	102	70.0	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 4888467)							
ES2305088-001	Anonymous	EK055G: Ammonia as N	7664-41-7	1 mg/L	# Not Determined	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4887521)							
ES2305626-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	99.6	70.0	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 4888466)							
ES2305088-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	86.2	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4888456)							
ES2305096-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	# Not Determined	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 4888458)							
ES2305718-002	BH9	EK067G: Total Phosphorus as P	----	10 mg/L	99.3	70.0	130
EP005: Total Organic Carbon (TOC) (QCLot: 4889507)							
ES2305718-002	BH9	EP005: Total Organic Carbon	----	100 mg/L	102	70.0	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 4888810)							
ES2305482-001	Anonymous	EP080: C6 - C9 Fraction	----	325 µg/L	101	70.0	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4888810)							
ES2305482-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	101	70.0	130
EP080: BTEXN (QCLot: 4888810)							
ES2305482-001	Anonymous	EP080: Benzene	71-43-2	25 µg/L	87.3	70.0	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EP080: BTEXN (QCLot: 4888810) - continued							
ES2305482-001	Anonymous	EP080: Toluene	108-88-3	25 µg/L	88.2	70.0	130
		EP080: Ethylbenzene	100-41-4	25 µg/L	88.8	70.0	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	87.1	70.0	130
		EP080: ortho-Xylene	95-47-6	25 µg/L	90.2	70.0	130
		EP080: Naphthalene	91-20-3	25 µg/L	84.4	70.0	130

Appendix D

Survey plan

ADJOINS SHEET 2

FOR CLARITY THIS PLAN CONTAINS FURTHER SURVEY INFORMATION THAT IS NOT SHOWN ON THE PRINTOUT BUT IS CONTAINED WITHIN THE AUTOCAD FILE

LTS CONTOUR AND DETAIL SURVEY, EASEMENT AND BOUNDARY INFORMATION SHOWN IN GREY ON THIS PLAN HAS NOT BEEN VERIFIED BY LANDPARTNERS AND LANDPARTNERS ACCEPTS NO RESPONSIBILITY FOR ITS ACCURACY

MGA

T.N.

-1.006°

LOT 2 DP305449 434.4m² 36 PARK RD SINGLE STOREY BRICK DWELLING

LOT 1 DP305449 38 PARK RD SINGLE STOREY BRICK DWELLING

LOT 37 DP666528 40A PARK RD TWO-STOREY BRICK DWELLING (G)

LOT 36 DP3044 40B PARK RD TOW-STOREY BRICK DWELLING

LOT 351 DP848236 42 PARK RD TWO-STOREY CLAD DWELLING (F)

LOT 352 DP848236 42A PARK RD TWO-STOREY CLAD DWELLING

LOT 1 DP225445 44 PARK RD SINGLE STOREY BRICK DWELLING (B)

LOT 2 DP225445 46 PARK RD SINGLE STOREY BRICK DWELLING (C)

LOT 3 DP225445 48 PARK RD SINGLE STOREY BRICK DWELLING (C)

LOT 4 DP225445 50 PARK RD TWO-STOREY BRICK DWELLING

SP16063 SINGLE COTTAGE 54 RIVER RD TWO-STOREY BRICK DWELLING

LOT 24 DP3044 436.8m² 39 BERRY RD SINGLE STOREY BRICK DWELLING

LOT 25 DP3044 41 BERRY RD SINGLE STOREY BRICK DWELLING

LOT 1 DP734702 43 BERRY RD SINGLE STOREY BRICK DWELLING (A)

LOT 2 DP734702 43A BERRY RD SINGLE STOREY BRICK DWELLING

LOT 27 DP3044 45 BERRY RD SINGLE STOREY BRICK DWELLING

LOT 28 DP3044 47 BERRY RD SINGLE STOREY BRICK DWELLING

LOT 31 DP3044 52 RIVER RD TWO-STOREY CLAD DWELLING

50 RIVER RD SINGLE STOREY BRICK DWELLING

LOT 1 DP1223070

LOT 29 DP72918 48 RIVER RD TWO-STOREY BRICK DWELLING

34 PARK RD BRICK DWELLING

PARK ROAD

BERRY ROAD

BERRY LANE (6.095)

RIVER ROAD

WEST PRECINCT

EAST PRECINCT

TREE SCHEDULE
HEIGHT(m) ie 18 = 18m
TRUNK(m) ie 0.7 = 0.7m DIAMETER
SPREAD(m) ie S8 = 8m DIAMETER

QUALITY B
4XDB
1.2m DEEP
68.89 MEASURED AT SURFACE LEVEL

QUALITY B
0.7m DEEP
0.1m DIAMETER
WATER MAIN
64.9 MEASURED AT SURFACE LEVEL

QUALITY A
1.0m DEEP
0.2m DIAMETER
HIGH PRESSURE
70.28 MEASURED AT SURFACE LEVEL

LOT SCHEDULE

WEST PRECINCT (3154.1m²)
LOT 1 IN DP305449
LOT 37 IN DP666528
LOT 36 IN DP666528
LOT 351 IN DP848236
LOT 352 IN DP848236
LOT 1 IN DP225445
LOT 2 IN DP225445
LOT 3 IN DP225445
LOT 4 IN DP225445
STRATA PLAN SP16063

EAST PRECINCT (3168.7m²)
LOT 25 IN DP3044
LOT 1 IN DP734702
LOT 2 IN DP734702
LOT 27 IN DP3044
LOT 28 IN DP3044
LOT 31 IN DP3044
LOT 1 IN DP1223070
LOT 29 IN DP72918

MGA 94 CO-ORDINATE TABLE

No.	BEARING	DISTANCE
A	332591.282	6255597.769
B	332668.102	6255586.298
C	332655.879	6255498.715
D	332579.059	6255510.526

EASEMENTS
(A) VARIABLE WIDTH PARTY WALL EASEMENT BETWEEN LOTS 1 AND 2 (W588738)
(B) 0.229m WIDE PARTY WALL EASEMENT BETWEEN LOTS 1 AND 2 (K171579)
(C) 0.229m WIDE PARTY WALL EASEMENT BETWEEN LOTS 3 AND 4 (K98061)
(D) RIGHT OF WAY VARIABLE WIDTH (DP225445)
(E) RIGHT OF WAY VARIABLE WIDTH (DP225445)
(F) 0.23m WIDE PARTY WALL EASEMENT BETWEEN LOTS 351 AND 352 (O165167)
(G) EASEMENT FOR SUPPORT VARIABLE WIDTH BETWEEN LOTS 36 AND 37 (D637580)

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0m 5 10 15m

SCALE 1:250 (A1)

CLIENT

BERRY ROAD DEVELOPMENT PTY LTD

PROJECT

ADDITIONAL DETAIL SURVEY OF LOT 45 IN DP76740, LOT 1 IN DP195104, LOT 46 IN DP1103247, LOT 1&2 IN DP586272

BEING 24-18 PARK ROAD ST LEONARDS

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2	DW	09/03/2023	ADD USL DATA
1	CLP	17/10/2022	INITIAL ISSUE

SYM	DESCRIPTION
	AUSPOST BOX
	BENCHMARK
	BIN
	BOLLARD
	BOREHOLE
	BUS STOP SIGN
	FLAG POLE
	GATE
	MAIL BOX
	SEAT
	UNKNOWN SERVICE
	DRAINAGE GULLY PIT
	DRAINAGE MANHOLE
	ELEC FUSE BOX
	ELEC GARDEN LIGHT
	ELEC GREEN PILLAR
	ELEC LIGHT POLE
	ELEC POLE & LIGHT
	ELEC POLE&TRANSFORMER
	ELEC POWER POLE
	ELEC SINGLE PIT
	ELEC STAY POLE
	ELEC TWIN PIT
	FUEL DIP

SYM	DESCRIPTION
	GAS MAIN
	GAS METER
	GAS VALVE
	SEWER LAMPHOLE
	SEWER MANHOLE
	SEWER VENT PIPE
	OPTICAL FIBRE MARKER
	OPTICAL FIBRE PIT
	TELECOM DIST PILLAR
	TELECOM POLE
	TELECOM SINGLE PIT
	TELECOM TWIN PIT
	TRAFFIC JUNCTION BOX
	TRAFFIC LIGHT
	TRAFFIC SIGN
	TRAF SIGNAL CONTROLLER
	SHRUB
	TREE
	WATER AIR VALVE
	WATER HYDRANT
	WATER METER
	WATER PUMP
	WATER STOP VALVE
	WATER TAP

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DRAINAGE PIPE U/G	SW
ELECT. LINE U/G	EU
HV ELEC. LINE U/G	EHV
HOW PRESSURE GAS	LG
HIGH PRESSURE GAS	HG
FENCE LINE	/
SEWERAGE PIPE	S
TELSTRA CABLE	T
WATER MAIN	W

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LEVEL DATUM AHD	LOCAL AUTHORITY LANE COVE
LEVEL ORIGIN SSM26101 RL57.313	SCALE 1:250 (A1)
MERIDIAN 56	CONTOUR INTERVAL 0.5 Metre
CO-ORD SYSTEM MGA2020	DRAWN JL / DATE 13/03/2023
SURVEYOR RL/GR/SL / DATE OF SURVEY 07/03/2023	CHECKED RL / DATE 13/03/2023
FIELD FILE SY074494_003_9_1	APPROVED RL / DATE 13/03/2023
UDN	SHEET 1 OF 2

SY074494_003_10_3-GDA 2020

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MGA

T.N.

-1.006°

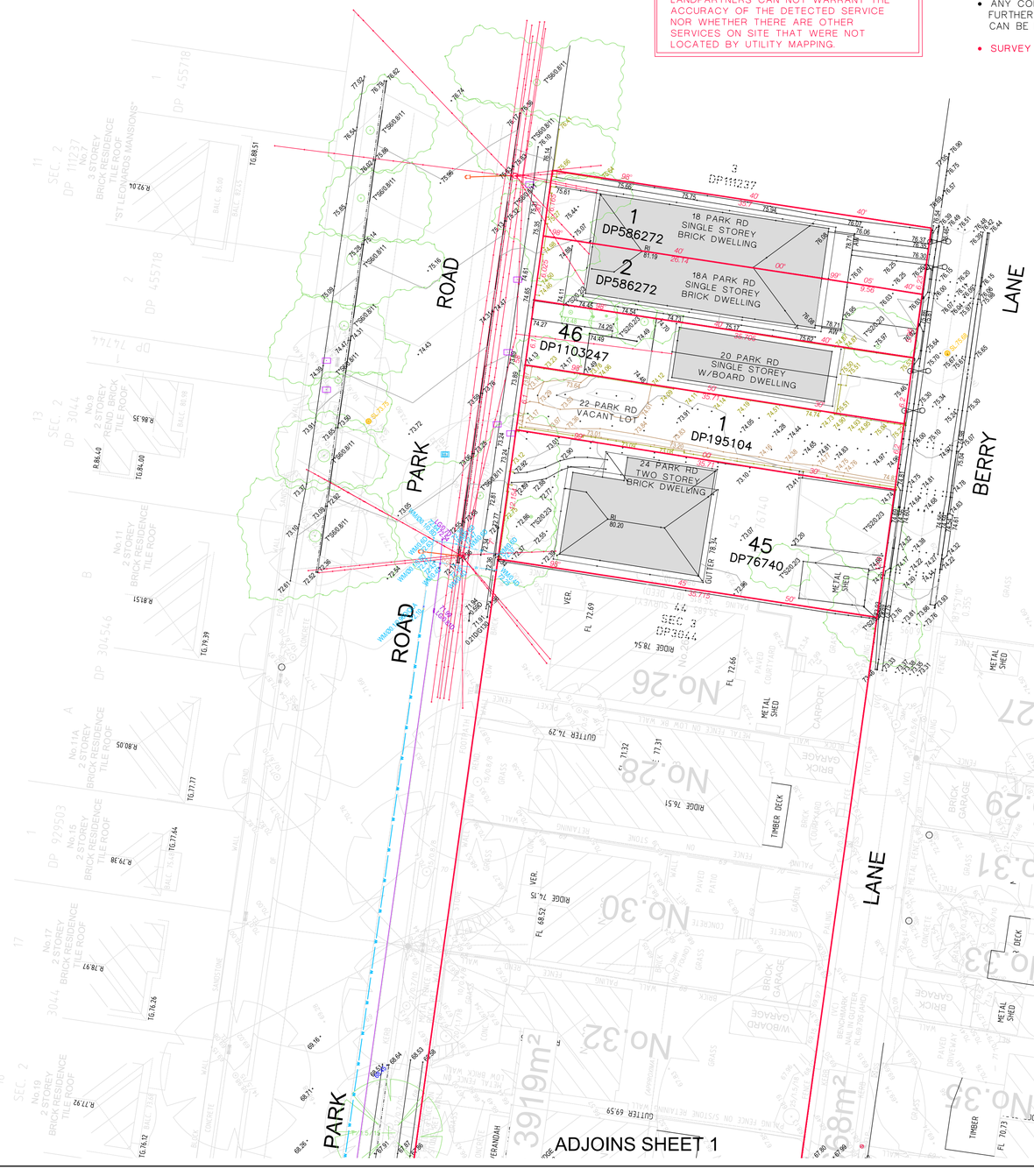
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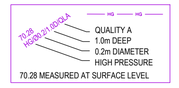
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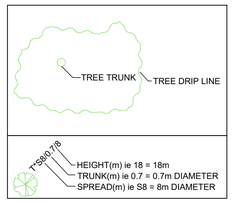
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0m 5 10 15m

SCALE 1:250 (A1)

CLIENT

BERRY ROAD DEVELOPMENT PTY LTD

PROJECT

ADDITIONAL DETAIL SURVEY OF LOT 45 IN DP76740, LOT 1 IN DP195104, LOT 46 IN DP1103247, LOT 1&2 IN DP586272

BEING 24-18 PARK ROAD ST LEONARDS

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DRAINAGE PIPE U/G	SW
ELECT. LINE U/G	EU
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HOW PRESSURE GAS	LG
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FENCE LINE	/
SEWERAGE PIPE	S
TELSTRA CABLE	T
WATER MAIN	W

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LEVEL DATUM AHD	LOCAL AUTHORITY LANE COVE
LEVEL ORIGIN SSM26101 RL57.313	SCALE 1:250 (A1)
MERIDIAN 56	CONTOUR INTERVAL 0.5 Metre
CO-ORD SYSTEM MGA2020	DRAWN JL DATE 13/03/2023
SURVEYOR RL/GR/SL DATE OF SURVEY 07/03/2023	CHECKED RL DATE 13/03/2023
FIELD FILE SY074494_003_9_1	APPROVED RL DATE 13/03/2023
UDN	SHEET 2 OF 2

SY074494_003_10_3-GDA 2020

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BH1

BH3

BH5

BH7A

BH9

BOREHOLES AND MONITORING WELLS ARE SHOWN IN RED

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T-SB0.7/8
HEIGHT(m) ie 18 = 18m
TRUNK(m) ie 0.7 = 0.7m DIAMETER
SPREAD(m) ie S8 = 8m DIAMETER

68.89 LQA/4DB/QCB
QUALITY B
4XDB
1.2m DEEP
68.89 MEASURED AT SURFACE LEVEL

64.9 LQA/200/10.7/QCB
QUALITY B
0.7m DEEP
0.1m DIAMETER
WATER MAIN
64.9 MEASURED AT SURFACE LEVEL

70.28 HQA/200/1.0/QCA
QUALITY A
1.0m DEEP
0.2m DIAMETER
HIGH PRESSURE
70.28 MEASURED AT SURFACE LEVEL

REFER TO R1 IN CCTV FOOTAGE

REFER TO B1 IN CCTV FOOTAGE

REFER TO B2 IN CCTV FOOTAGE

REFER TO B3 IN CCTV FOOTAGE

REFER TO B4 IN CCTV FOOTAGE

REFER TO B5 IN CCTV FOOTAGE

REFER TO B2 IN CCTV FOOTAGE

BOREHOLE	EASTING (MGA2020)	NORTHING (MGA2020)	GROUND RL (AHD)
BH1	332594.37	6255593.64	64.47
BH3	332664.22	6255580.73	66.35
BH5	332632.90	6255546.39	60.55
BH7A	332584.55	6255514.80	56.17
BH9A	332667.22	6255517.92	60.34
BH9A	332602.87	6255665.93	71.69
BH10	332651.06	6255657.89	74.17
BH10A	332650.51	6255657.04	74.25
BH11	332627.58	6255622.34	67.92
BH12	332639.82	6255620.78	69.80

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SCALE 1:250 (A1)

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5	RL	20/04/2023	ADD EXTRA CCTV USL DATA
4	RL	31/03/2023	ADD EXTRA USL DATA RIVER RD
3	RL	28/03/2023	ADD EXTRA USL DATA BERRY RD
2	DW	09/03/2023	ADD USL DATA
1	CLP	17/10/2022	INITIAL ISSUE

SYM	DESCRIPTION
	AUSPOST BOX
	BENCHMARK
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	SEAT
	UNKNOWN SERVICE
	DRAINAGE GULLY PIT
	DRAINAGE MANHOLE
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HOW PRESSURE GAS
HIGH PRESSURE GAS
FENCE LINE
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TELSTRA CABLE
WATER MAIN

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FIELD FILE SY074494_003_9_1	APPROVED RL / DATE 20/04/2023
UDN	SHEET 1 OF 2

SY074494_003_10_BHS

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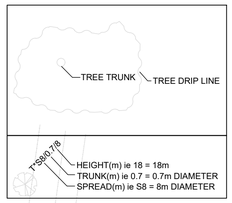
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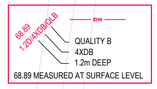
LANDPARTNERS CAN NOT WARRANT THE ACCURACY OF THE DETECTED SERVICE NOR WHETHER THERE ARE OTHER SERVICES ON SITE THAT WERE NOT LOCATED BY UTILITY MAPPING.

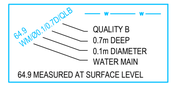
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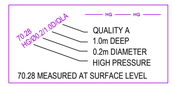
- TREE SIZES ARE ESTIMATES ONLY
- ONLY VISIBLE SERVICES HAVE BEEN LOCATED IN THIS SURVEY.
- ALL DIMENSIONS MUST BE VERIFIED ON SITE PRIOR TO ANY CONSTRUCTION.
- THE POSITION OF SURVEYED DATA HAS BEEN LOCATED AND IS SHOWN TO TOPOGRAPHIC ACCURACIES. IF CLEARANCES TO BOUNDARIES OR OTHER FEATURES ARE CRITICAL AND DIMENSIONS ARE NOT SHOWN FURTHER SURVEY MAY BE REQUIRED.
- THERE ARE DISCREPANCIES BETWEEN THE TITLE DIAGRAM DIMENSIONS AND THE ORIGINAL DEPOSITED PLAN DIMENSIONS AND AS SUCH THE BOUNDARIES ARE SUBJECT TO CHANGE BASED ON A FORMAL BOUNDARY REDEFINITION SURVEY.
- ANY CONSTRUCTION ON OR NEAR BOUNDARIES WILL REQUIRE FURTHER SURVEY IN ORDER THAT MARKS DEFINING BOUNDARIES CAN BE PLACED.
- SURVEY IS ON GDA2020 MAP PROJECTION



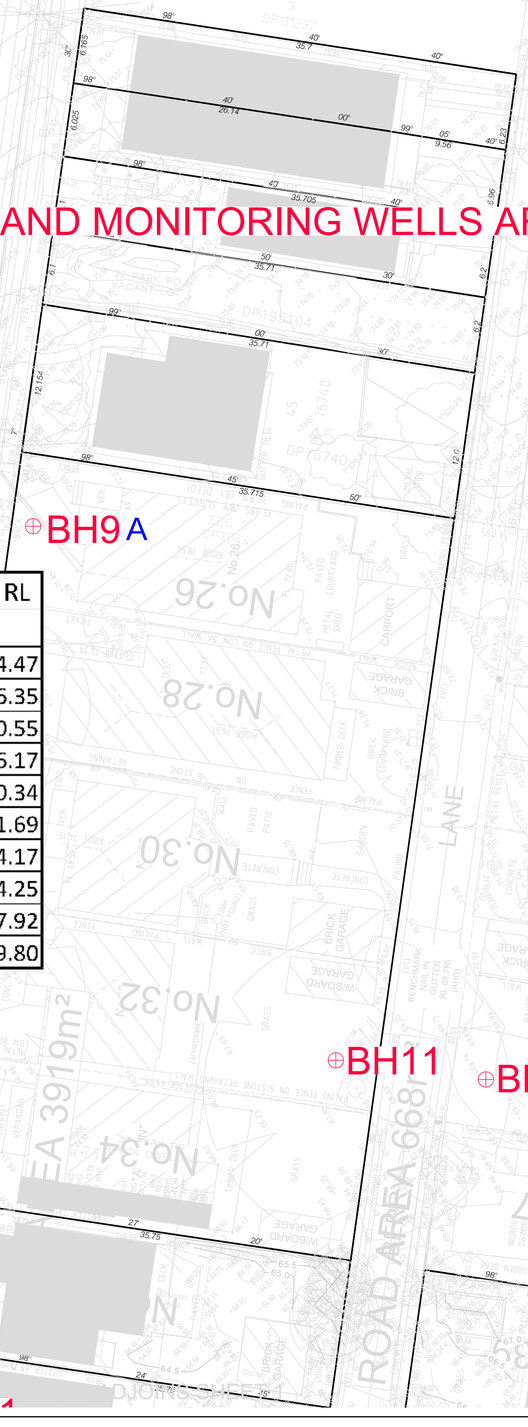
LTS CONTOUR AND DETAIL SURVEY, EASEMENT AND BOUNDARY INFORMATION SHOWN IN GREY ON THIS PLAN HAS NOT BEEN VERIFIED BY LANDPARTNERS AND LANDPARTNERS ACCEPTS NO RESPONSIBILITY FOR ITS ACCURACY







BOREHOLES AND MONITORING WELLS ARE SHOWN IN RED



BOREHOLE	EASTING (MGA2020)	NORTHING (MGA2020)	GROUND RL (AHD)
BH1	332594.37	6255593.64	64.47
BH3	332664.22	6255580.73	66.35
BH5	332632.90	6255546.39	60.55
BH7A	332584.55	6255514.80	56.17
BH9X	332667.22	6255517.92	60.34
BH9A	332602.87	6255665.93	71.69
BH10A	332651.06	6255657.89	74.17
BH10B	332650.51	6255657.04	74.25
BH11	332627.58	6255622.34	67.92
BH12	332639.82	6255620.78	69.80

BEFORE YOU DIG www.byda.com.au

A Before You Dig enquiry must be lodged at least two business days prior to starting any excavation or work site project.

CLIENT

BERRY ROAD DEVELOPMENT PTY LTD

PROJECT

ADDITIONAL DETAIL SURVEY OF LOT 45 IN DP76740, LOT 1 IN DP195104, LOT 46 IN DP1103247, LOT 1&2 IN DP586272

BEING 24-18 PARK ROAD ST LEONARDS

NOTES

(i) This plan has been prepared for the exclusive use of BERRY ROAD DEVELOPMENT PTY LTD and their consultants for design purposes and is not to be used for any other purpose or by any other entity without the express permission of LandPartners Pty Ltd.

(ii) The title boundaries as shown hereon were not marked at the time of survey. Field survey was undertaken to confirm there are no significant differences to the title dimensions.

(iii) Services shown hereon have been located where visible by field survey. If not able to be so located, services have been plotted from the records of relevant authorities where available and have been noted or symbolised accordingly. Where such records do not exist or are inadequate a notation has been made hereon.

(iv) Underground connections between services have been joined based on relevant authority records and have been symbolised accordingly.

(v) Prior to any demolition, excavation or construction on the site, the relevant authority should be contacted for possible location of further underground services and detailed locations of all services.

(vi) This data should not be reproduced in any way without the permission of LandPartners Pty Ltd. Any reproduction of this data must contain these notes

5	RL	20/04/2023	ADD EXTRA CCTV USL DATA
4	RL	31/03/2023	ADD EXTRA USL DATA RIVER RD
3	RL	28/03/2023	ADD EXTRA USL DATA BERRY RD
2	DW	09/03/2023	ADD USL DATA
1	CLP	17/10/2022	INITIAL ISSUE

SYM	DESCRIPTION
	AUSPOST BOX
	BENCHMARK
	BIN
	BOLLARD
	BOREHOLE
	BUS STOP SIGN
	FLAG POLE
	GATE
	MAIL BOX
	SEAT
	UNKNOWN SERVICE
	DRAINAGE GULLY PIT
	DRAINAGE MANHOLE
	ELEC FUSE BOX
	ELEC GARDEN LIGHT
	ELEC GREEN PILLAR
	ELEC LIGHT POLE
	ELEC POLE & LIGHT
	ELEC POLE&TRANSFORMER
	ELEC POWER POLE
	ELEC SINGLE PIT
	ELEC STAY POLE
	ELEC TWIN PIT
	FUEL DIP

SYM	DESCRIPTION
	GAS MAIN
	GAS METER
	GAS VALVE
	SEWER LAMPHOLE
	SEWER MANHOLE
	SEWER VENT PIPE
	OPTICAL FIBRE MARKER
	OPTICAL FIBRE PIT
	TELECOM DIST PILLAR
	TELECOM POLE
	TELECOM SINGLE PIT
	TELECOM TWIN PIT
	TRAFFIC JUNCTION BOX
	TRAFFIC LIGHT
	TRAFFIC SIGN
	TRAF SIGNAL CONTROLLER
	SHRUB
	TREE
	WATER AIR VALVE
	WATER HYDRANT
	WATER METER
	WATER PUMP
	WATER STOP VALVE
	WATER TAP

Symbols shown are indicative only. The symbol size and orientation does not necessarily represent the real size or orientation of the feature.

DRAINAGE PIPE U/G
ELECT. LINE U/G
HV ELEC. LINE U/G
HOW PRESSURE GAS
HIGH PRESSURE GAS
FENCE LINE
SEWERAGE PIPE
TELSTRA CABLE
WATER MAIN

LANDPARTNERS surveyors and planners

Sydney Office
Level 2
23-29 South Street
Rydalmere NSW 2116
PO Box 1144
Dundas NSW 2117

p: (02) 9685 2000
e: info@landpartners.com.au
w: www.landpartners.com.au

bsi ISO 9001 Quality Management Systems CERTIFIED; ISO 45001 Occupational Health and Safety Management CERTIFIED; AS/NZS 4801 Occupational Health and Safety CERTIFIED

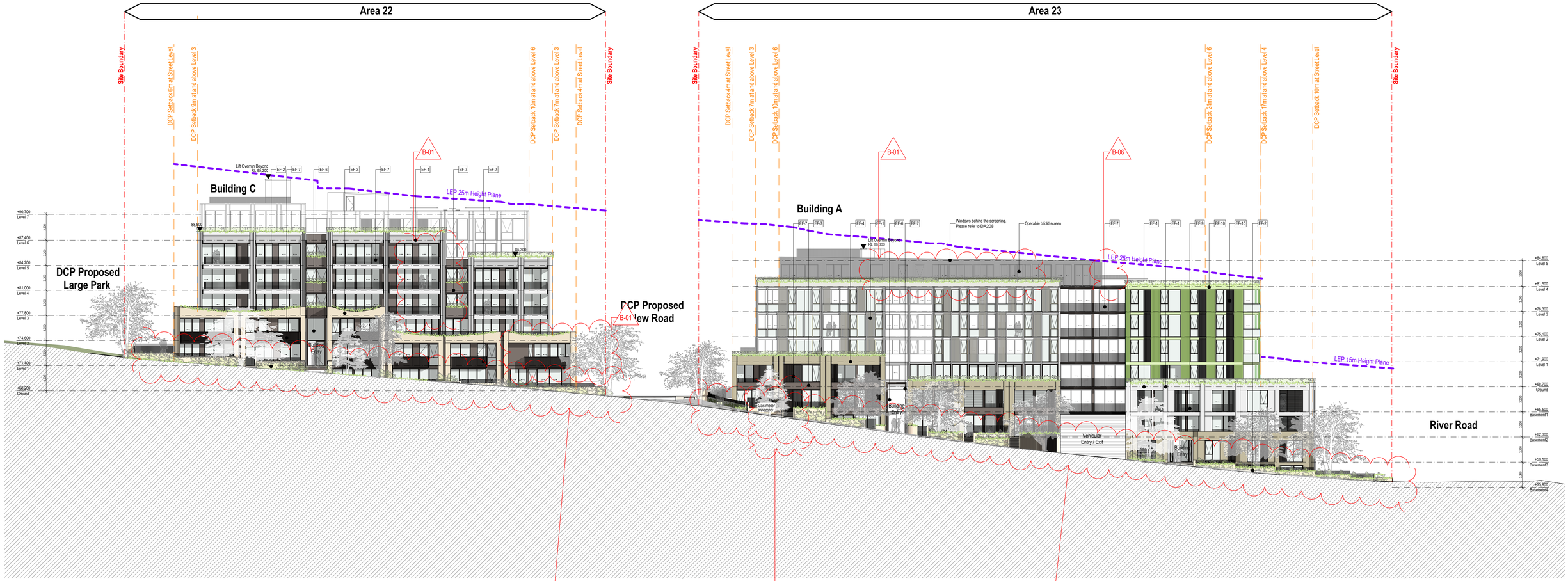
LEVEL DATUM AHD	LOCAL AUTHORITY LANE COVE
LEVEL ORIGIN SSM26101 RL57.313	SCALE 1:250 (A1)
MERIDIAN 56	CONTOUR INTERVAL 0.5 Metre
CO-ORD SYSTEM MGA2020	DRAWN JL / DATE 20/04/2023
SURVEYOR RL/GR/SL / DATE OF SURVEY 07/03/2023	CHECKED RL / DATE 20/04/2023
FIELD FILE SY074494_003_9_1	APPROVED RL / DATE 20/04/2023
UDN	SHEET 2 OF 2

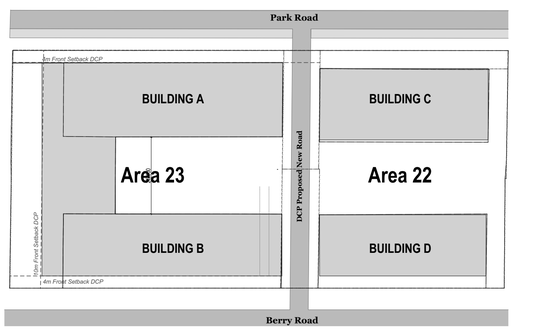
SY074494_003_10_BHS

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Appendix B

Proposed Development Drawings





List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
03: Substations relocated as per the electrical engineer's advice.
04: Gas meter assembly relocated
05: Facade update to match updated service rooms as per service engineer;s advice.
06: New awning to provide weather protection

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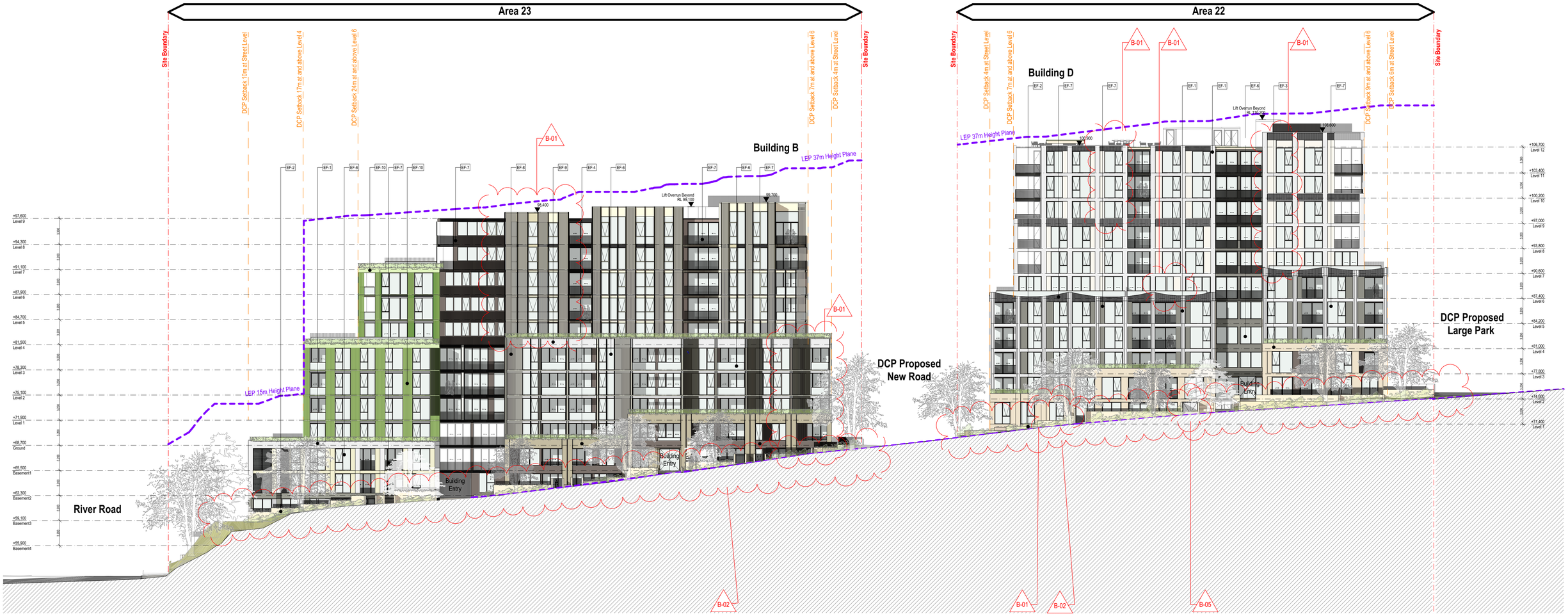
MINOR CHANGES TO FORM & CONFIGURATION MAY BE REQUIRED AFTER DEVELOPMENT CONSENT WHEN DRAWINGS ARE PREPARED FOR CONSTRUCTION PURPOSES.

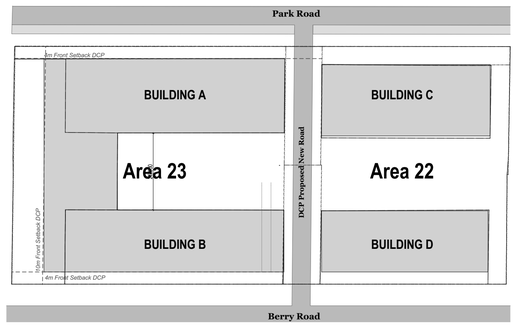
Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
B	9/05/2023	AC	XD	DA Amendment

DKO Architecture (NSW) Pty Ltd
42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
info@DKO.com.au
www.DKO.com.au
ABN: 81956706590
NSW: Nominated Architects
Koos de Keijzer 5767
David Randerson 8542

DKO

Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	West Elevation - Park Road
		Scale	1:250@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA301
		Revision	B





List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
03: Substations relocated as per the electrical engineer's advice.
04: Gas meter assembly relocated
05: Facade update to match updated service rooms as per service engineer;s advice.
06: New awning to provide weather protection

Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
B	9/05/2023	AC	XD	DA Amendment

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DKO Architecture (NSW) Pty Ltd
42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
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www.DKO.com.au
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NSW: Nominated Architects
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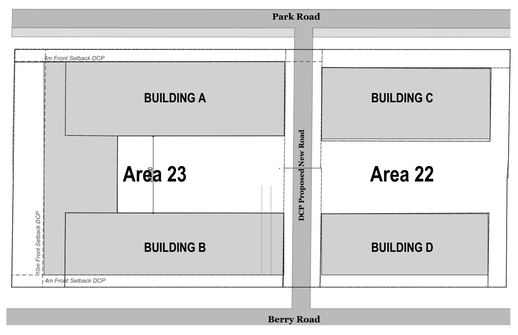
DKO

Project Name	Park Road
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065
Client	Berry Road Development Pty Ltd.
Project Number	12883
Drawing Name	East Elevation - Berry Road
Scale	1:250@A1
Date	May 2023
Drawing Number	DA302
Revision	B



List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
03: Substations relocated as per the electrical engineer's advice.
04: Gas meter assembly relocated
05: Facade update to match updated service rooms as per service engineer;s advice.
06: New awning to provide weather protection



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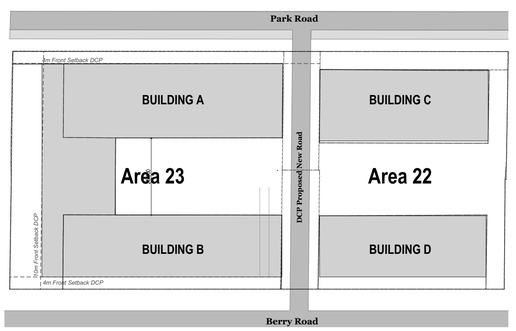
Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
B	9/05/2023	AC	XD	DA Amendment

DKO Architecture (NSW) Pty Ltd
42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
info@DKO.com.au
www.DKO.com.au
ABN: 81956706590
NSW: Nominated Architects
Koos de Keijzer 5767
David Randerson 8542

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Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	North Elevation - DCP Park
		Scale	1:250@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA303
		Revision	B





List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
03: Substations relocated as per the electrical engineer's advice.
04: Gas meter assembly relocated
05: Facade update to match updated service rooms as per service engineer;s advice.
06: New awning to provide weather protection

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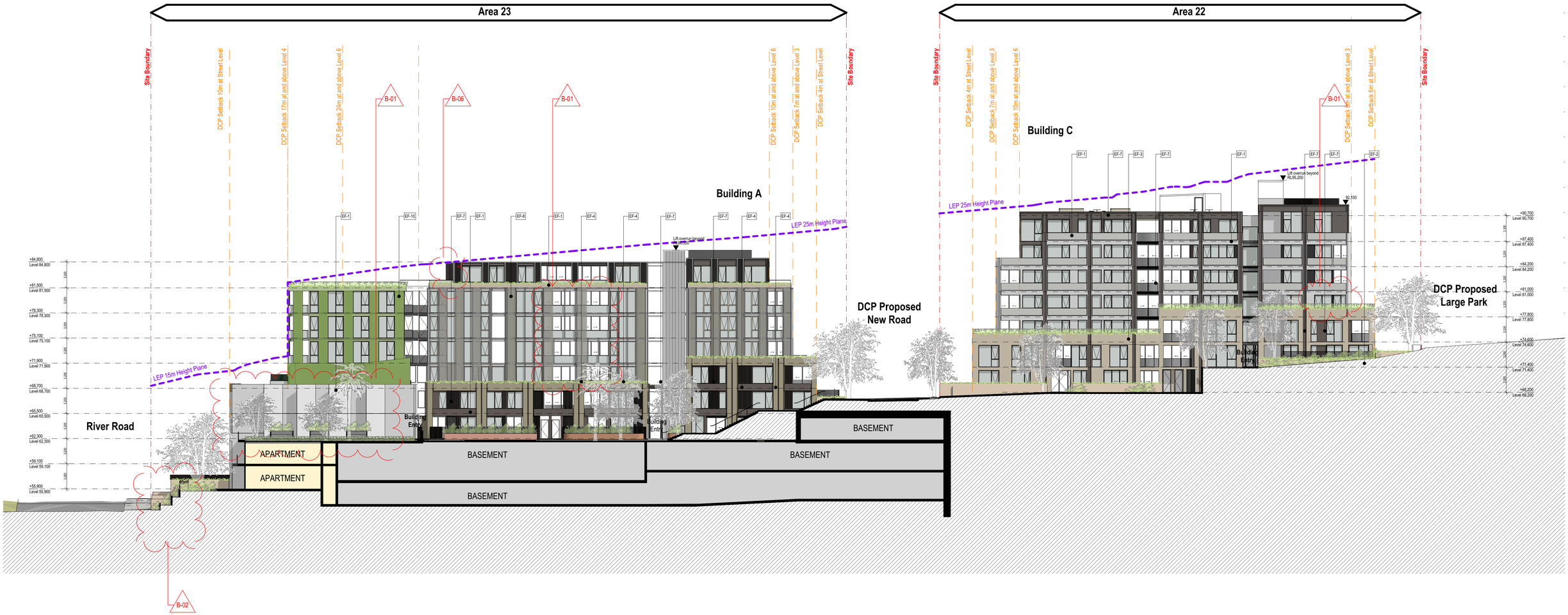
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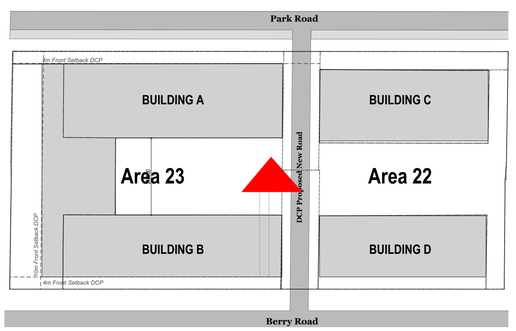
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DKO Architecture (NSW) Pty Ltd
42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
info@DKO.com.au
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NSW: Nominated Architects
Koos de Keijzer 5767
David Randerson 8542

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Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	South Elevation - River Road
		Scale	1:250@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA304
		Revision	B





List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
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04: Gas meter assembly relocated
05: Facade update to match updated service rooms as per service engineer;s advice.
06: New awning to provide weather protection

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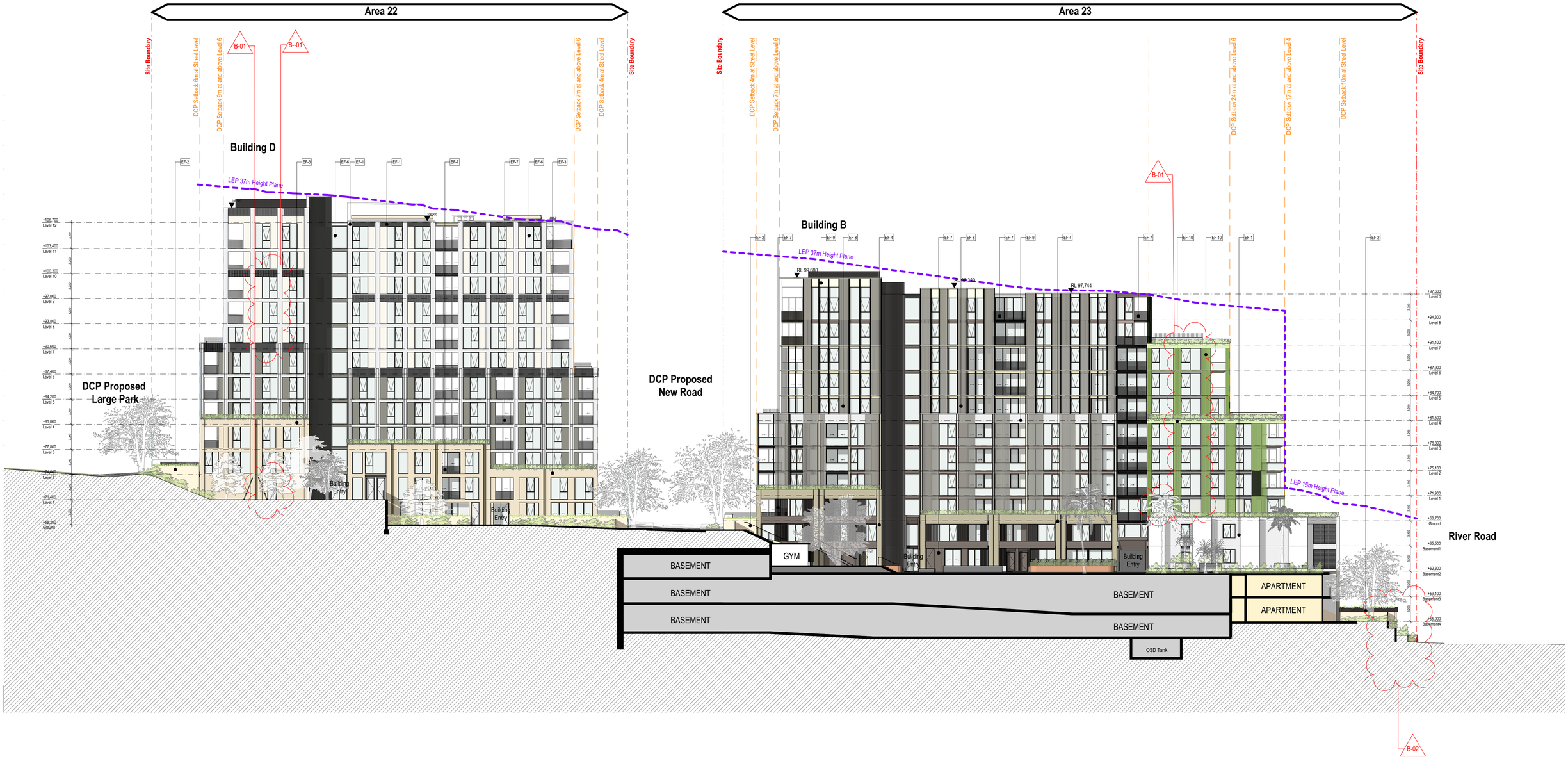
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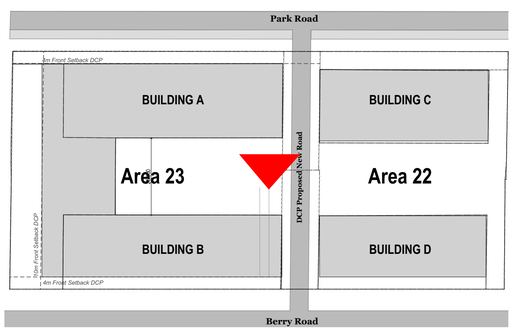
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42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
info@DKO.com.au
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Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	East Elevation - Green Spine
		Scale	1:250@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA305
		Revision	B





List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
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06: New awning to provide weather protection

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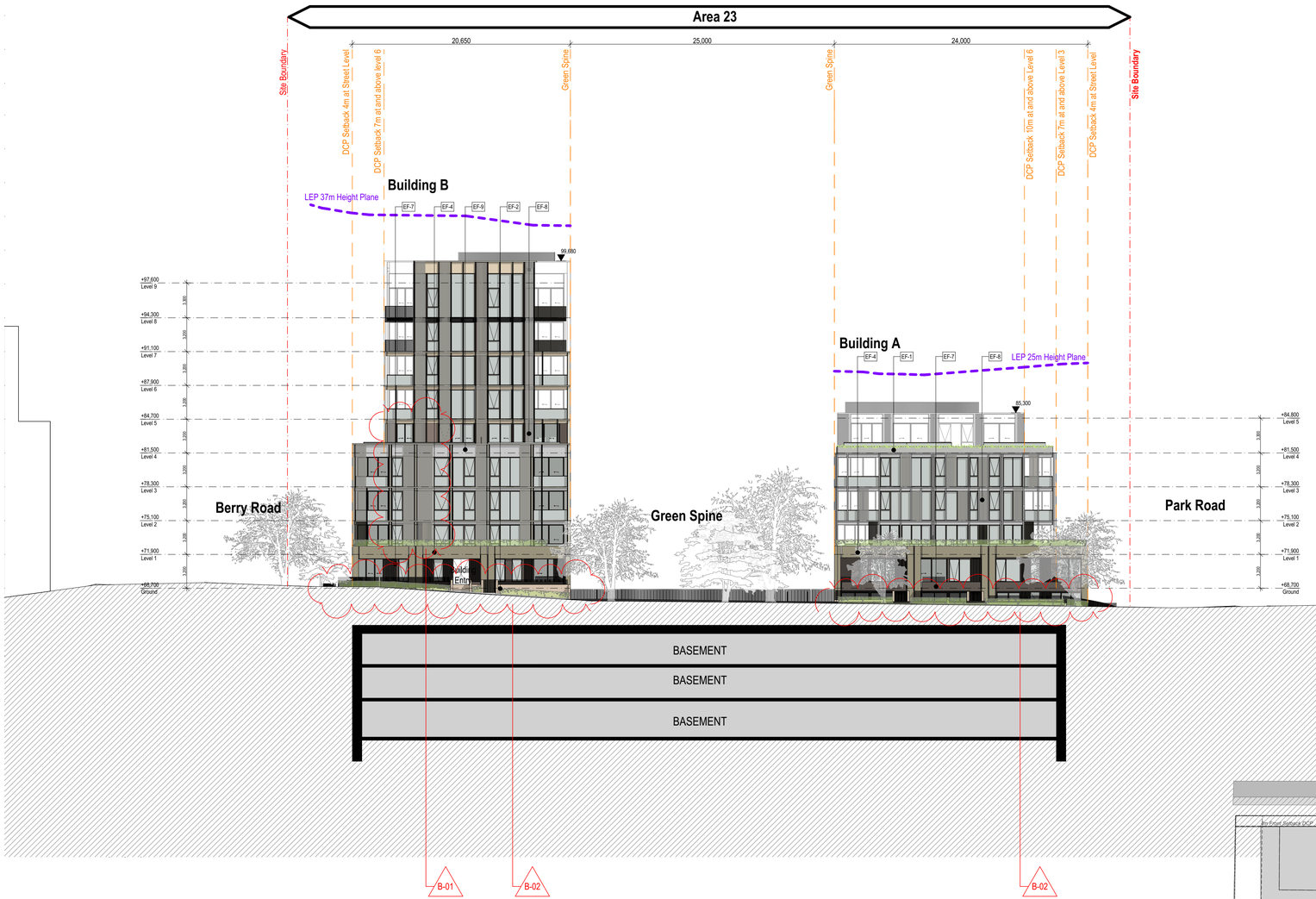
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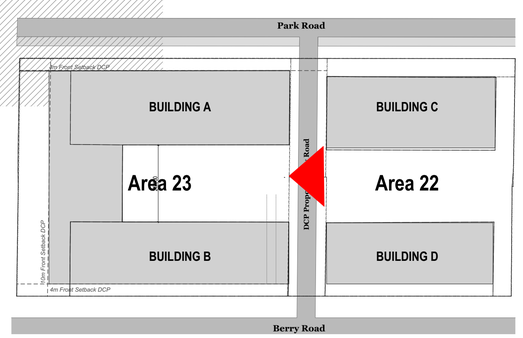
DKO

Project Name	Park Road
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065
Client	Berry Road Development Pty Ltd.
Project Number	12883
Drawing Name	West Elevation - Green Spine
Scale	1:250@A1
Date	May 2023
Drawing Number	DA306
Revision	B



List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
03: Substations relocated as per the electrical engineer's advice.
04: Gas meter assembly relocated
05: Facade update to match updated service rooms as per service engineer;s advice.
06: New awning to provide weather protection



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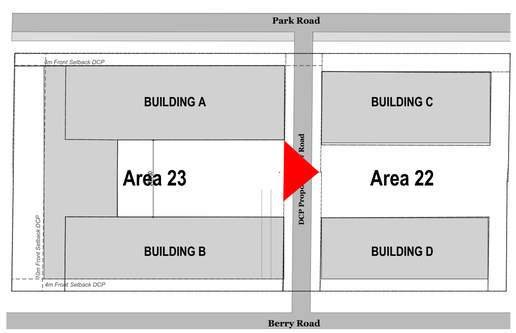
Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
B	9/05/2023	AC	XD	DA Amendment

DKO Architecture (NSW) Pty Ltd
42 Davies Street
Surry Hills, NSW 2010
T +61 2 9346 4500
info@DKO.com.au
www.DKO.com.au
ABN: 81956706590
NSW: Nominated Architects
Koos de Keijzer 5767
David Randerson 8542

DKO

Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	North Elevation - New Road
		Scale	1:250@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA307
		Revision	B





List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
03: Substations relocated as per the electrical engineer's advice.
04: Gas meter assembly relocated
05: Facade update to match updated service rooms as per service engineer;s advice.
06: New awning to provide weather protection

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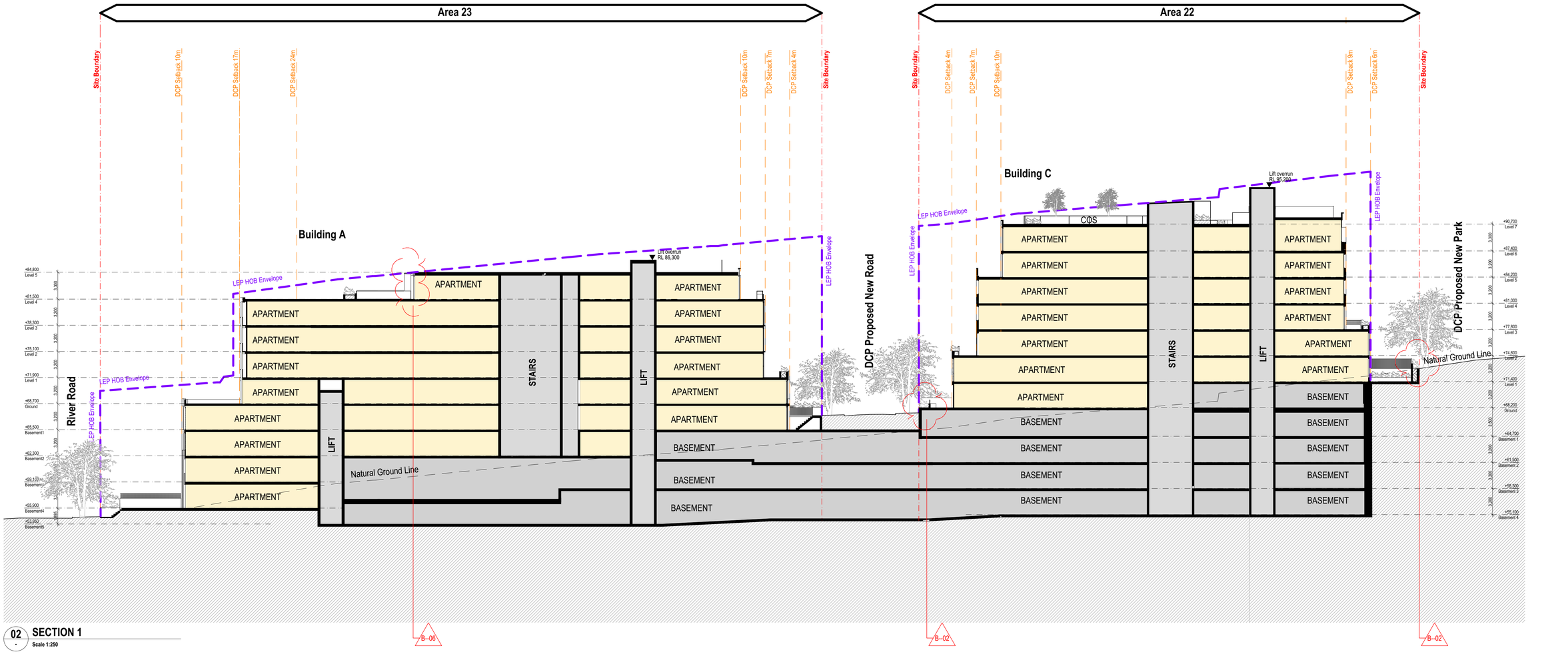
Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
B	9/05/2023	AC	XD	DA Amendment

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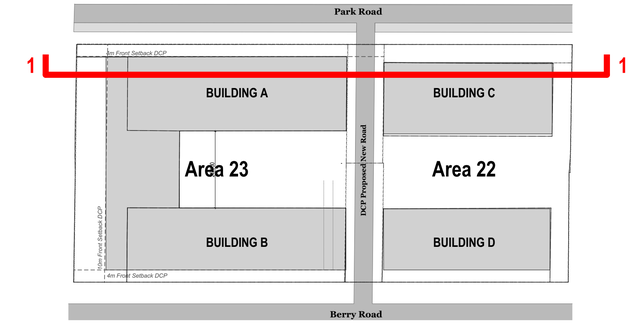
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42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
info@DKO.com.au
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Koos de Keijzer 5767
David Randerson 8542

Project Name	Park Road
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065
Client	Berry Road Development Pty Ltd.
Project Number	12883
Drawing Name	South Elevation - New Road
Scale	1:250@A1
Date	May 2023
Drawing Number	DA308
Revision	B



02 **SECTION 1**
Scale 1:250



List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
03: Substations relocated as per the electrical engineer's advice.
04: Gas meter assembly relocated
05: Facade update to match updated service rooms as per service engineer;s advice.
06: New awning to provide weather protection

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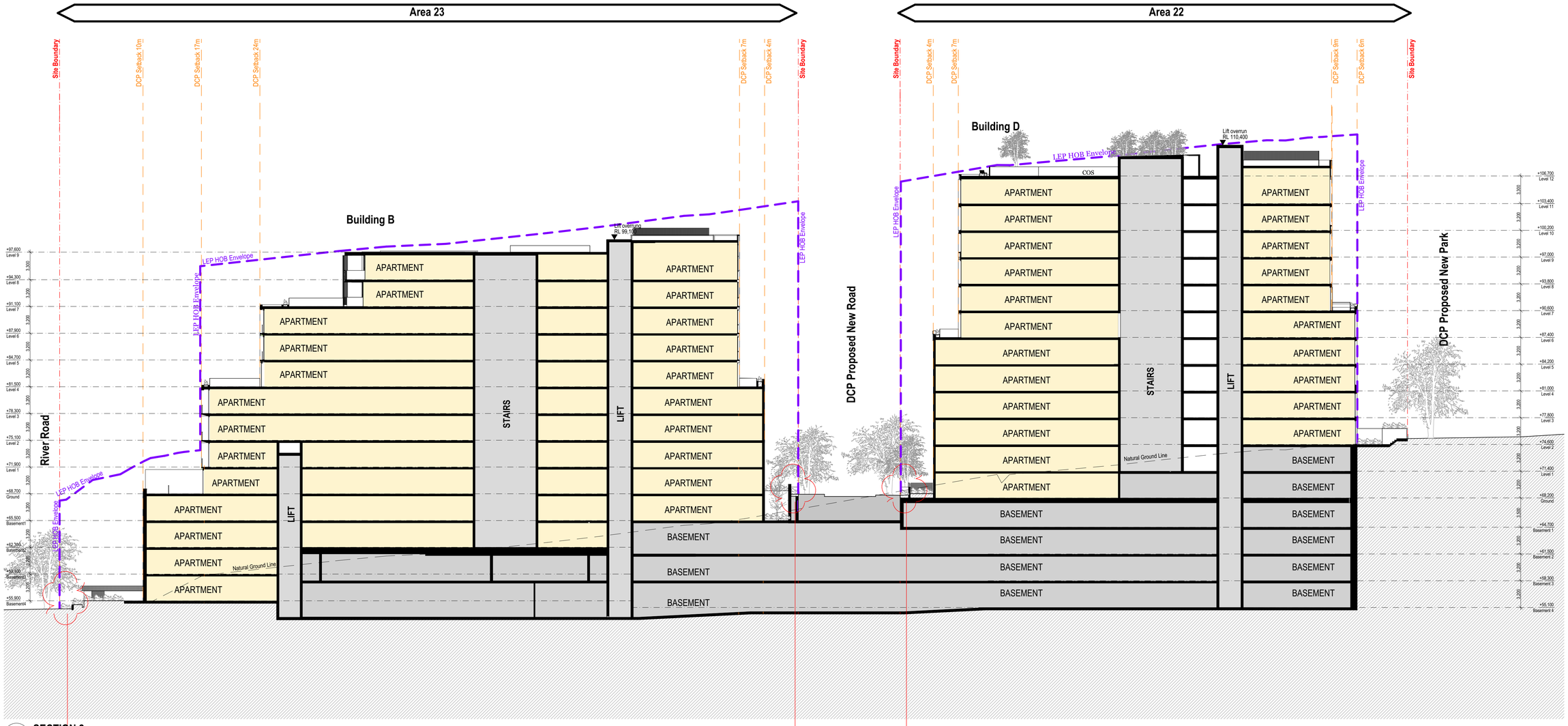
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Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
B	9/05/2023	AC, MJ, XD	XD	DA Amendment

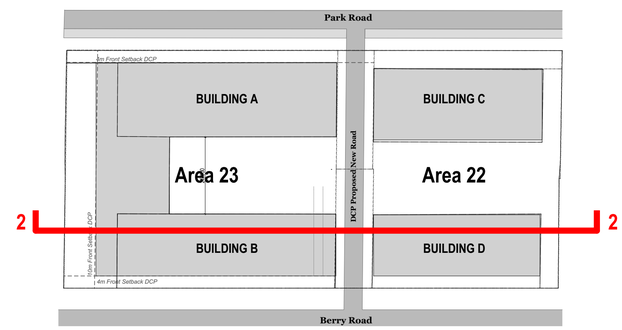
DKO Architecture (NSW) Pty Ltd
42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
info@DKO.com.au
www.DKO.com.au
ABN: 81956706590
NSW: Nominated Architects
Koos de Keijzer 5767
David Randerson 8542

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Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	Section 1
		Scale	1:250@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA309
		Revision	B



02 SECTION 2
Scale 1:250



List of Amendments:

01: Facade update to match updated internal layouts.
02: Planters along the boundary amended as per Oculus's advice
03: Substations relocated as per the electrical engineer's advice.
04: Gas meter assembly relocated
05: Facade update to match updated service rooms as per service engineer;s advice.
06: New awning to provide weather protection

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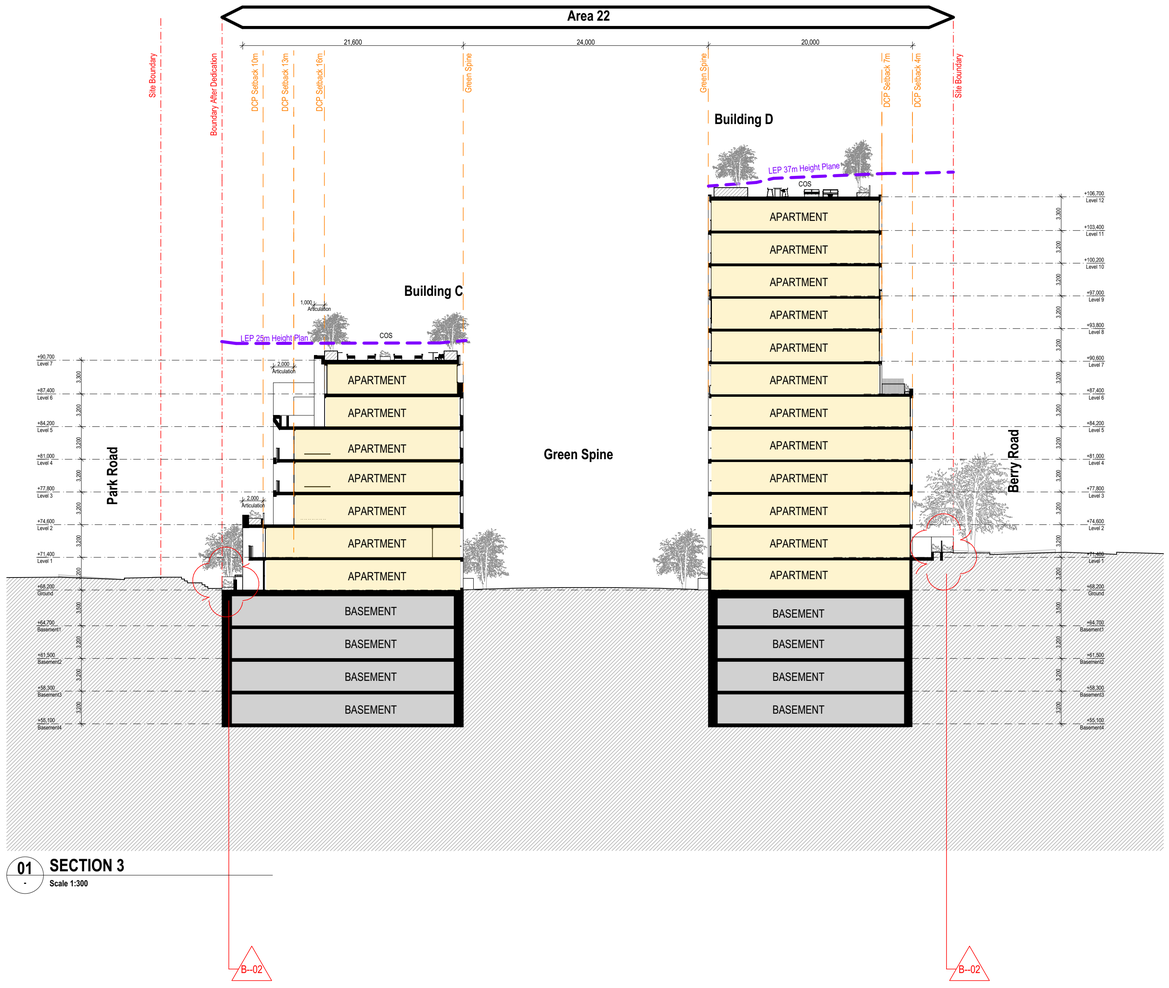
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Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
B	9/05/2023	AC, MJ, XD	XD	DA Amendment

DKO Architecture (NSW) Pty Ltd
42 Davies Street
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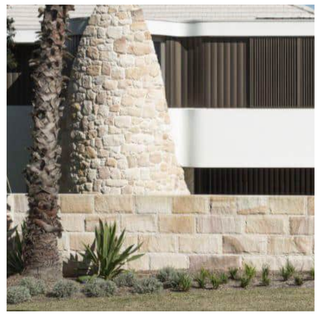
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Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	Section 2
		Scale	1:250@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA310
		Revision	B


Area 22
21,600
24,000
20,000
Site Boundary
Boundary After Dedication
DCP Setback 10m
DCP Setback 10m
DCP Setback 16m
Green Spine
Green Spine
DCP Setback 7m
DCP Setback 4m
Site Boundary
Building C
Building D
LEP 25m Height Plane
LEP 37m Height Plane
COS
1,000 Articulation
2,000 Articulation
2,000 Articulation
APARTMENT
BASEMENT
Park Road
Green Spine
Berry Road
+90,700 Level 7
+87,400 Level 6
+84,200 Level 5
+81,000 Level 4
+77,800 Level 3
+74,600 Level 2
+71,400 Level 1
+68,200 Ground
+64,700 Basement01
+61,500 Basement02
+58,300 Basement03
+55,100 Basement04
+106,700 Level 12
+103,400 Level 11
+100,200 Level 10
+97,000 Level 9
+93,800 Level 8
+90,600 Level 7
+87,400 Level 6
+84,200 Level 5
+81,000 Level 4
+77,800 Level 3
+74,600 Level 2
+71,400 Level 1
+68,200 Ground
+64,700 Basement01
+61,500 Basement02
+58,300 Basement03
+55,100 Basement04
3,200
3,200
3,200



EF - 1
Concrete, Colour: light



EF - 2
Sandstone
Colour: Natural



EF - 3
Brick
Colour: Light colour brick type 1



EF - 4
Brick
Colour: Medium colour brick type 2



EF - 5
Brick
Colour: Light colour brick type 3



EF - 6
Glazing: transparent

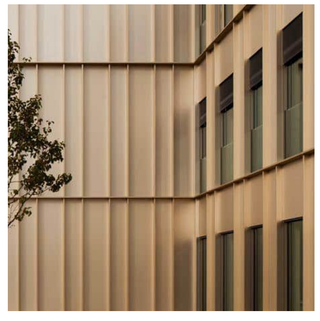








EF - 7
Metal palisade , Colour: medium bronze
Metal cladding , Colour: medium bronze



EF - 8
Metal palisade , Colour: Light bronze
Metal cladding , Colour: Light bronze



EF - 9
Metal cladding , Colour: white



EF - 10
Metal palisade , Colour: Green
Metal cladding , Colour: Green

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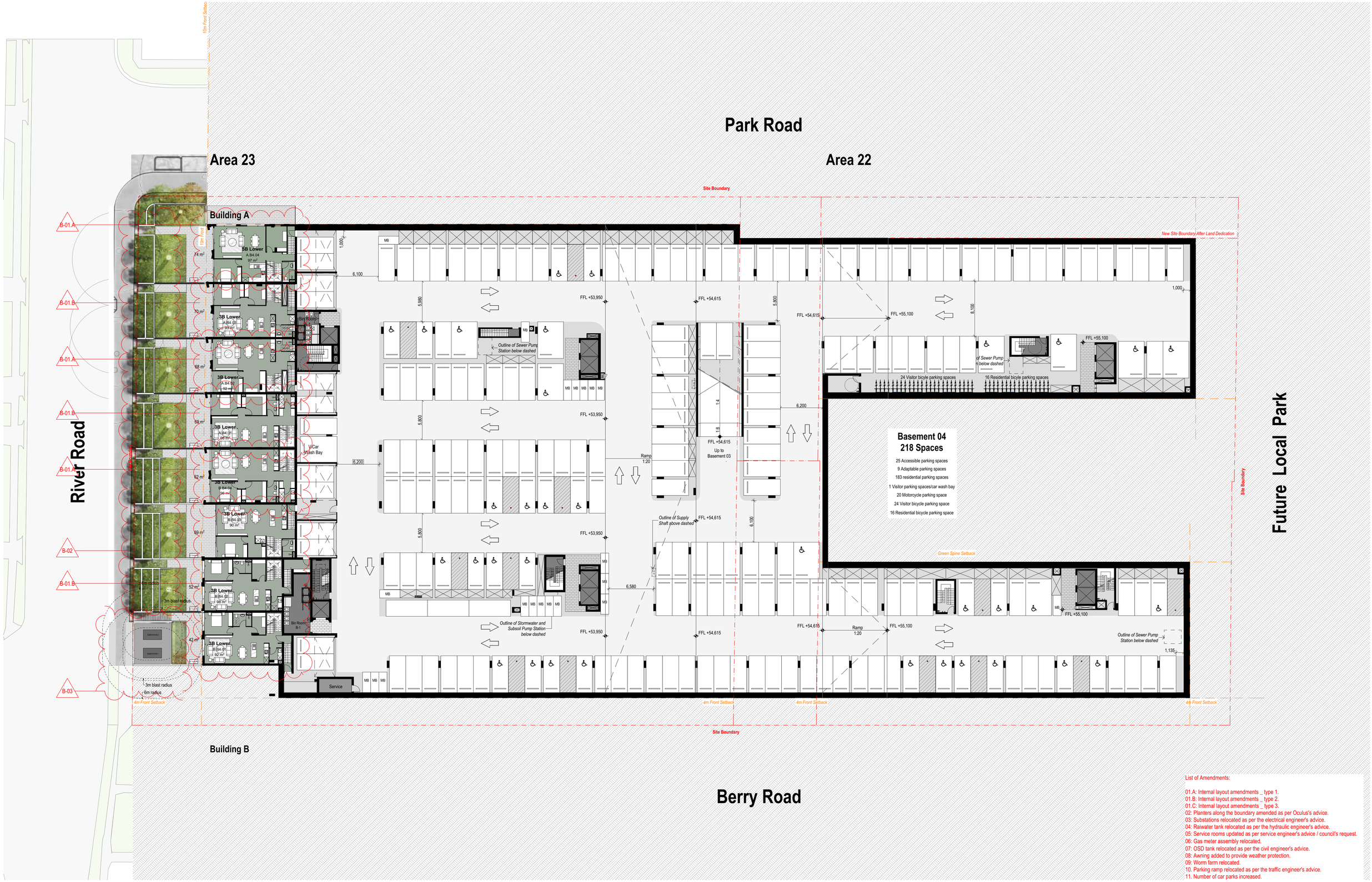
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Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA

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David Randerson 8542

DKO

Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	External Finishes schedule
		Scale	@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA312
		Revision	A



List of Amendments:

01.A: Internal layout amendments _ type 1.
01.B: Internal layout amendments _ type 2.
01.C: Internal layout amendments _ type 3.
02: Planters along the boundary amended as per Oculus's advice.
03: Substations relocated as per the electrical engineer's advice.
04: Rainwater tank relocated as per the hydraulic engineer's advice.
05: Service rooms updated as per service engineer's advice / council's request.
06: Gas meter assembly relocated.
07: OSD tank relocated as per the civil engineer's advice.
08: Awning added to provide weather protection.
09: Worm farm relocated.
10. Parking ramp relocated as per the traffic engineer's advice.
11. Number of car parks increased.

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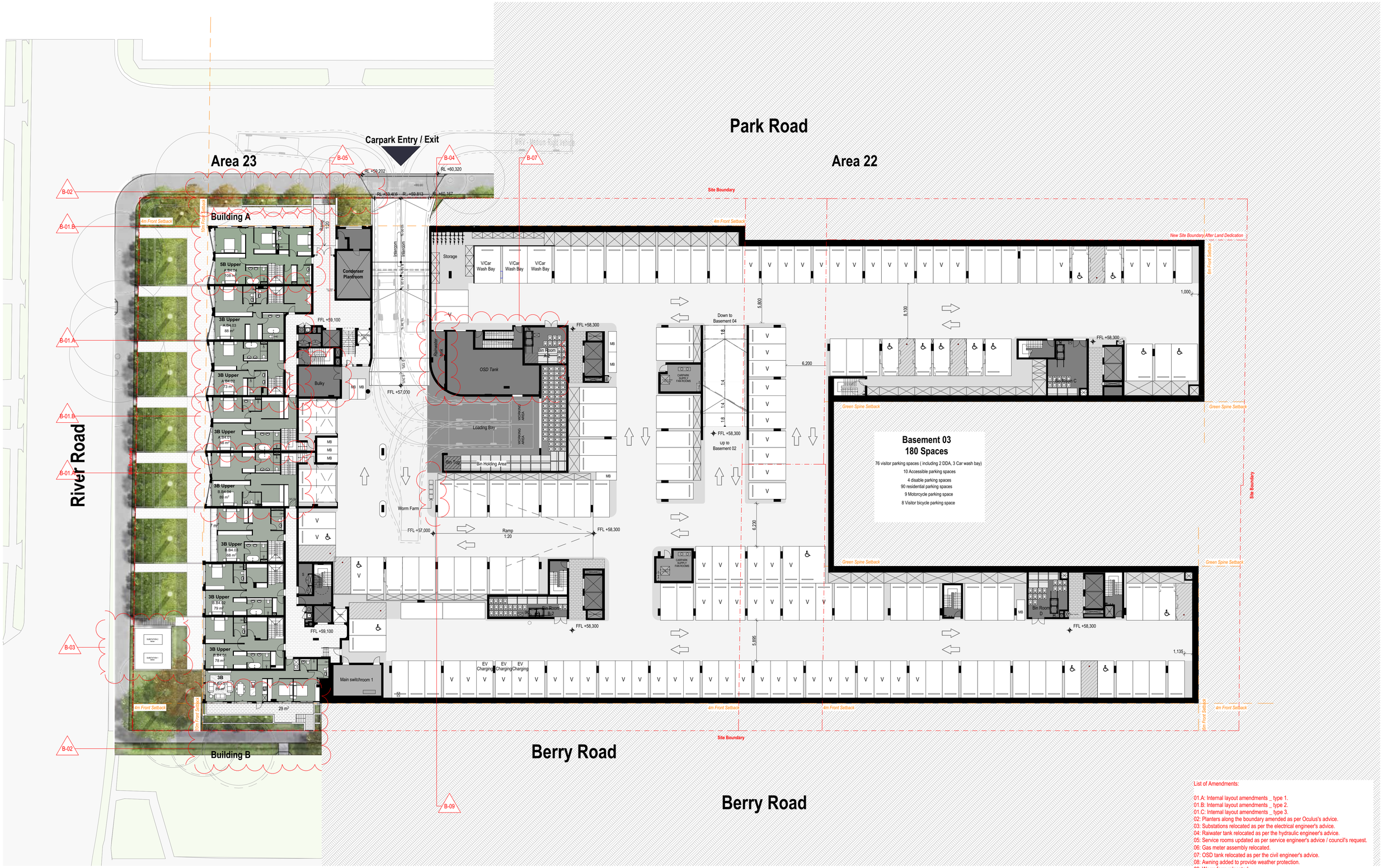
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Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
B	9/05/2023	AC	XD	DA Amendment

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Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	Basement 4
		Scale	1:250@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA200
		Revision	B



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01.B: Internal layout amendments _ type 2.
01.C: Internal layout amendments _ type 3.
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03: Substations relocated as per the electrical engineer's advice.
04: Raiwater tank relocated as per the hydraulic engineer's advice.
05: Service rooms updated as per service engineer's advice / council's request.
06: Gas meter assembly relocated.
07: OSD tank relocated as per the civil engineer's advice.
08: Awning added to provide weather protection.
09: Worm farm relocated.
10. Parking ramp relocated as per the traffic engineer's advice.
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Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
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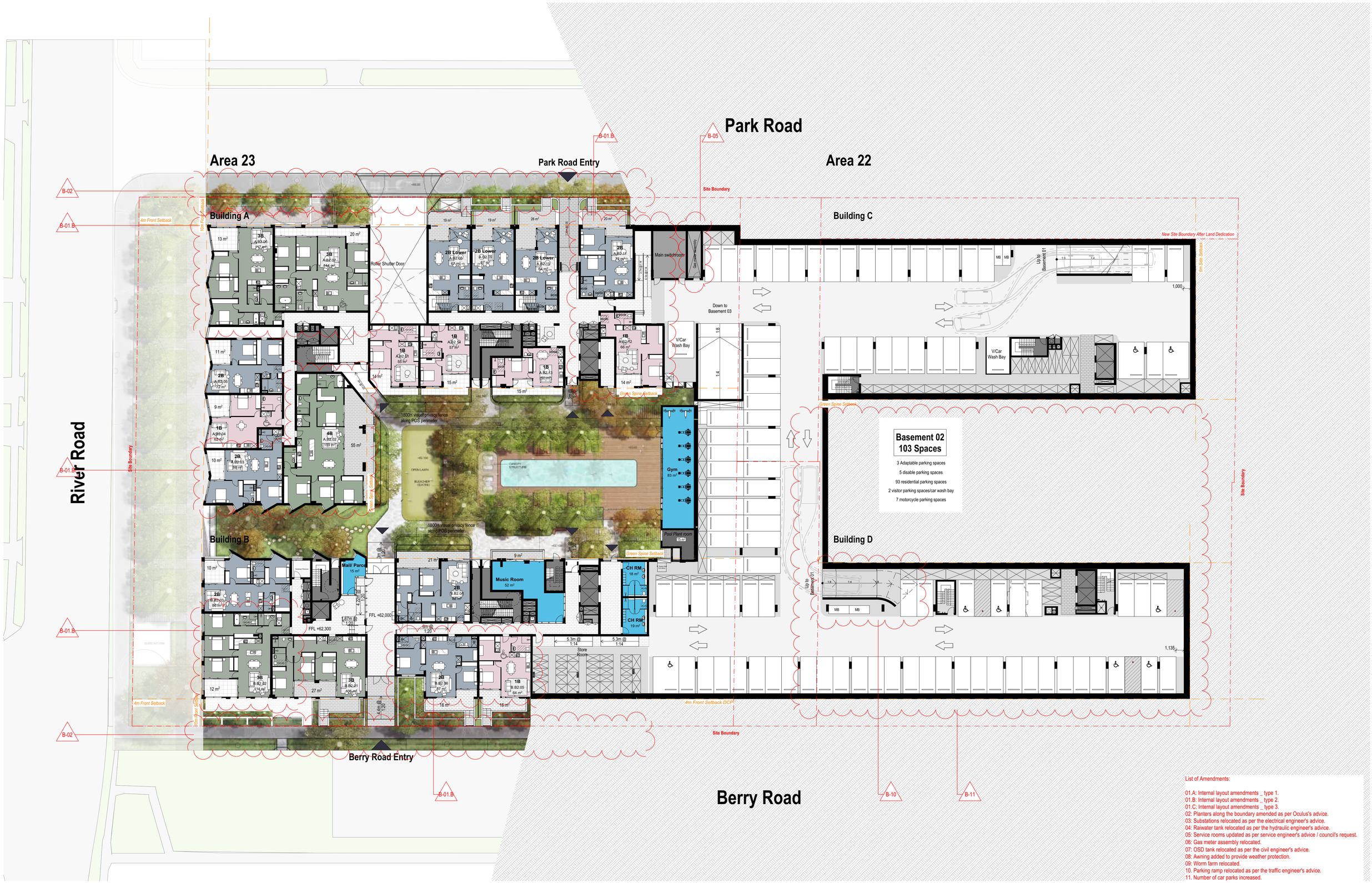
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Project Name	Park Road
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065
Client	Berry Road Development Pty Ltd.
Project Number	12883
Drawing Name	Basement 3
Scale	1:250@A1
Date	May 2023
Drawing Number	DA201
Revision	B



List of Amendments:

01.A: Internal layout amendments _ type 1.
01.B: Internal layout amendments _ type 2.
01.C: Internal layout amendments _ type 3.
02: Planters along the boundary amended as per Oculus's advice.
03: Substations relocated as per the electrical engineer's advice.
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Project Name	Park Road
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065
Client	Berry Road Development Pty Ltd.
Project Number	12883
Drawing Name	Basement 2
Scale	1:250@A1
Date	May 2023
Drawing Number	DA202
Revision	B

33 Park Road | 31 & 31A Park Road | 29 Park Road | 27 Park Road | 23 & 25 Park Road | 21 Park Road | 19 Park Road

Park Road

Refer to CE's drawings for detailed road design

Area 23

Building A

Building B

Area 22

Building C

Building D

Basement 01
25 Spaces
5 adptable parking spaces

Basement 01
23 Spaces
2 adptable parking spaces
21 Residential parking spaces

FFL+64.700
Down to Basement 02

FFL+65.700
Down to Basement 02

River Road

DCP Proposed New Road

Berry Road

Berry Road Entry

Site Boundary

New Site Boundary After Land Dedication

4m Front Setback

10m Front Setback

4m Side Setback

6m Side Setback

Green Spine Setback

Gas Meter Assembly

B-01.B | B-02 | B-06 | B-01.B | B-01.B | B-02 | B-01.B | B-01.A | B-01.C | B-10 | B-11

List of Amendments:

01.A: Internal layout amendments _ type 1.
01.B: Internal layout amendments _ type 2.
01.C: Internal layout amendments _ type 3.
02: Planters along the boundary amended as per Oculus's advice.
03: Substations relocated as per the electrical engineer's advice.
04: Raiwater tank relocated as per the hydraulic engineer's advice.
05: Service rooms updated as per service engineer's advice / council's request.
06: Gas meter assembly relocated.
07: OSD tank relocated as per the civil engineer's advice.
08: Awning added to provide weather protection.
09: Worm farm relocated.
10. Parking ramp relocated as per the traffic engineer's advice.
11. Number of car parks increased.

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Rev	Date	By	Chk	Description
A	24/11/2022	AC, MJ, XD	XD, MR	Issued for DA
B	9/05/2023	AC	XD	DA Amendment

DKO Architecture (NSW) Pty Ltd
42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
info@DKO.com.au
www.DKO.com.au
ABN: 81956706590
NSW: Nominated Architects
Koos de Keijzer 5767
David Randerson 8542

DKO

Project Name	Park Road
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065
Client	Berry Road Development Pty Ltd.
Project Number	12883
Drawing Name	Basement 1
Scale	1:250@A1
Date	May 2023
Drawing Number	DA203
Revision	B

33 Park Road | 31 & 31A Park Road | 29 Park Road | 27 Park Road | 23 & 25 Park Road | 21 Park Road | 19 Park Road | 17 Park Road | 15 Park Road

Park Road

River Road

Area 23

Building A

Building B

Area 22

Building C

Building D

DCP Proposed New Road

Berry Road

Site Boundary

New Site Boundary After Land Dedication

7m Front Setback

4m Front Setback

10m Front Setback

4m Side Setback

Green Spine Setback

NTR

FFL 10

FFL+68,200

FFL+68,050

FFL+68,000

41 Residential bicycle parking space

SERVICES/ STORAGE

Service

Services

Fan RM

Services / Storage

23 Residential bicycle parking space

B-01.A

B-01.B

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B	9/05/2023	AC	XD	DA Amendment

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42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
info@DKO.com.au
www.DKO.com.au
ABN: 81956706590
NSW: Nominated Architects
Koos de Keijzer 5767
David Randerson 8542

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Project Name	Park Road	Project Number	12883
Project Address	26-50 Park Rd, 27-47 Berry Rd, 48-54 River Rd , (Area 22 & 23), NSW 2065	Drawing Name	Ground Floor Plan
		Scale	1:2500@A1
		Date	May 2023
Client	Berry Road Development Pty Ltd.	Drawing Number	DA204
		Revision	B

Project: 26 Park Ave, St Leonards
Client: JQZ
Drawing: No structural drawings prepared to date.

Project No.: 157-010
Issue: P1
Date: 6/03/2023

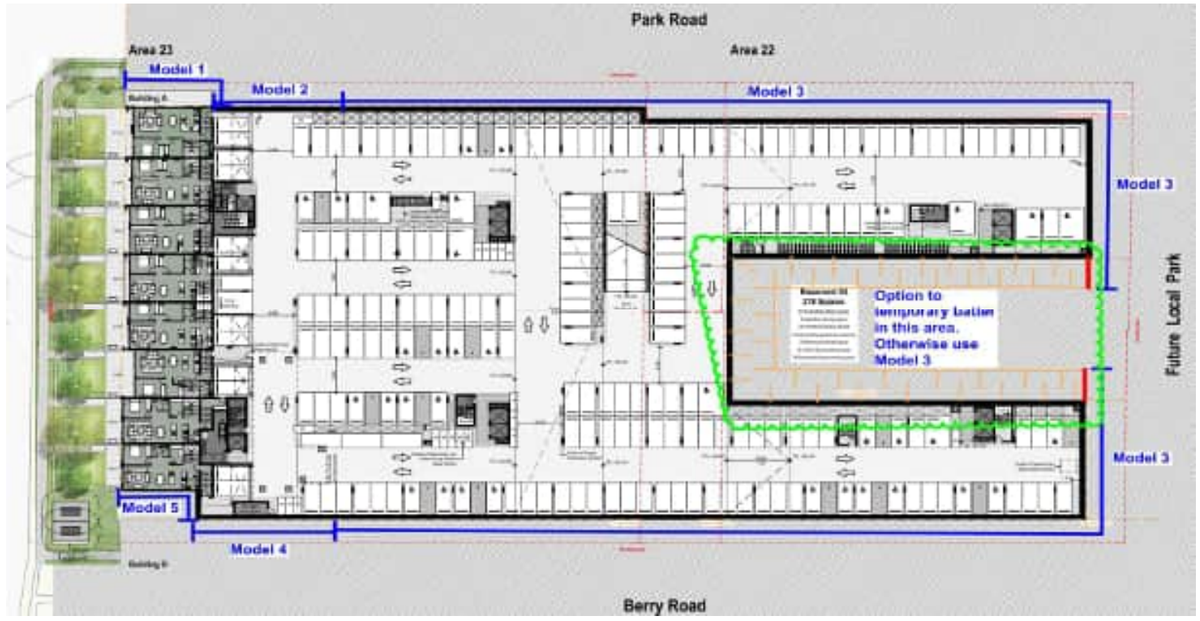
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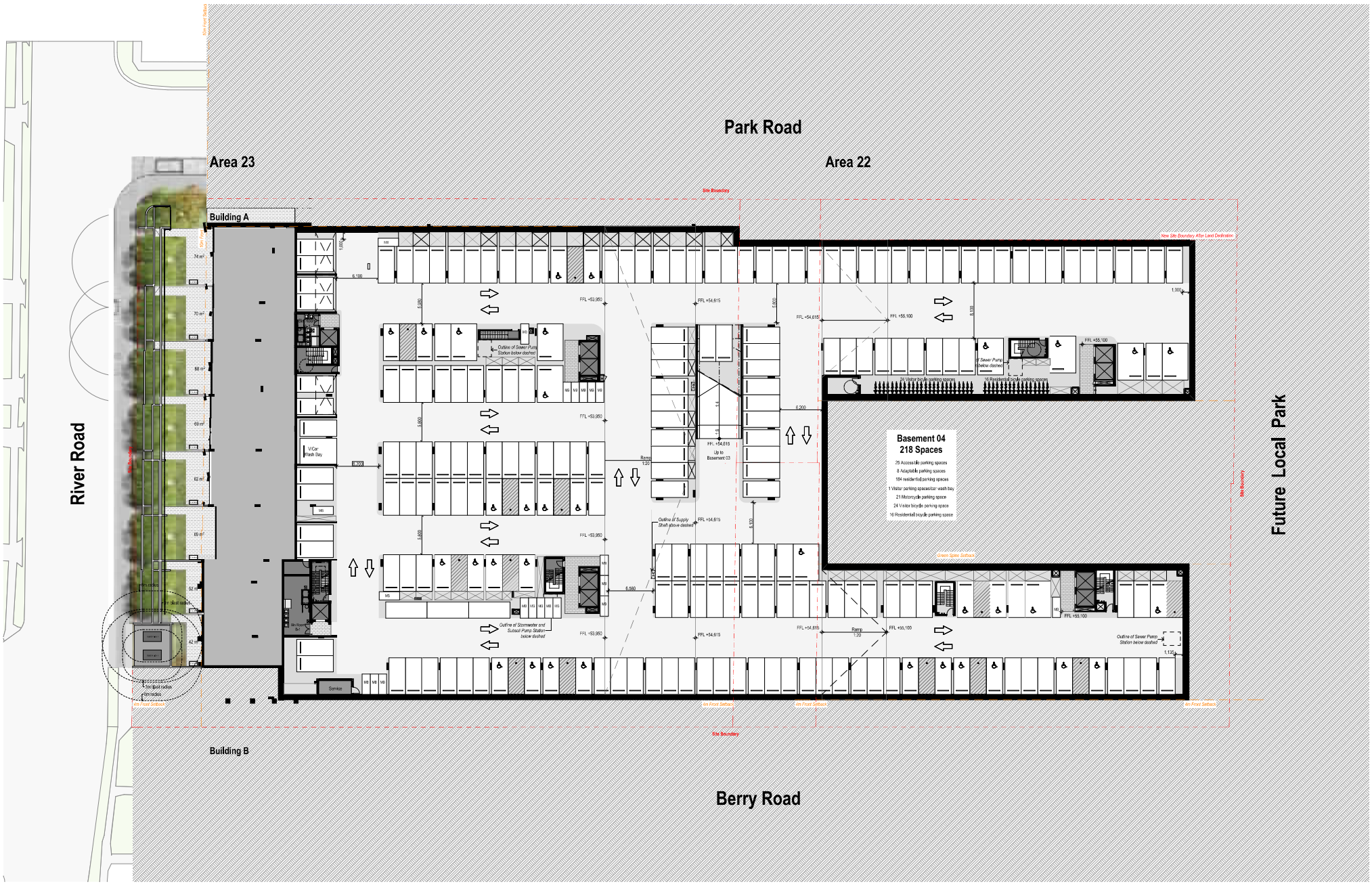
Model	Existing Ground Level (RL mAHD)	Max Top of Capping Beam Level (RL mAHD)	Lowest Basement FFL (RL mAHD)	Assumed Max Footing Depth (m)	Design Excavation Level (RL mAHD)	Design Excavation Depth (m)	Design Toe (RL mAHD)	WALLAP Outputs				Design Loads per Pile			Pile Details							Anchor / Strut Details							
								FOS	Estimated Deflection (mm)	Short Term Moment (kN.m/m)	Shear (kN/m)	Moment, M_d (kN.m)	Assumed N_d (kN)	Shear, V_d (kN)	Pile Dia (m)	Max. Pile Spacing (m)	F'c @ 28D (MPa)	Long Reinforcing	Spiral	Cover (mm)	Founding Criteria	Type	RL (m AHD)	Spacing (m)	Min. Free Length (m)	Inclination (deg)	Horiz Load per m (kN)	SWL per Anchor / Strut (kN)	Lock off Load (kN)
Model 1	58.50	58.50	55.90	1.00	54.90	3.60	51.00	>1.5	9	43	28	128	0	83	0.600	**2.00**	40	6N24	N10-200	75	FC1	Cantilever							
Model 2	61.00	61.00	53.95	1.00	52.95	8.05	51.00	>1.5	5	30	39	137	0	174	0.600	3.00	40	6N24	N10-200	75	FC1	Anchor	58.80	3.00	3.0	30	69	300	200
Model 3	Varies	Varies	n/a Toe above Excavation	n/a Toe above Excavation	Varies	Varies	Varies	>1.5	5	29	37	131	0	165	0.600	3.00	40	6N24	N10-200	75	**FC2**	Anchor	61.80	3.00	5.0	30	62	300	200
																						Anchor	58.80	3.00	3.0	30	63	300	200
Model 4	62.00	62.00	53.95	1.00	52.95	9.05	51.00	>1.5	13	50	54	224	0	241	0.600	3.00	40	6N24	N10-200	75	FC1	Anchor	58.80	3.00	3.0	30	78	300	200
Model 5	59.10	59.10	53.95	1.00	52.95	6.15	51.00	>1.5	2	15	37	67	0	166	0.600	3.00	40	6N24	N10-200	75	FC1	Anchor	57.50	3.00	3.0	30	62	300	200

Notes

1 Preliminary concept design based on preliminary information
2 Prelim Design is based on the geotechnical report by Coffey Geotechnics ref:SYDGE219558-GET-RPT-02 Dated 30 August 2022
3 Additional boreholes required on Northern half of the site as advised previously.
4 All Reinforcement to be full depth in pile.
5 No Pile load testing
6 No pile integrity testing required.
7 All sockets require a minimum roughness of R2.
8 Minimum 90% base cleanliness is required.
9 Geotechnical Inspections are required to ensure the piles are socketed into the required founding stratum.
10 Minimum socket required below design excavation level and into specified Bedrock, refer founding criteria above.
11 Capping Beam and support of existing basement wall to be designed by others
12 General Surcharge 20kPa. No allowance for any specific loading. Client to advise if any high-level footings adjacent to shoring wall, or if the 20kPa is to be exceeded.
13 A Mild exposure classification for concrete has been adopted in accordance with the geotechnical investigation report
14 Temporary anchor design required by others based on working loads and levels provided in above table. Max. Excavation 500mm below Temp Anchor RL's before installation.
15 A design excavation level has been assumed 1000mm below the lowest basement FFL.
16 No deflection criteria/limits have been provided. PDS have made no assessment of the effects of the estimated deflections on adjacent structures/services.
17 Permanent lateral restraint to be provided from the structural elements at capping beam levels, floor slabs and slab on ground.
18 The shoring has been designed as non load bearing as the pile toe is founding above the excavation for the majority of the site. TBC by the structural engineer.
19 **Founding Criteria**

FC1: Piles to design toe level, and min 1m socket into medium strength (or better) sandstone, whichever is the deeper.
FC2: Mininmum 1m socket into medium strength (or better) sandstone, and 1m socket below the basement suspended floor slab FFL.
Toe levels to be confirmed during detailed design.





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Rev	Date	By	Chk	Description
RFI2	1/06/2023	AC	XD	RFI2

DKO Architecture (NSW) Pty Ltd
42 Davies Street
Surry Hills, NSW 2010
T +61 2 8346 4500
info@DKO.com.au
www.DKO.com.au
ABN: 81956706590
NSW: Nominated Architects
Kose de Keijzer 5767
David Randerson 8512

DKO

Project Name	Park Road
Project Address	26-30 Park Rd, 27-47 Berry Rd, 48-54 River Rd, (Area 22 & 23), NSW 2065
Client	Berry Road Development Pty Ltd.
Project Number	12883
Drawing Name	Basement 4
Scale	1:250@A1
Date	June 2023
Drawing Number	DA200
Revision	RFI2

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Appendix C

Tetra Tech Coffey Report

Contact: Gerrod Webb
Phone: 04294653402
Email: gerrod.webb@waternsw.com.au

Lane Cove Municipal Council

Our ref: IDAS1147040
Your ref: PAN-287623

cshortt@lanecove.nsw.gov.au

Dear Applicant,

REQUEST FOR FURTHER INFORMATION

RE: Proposed Development PAN-287623
Lot Not Provided **DP** Not Provided
Area 22 and 23, St Leonards South

Reference is made to (Planning Portal No. A-58516).

WaterNSW has reviewed the information provided with the development application related to water supply works.

WaterNSW requests that the consent authority stop-the-clock for this development and arrange for the applicant ,**Berry Road Development Pty Limited** , to provide the following information to enable assessment of the application:

1. Confirmation that the structures below the predicted highest groundwater table are waterproof (tanked basement) and dewatering management program is designed considering the Minimum requirements for building site groundwater investigations and reporting. Note: Department of Planning, Industry & Environment (DPIE) require the perimeter walls and floor of the basement being constructed using a 'tanked' (waterproof) construction method. https://www.industry.nsw.gov.au/__data/assets/pdf_file/0004/343291/minimum-requirements.pdf
2. Volume of water to be extracted annually
3. Duration of the water take for dewatering
4. Method of measuring the water take and recording
5. Provide documents updated with the above information
6. It a tanked basement design is not possible, DPIE will require additional modelled data to support a hydro-geological review and assessment of the alternative drained basement design. The Geotech report will need to be updated accordingly. For details

of the additional data requirements for DPIE to assess drained basement scenarios , please refer to **Table 1 Modelling Inputs in the attachment.**

Please arrange to provide this information within 28 days from the date of this document. Should there be any further enquiry in this matter, please email gerrod.webb@waternsw.com.au

Yours sincerely

Gerrod Webb
Water Regulation Officer
WaterNSW

Table 1 Modelling inputs

WaterNSW and DPIE do not support the drained basement option for basements. However if the proponent is insistent on a drained basement alternative for the design of the basement, they will need to provide all the following additional data and modelling inputs to enable DPIE to undertake the necessary hydrogeological assessment.

#	Assessment Item
1	The estimate volume of water take has been specified in the documentation supplied with the application (in megalitres). Refer Section 4.2.1
2	Detailed explanation and supporting evidence have been provided to demonstrate the suitability of the volume estimation method (either description of numerical model used or analytical solution and source document). Refer Section 4.1
3	The ground elevation across the site has been provided on an architectural plan or section or detailed in other supporting documents in a manner acceptable to WaterNSW and DPIE-Water. Approximate ground contours provided in Figure 6 in Section 3.4
4	A report outlining the geotechnical characterisation of the ground conditions, based on site-specific intrusive investigations that fully penetrate to a deep geological unit beneath the property that is identified in the geotechnical report as being consolidated or hard. Refer to previous geotechnical reports in 2018 (SYDGE219558-GAR-RPT-02) and 2022 (SYDGE304523-AA-01)
5	Frequently repeated water level measurements illustrating the natural range over at least three months (in metres below ground level) Refer to Table 2 of Section 3.4. Groundwater levels measured at five locations in 2018 and 2023 with generally consistent results
6	The magnitude of required drawdown in water level to achieve dry conditions in the excavation has been identified (in metres). Refer Section 4.1.2
7	The works proposed to be used for dewatering have been described in detail (number, spacing, depth, individual discharge rates, cumulative discharge rate) and illustrated on specific plan and section diagrams. Dewatering will be as as result of the excavation into sandstone. Refer Section 4.1.1 and 4.1.2
8	The base level of the aquifer has been identified or can it be determined from supplied bore logs (in metres below ground level) Refer Section 4.1.1 and 4.1.2. Assumed no-flow boundary in Sandstone bedrock
9	Accurate excavation footprint dimensions (length, width, bulk excavation level) have been specified (in metres). Refer Section 2.1, 4.1.1 and 4.1.2
10	Field test results to determine the hydraulic conductivity of lithological units present beneath the site have been reported (in metres per day). Refer Section 3.5
11	The anticipated duration of dewatering pumping has been specified (days or weeks or months). It is anticipated that the basement will be drained for the life of the building.
12	The depth of piling embedment beneath the bulk excavation level has been specified (in metres). Not included in, or relevant to the hydrogeological report. This would be provided by structural designers.

In the case of a drained basement, we request that the geotechnical report be updated accordingly and uploaded to the planning portal. Further information can also be found at https://www.industry.nsw.gov.au/water/science/groundwater/aquifer-interference-activities

Park Rd St Leonards

Dewatering management plan

JQZ Pty Ltd



Reference: SYDGE304523-1-AA

6 March 2023

PARK RD ST LEONARDS

Dewatering Management Plan

Report reference number: SYDGE304523-1-AA
6 March 2023

PREPARED FOR

JQZ Pty Ltd
18 Parramatta Rd
Homebush NSW 2140

PREPARED BY

Tetra Tech Coffey
Level 19, Tower B, Citadel Tower, 799 Pacific Highway
Chatswood
NSW 2067 Australia
p: +61 2 9406 1000
f: +61 2 9415 1678
ABN 55 139 460 521

QUALITY INFORMATION

Revision history

Revision	Description	Date	Author	Reviewer	Approver
Rev 0	-	6 March 2023	AC	AO	AO

Distribution

Report Status	No. of copies	Format	Distributed to	Date
Rev 0	1	PDF	David Zhao	6 March 2023

CONTENTS

1. INTRODUCTION 1

2. BACKGROUND 1

2.1 Site description and proposed development 1

2.2 Previous site investigation information 3

2.3 Rainfall 4

3. SITE HYDROGEOLOGY 5

3.1 Geology 5

3.2 Acid sulfate soils 7

3.3 Regional aquifers 7

3.4 Groundwater levels 7

3.5 Aquifer parameters 10

4. GROUNDWATER INFLOW AND DRAWDOWN ASSESSMENT 12

4.1 Basis of assessment 12

4.1.1 Basement geometry 12

4.1.2 Conceptual cross section 12

4.1.3 Assessment method and boundary conditions 14

4.2 Assessed inflows 15

4.2.1 Total groundwater take 15

4.3 Assessed drawdowns 15

5. RISK ASSESSMENT 17

5.1 Effects on nearby users 17

5.2 Effects on nearby groundwater dependent ecosystems 17

5.3 Risk of increased salinity 17

5.4 Risk of increased contamination in aquifers 17

5.5 Surface settlement 17

5.6 Minimal impact assessment 18

6. GROUNDWATER CHEMISTRY AND DISCHARGE 19

7. DEWATERING AND MONITORING METHODOLOGY 20

7.1 Dewatering methodology 20

7.2 Treatment of discharged water 20

8. MONITORING AND REPORTING REQUIREMENTS 21

8.1 Volume 21

8.2 Quality 21

8.3 Groundwater levels 21
8.4 Reporting 22
9. CONCLUDING REMARKS 22
10. REFERENCES 23

LIST OF TABLES

Table 1: Piezometer details 7
Table 2: Observed groundwater levels at monitoring piezometers 9
Table 3: Rising head test results - Hvorslev (1951) analysis 11
Table 4: Estimated groundwater inflows 15
Table 5: Summary of drawdown distances 16
Table 6: Groundwater induced settlement for a 1 m drawdown in groundwater levels over a 1 m thick compressible soil layer 18
Table 7: Minimal impact consideration – Less Productive – Porous and fractured rock water sources 19

LIST OF FIGURES

Figure 1: Site locality and approximate boundaries 2
Figure 2: Plan of the lowest basement level 3
Figure 3: Previous investigation locations 4
Figure 4: Long-term mean rainfall data 5
Figure 5: Geological boundaries 6
Figure 6: Location of monitoring piezometers 8
Figure 7: Groundwater level contours and inferred groundwater flow direction 10
Figure 8: Cumulative permeability frequency based on packer testing in Sydney Sandstone (after Best and Parker, 2004) 11
Figure 9: Plan view of assumed excavation 13
Figure 10: North-South elevation of conceptual model showing assumed groundwater level and rock properties 13
Figure 11: Section 1 of conceptual site model 14
Figure 12: Section 2 of conceptual site model 14
Figure 13: Drawdown curve for Section 1 16
Figure 14: Drawdown curve for Section 2 16

APPENDICES

APPENDIX A: BOREHOLE LOGS 24
APPENDIX B: RISING HEAD TEST DATA 25
APPENDIX C: SEEP/W RESULTS 26
APPENDIX D: LABORATORY RESULTS 27

1. INTRODUCTION

This report provides a hydrogeological assessment and dewatering management plan for the proposed development of the JQZ Pty Ltd (JQZ) owned Park Road site, located in St Leonards NSW. The site incorporates the properties at 26-52 Park Road, 27-52 Berry Road, and approximately 160m of Berry Lane between these properties, and will be referred to as 'the site'. This assessment was carried out by Tetra Tech Coffey (Coffey) and was commissioned by JQZ.

We understand that the proposed development will comprise the construction of several residential towers over a combined multi-level basement carpark.

The purpose of this report is to provide the following information and assessment in relation to the NSW Aquifer Interference Policy (NSW Department of Primary Industries, 2012) [8]:

- Site hydrogeological information
- Groundwater inflow and drawdown assessment
- Guidance on construction dewatering and monitoring

2. BACKGROUND

2.1 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The proposed development site comprises a rectangular area of approximately 12,700m^2. The site is currently occupied by several one and two storey residential properties with some medium height trees and garden areas. The site also includes approximately 160m of laneway, named Berry Lane, to the rear of these properties, orientated approximately north-south along the site's main axis. The site is bounded by Berry Road to the east, River Road to the south, Park Road to the west and existing residential properties to the north.

The topography of the site slopes from north to south towards River Road, with surface elevation varying from approximately 75m AHD (Australian height Datum) in the north, to 55m AHD to the south, with an average gradient of 1V:8H.

A review of the Architectural drawings indicates that the proposed development involves the demolition of the existing site structures and construction of four separate residential structures between 7 and 12 storeys in height. A combined basement structure will be constructed beneath the towers which will vary between 2 (at the south part of the site) to 6 stories below ground level (at the north). This will include excavations up to approximately 20m below ground level (55m AHD) in the northern part of the site.

A new road will be constructed which will bisect the proposed development from east to west into approximately equal proportions. The basement in the southern part of the site will cover the majority of the site, whereas in the northern part the basement the excavation will extend to two north-south excavations with separation between them.

Figure 1 below illustrates the site locality with the approximate site boundaries shown in red. Figure 2 shows a plan of the lowest basement level.



Figure 1: Site locality and approximate boundaries

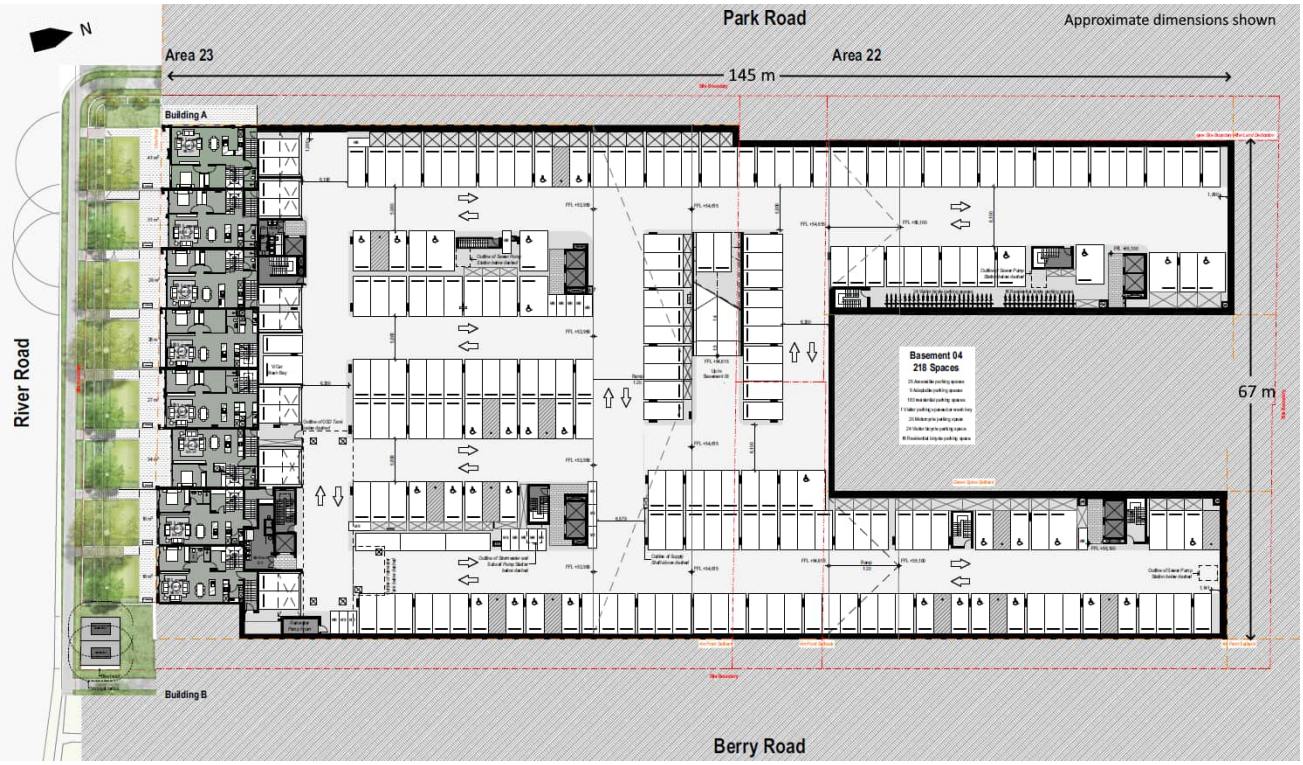


Figure 2: Plan of the lowest basement level

2.2 PREVIOUS SITE INVESTIGATION INFORMATION

Coffey completed a geotechnical investigation for the proposed development in 2018. This included the drilling of 10 boreholes (BH1 to BH9, and BH7A) across the southern portion of proposed development to characterise the site's geotechnical and hydrogeological conditions. The work included installation of five standpipe piezometers boreholes BH1, BH3, BH5, BH7A and BH9 to monitor groundwater levels. A site plan is provided Figure 3 which outlines the borehole locations relative to the site boundaries. It should be noted that this investigation covered the southern portion of the site only. No investigations have been undertaken within the northern half of the site.



Figure 3: Previous investigation locations

Further details of the geotechnical investigations are provided in the Geotechnical Investigation Report (ref: 754-SYDGE219558-GAR-RPT-02, dated 19 October 2018) [1] and a recent desktop study prepared by Coffey (ref: SYDGE304523-AA-01 dated 30 August 2022) [2]. The relevant borehole logs, rock core photographs and well installation logs are attached in Appendix A of this report.

2.3 RAINFALL

Long term average monthly rainfall data has been obtained from the Australian Bureau of Meteorology (BOM) [3] for Sydney Observatory Hill (BOM station no. 066062). This station is located approximately 3 km south-east of the site.

Figure 4 below shows mean monthly rainfall data for Sydney Observatory Hill between 1858 and 2020. The mean annual rainfall is 1,213 mm and the median is 1,164 mm.

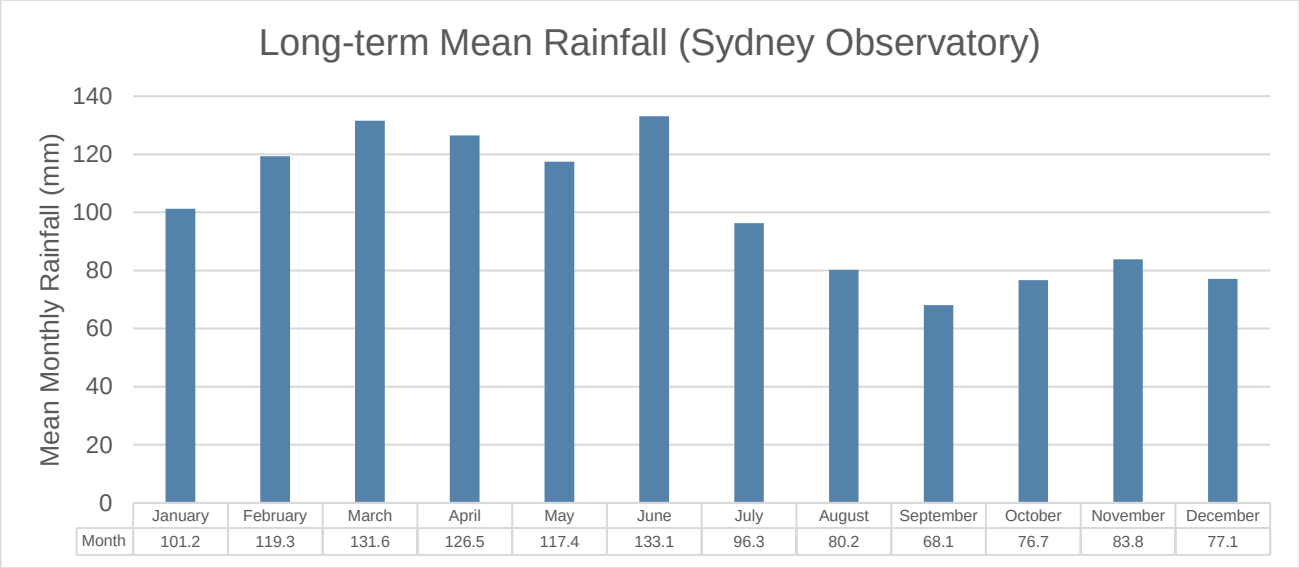


Figure 4: Long-term mean rainfall data

3. SITE HYDROGEOLOGY

3.1 GEOLOGY

A review of the NSW Seamless Geology database [4] indicates the site is bisected by the boundary between the Ashfield Shale and the underlying Hawkesbury Sandstone. This boundary is located near the junction between the Coffey 2018 investigation [1] and the newly acquired land. This is illustrated in Figure 5 below.

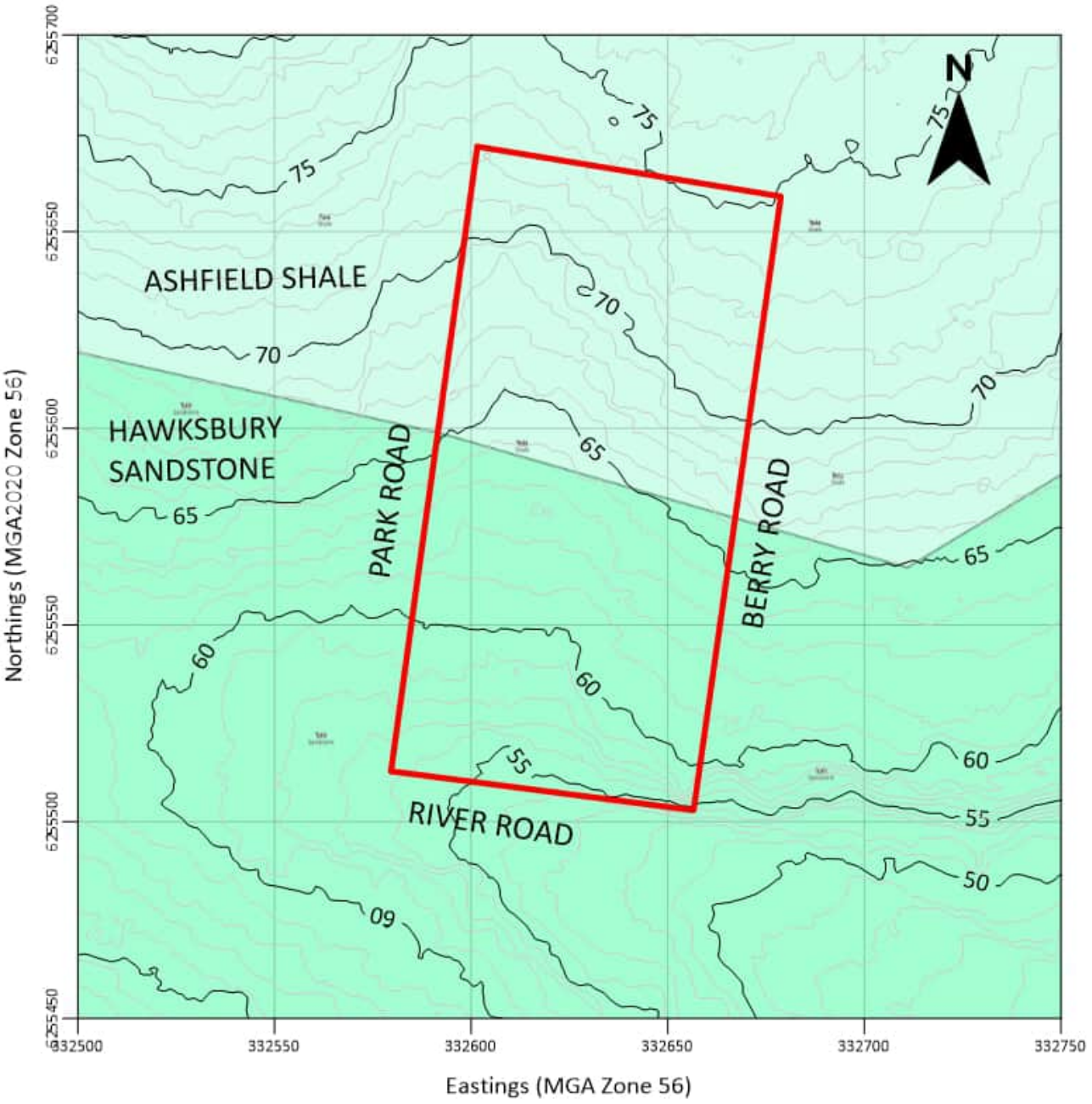


Figure 5: Geological boundaries

The bedrock units are summarised below.

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

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

The site subsurface generally consists of up to about 3 m of soil strength materials (fill or residual soil) overlying bedrock.

Further details on the site geology are presented in the recent desktop study [2] of the site.

3.2 ACID SULFATE SOILS

Reference to Department of Land and Water Conservation, Acid Sulfate Soil Risk Map for Prospect/Parramatta [5] indicates that the site is in an area of no known occurrence of acid sulfate soils.

3.3 REGIONAL AQUIFERS

Groundwater at the site is located within the fractured rock aquifer of the Hawkesbury Sandstone and potentially a small part of the overlying Ashfield Shale. Surface water drains via Berrys Creek to Sydney Harbour at Gore Cove, approximately 800 m south of the site.

The site is located in the Sydney Basin Central Groundwater Source as defined in the NSW Government (2011) Water sharing plan for the greater metropolitan region groundwater sources

3.4 GROUNDWATER LEVELS

Groundwater levels from piezometers previously installed by Coffey have been measured on several occasions. Table 1 provides the coordinates and screen elevations for these piezometers. Figure 6 shows their location on the site along with approximate surface elevation contours.

Table 1: Piezometer details

Piezometer ID	Easting (GDA2020)	Northing (GDA2020)	Surface elevation (mAHD)	Top of screen (m below ground level)	Base of screen (m below ground level)
BH1	332593.62	6255594.30	66.20	4.02	10.02
BH3	332664.31	6255580.56	66.20	4.08	10.08
BH5	332632.44	6255545.67	60.15	1.00	10.00
BH7A	332584.89	6255513.82	56.85	4.26	10.26
BH9	332667.23	6255517.90	60.16	4.48	10.48



Figure 6: Location of monitoring piezometers

A Coffey engineer visited the site on 14 and 21 February to record the depth to groundwater at piezometers using an electronic dip meter. Groundwater levels were previously recorded by a Coffey engineer on 4 September 2018. Table 2 presents the observed groundwater levels on these dates.

Table 2: Observed groundwater levels at monitoring piezometers

Piezometer ID	04-Sep-18 Site Visit		14-Feb-23 Site Visit		21-Feb-23 Site Visit	
	Groundwater elevation (mAHD)	Groundwater depth (m below ground)	Groundwater elevation (m below ground)	Groundwater depth (m below ground)	Groundwater elevation (m below ground)	Groundwater depth (m below ground)
BH1	61.73	4.47	62.31	3.89	-	-
BH3	62.38	3.82	-	-	63.19	3.01
BH5	55.85	4.3	56.24	3.91	-	-
BH7A	52.95	3.9	53.42	3.43	-	-
BH9	54.99	5.17	55.61	4.55	-	-

The groundwater levels measured in 2018 and 2023 are generally consistent, with the groundwater level readings in 2023 typically 0.4m to 0.8m higher in elevation than 2018. This is consistent with the above average rainfall recorded in Sydney during 2022.

Groundwater levels are relatively consistent with regards to depth below ground level across the site, generally varying between 3 to 4.5m below ground level. This infers a groundwater flow direction across the site from north to south at a gradient of approximately 1V:8H, similar to the topography. It should be noted that the groundwater level measurements have only been taken from piezometers on the southern half of the site.

Based on the groundwater levels measured in February 2023, a groundwater contour plan for the southern portion of the site is shown in Figure 7 below, along with the inferred direction of groundwater flows.



Figure 7: Groundwater level contours and inferred groundwater flow direction

3.5 AQUIFER PARAMETERS

Three rising head tests were carried out by Coffey in February 2023 at piezometers BH1, BH7A and BH9. These tests provide an assessment of hydraulic conductivity near these wells. The rising head tests were conducted as follows:

- Groundwater levels were initially measured using an electronic dip meter to record the standing groundwater level.
- The wells were then bailed using a plastic bailer to lower the groundwater level in the wells by at least 2m.

- The recovery of the groundwater level was then measured using the electronic dip meter with levels recorded at regular intervals.

The results of the rising head test were then analysed using the Hvorslev Method (1951) and results presented in Table 3 below. The test reports are provided in Appendix B.

Table 3: Rising head test results - Hvorslev (1951) analysis

Piezometer ID	Hydraulic Conductivity (m/s)
BH1	1.5×10^{-7}
BH7A	1.2×10^{-7}
BH9	0.6×10^{-7}

The tests yielded reasonably consistent values, with an average hydraulic conductivity of 1.1×10^{-7} m/s and a maximum of 1.5×10^{-7} m/s.

These assessed values are above the median values for Hawksbury Sandstone reported by Best and Parker (2004) [6] based on test results for over 900 packer tests, as shown in Figure 8. It can be assumed that one Lugeon is approximately equal to a hydraulic conductivity of 1×10^{-7} m/s

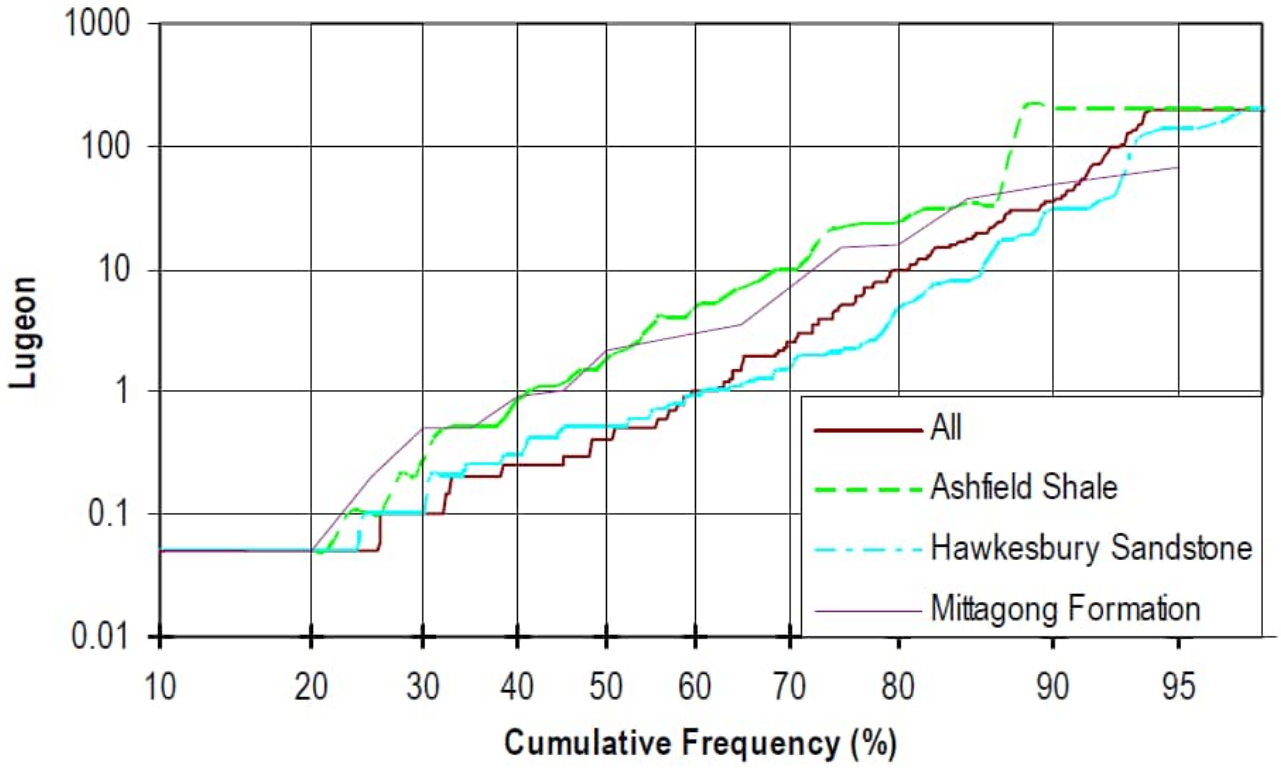


Figure 8: Cumulative permeability frequency based on packer testing in Sydney Sandstone (after Best and Parker, 2004)

The base of the excavation will be approximately 10 m below the top of the Hawkesbury Sandstone, and a hydraulic conductivity of 1.5×10^{-7} m/s is considered as reasonable to adopt for the underlying bedrock units for the purposes of inflow assessment.

4. GROUNDWATER INFLOW AND DRAWDOWN ASSESSMENT

4.1 BASIS OF ASSESSMENT

It is assumed that the basement levels for the development will be drained with groundwater inflows occurring from seepage through the bedrock. It is assumed that dewatering will be carried out for the permanent design life of the basement.

The assessment assumes a steady-state analysis.

4.1.1 Basement geometry

For the purpose of this inflow assessment the basement geometry can be summarised as follows:

- The basement can be described as a horseshoe shape, with a rectangular area in the southern portion of the site and two peninsula basement sections in the north. For modelling the inflow assessment, the basement structure is treated as a rectangular excavation with approximate dimensions of 72m x 144m in plan.
- The excavation is cut into the hillside with a bulk excavation level of between 54m and 55m AHD. For this analysis a consistent bulk excavation of 54m AHD has been assumed across the site.
- The ground surface is sloped such that the surface levels range from 55m AHD in the south to 74m AHD in the north.

4.1.2 Conceptual cross section

Figure 9 provides a simplified site plan of the proposed development. The site has been divided into a northern and southern area for the assessment. Two Sections have been selected for inflow analysis for each area. The sections are located in the deeper (in terms of excavation below groundwater table) half of each of the areas.

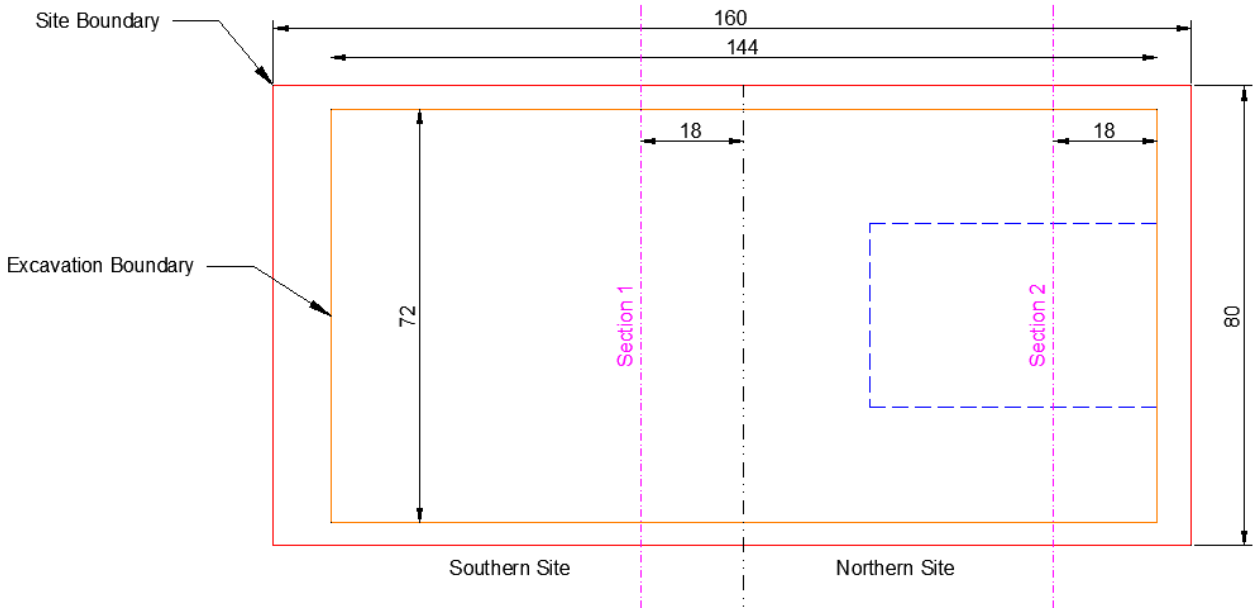


Figure 9: Plan view of assumed excavation

Figure 10 to Figure 12 below present conceptual cross sections of the site, showing the proposed excavation in relation to the current groundwater level and underlying bedrock (Hawksbury Sandstone/Ashfield Shale) aquifer.

The maximum drawdown to achieve dry conditions in the excavation is approximately 16.5 m in the northern part of the site, assuming groundwater to be at between 3.5 m and 4 m below ground in that area.

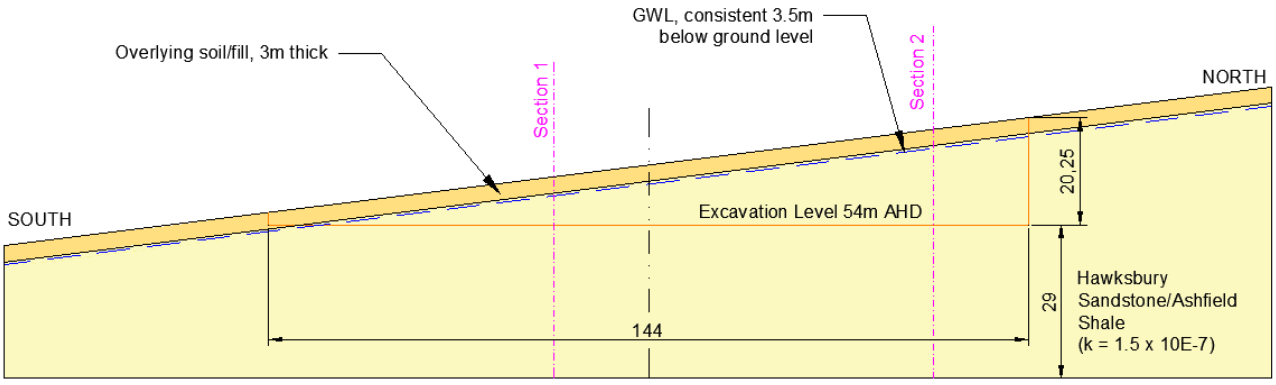


Figure 10: North-South elevation of conceptual model showing assumed groundwater level and rock properties

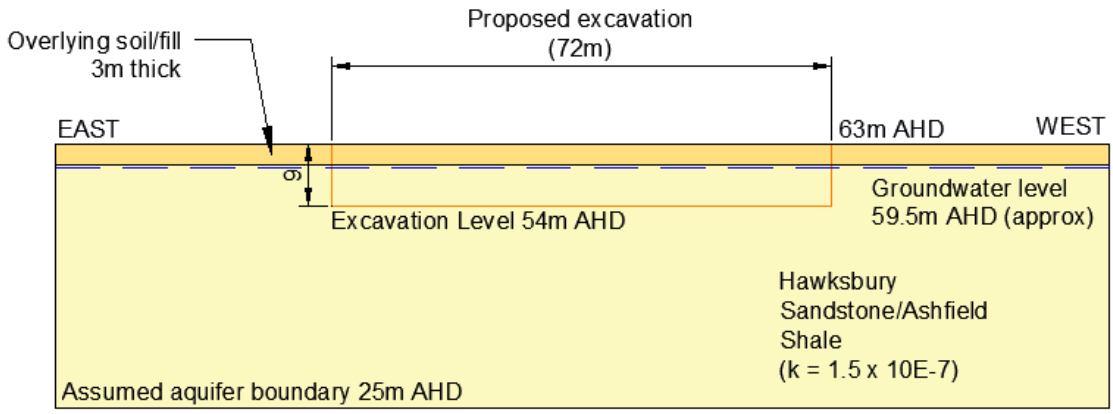


Figure 11: Section 1 of conceptual site model

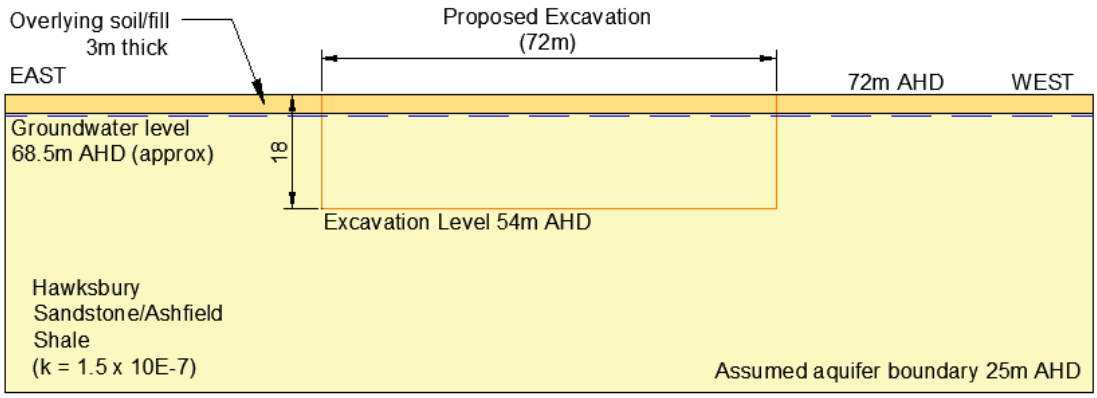


Figure 12: Section 2 of conceptual site model

4.1.3 Assessment method and boundary conditions

An estimation of steady state groundwater inflow rates to the proposed excavation was carried out using the proprietary software Geostudio SEEP/W R18 Version 9.

The following assumptions were adopted for the inflow assessment:

- The flow to the excavation is unconfined and predominantly in the horizontal section.
- The initial groundwater level is 59.5m AHD for Section 1 and 68.5m AHD for Section 2.
- The base of the aquifer is set at 25m AHD and defined as a no-flow boundary.
- The hydraulic conductivity of the bedrock is k = 1.5 x 10^{-7} m/s with a kv/kh ratio of 0.2.
- The excavation face is a seepage face which allows water to flow out of the model.
- An estimated rainfall infiltration rate 7.6 x 10^{-10} m/sec is applied to the ground surface. This is approximately equal to 2% of annual rainfall.
- An estimated zone of influence or distance to lateral fixed head boundaries of 275m from the edge of excavation has been adopted.
- Due to symmetry across the conceptual cross sections presented in Section 4.1.2, only half the excavation has been modelled.

4.2 ASSESSED INFLOWS

The results of the SEEP/W models are presented in Appendix C of this report. The results of the SEEP/W analysis provide an inflow of m^3/s per linear meter of excavation face of each section. To calculate the total inflow rate from the excavation, the inflow rates from the SEEP/W results need to be multiplied by the perimeter of each portion of the site.

Table 4 below summarises the estimated groundwater inflows for each section.

Table 4: Estimated groundwater inflows

	Groundwater inflow rate (m^3/s per m excavation perimeter)	Site perimeter (m)	Groundwater inflow rate Q (m^3/sec)	
			m^3/s	m^3/day
Southern part of site (Section 1)	1.8×10^{-7}	216	3.9×10^{-5}	3.4
Northern part of site (Section 2)	4.0×10^{-7}	216	8.6×10^{-5}	7.5
Total		432	12.5×10^{-5}	10.8

Based on the SEEP/W analysis, an inflow rate of 10.8 m^3/day (0.125 L/s) into the excavation was assessed. Considering the uncertainty in the predictions of inflow, we consider a reasonable estimate of inflows during construction to be between 5 and 20 m^3/day.

4.2.1 Total groundwater take

The estimated groundwater take during and following construction works from groundwater seeping through the excavation faces is between 2 ML and 8 ML a year, based on groundwater inflow rates of between 5 and 20 m^3/day.

An assessment of groundwater within excavated soil/rock has also been considered based on the following information:

- An excavated volume of rock below groundwater table of 58,800m^3 and;
- A rock porosity of 0.17.

For this excavation, it is expected that an additional approximately 10ML of groundwater take will be required during excavation.

The assessed groundwater inflow rates are for working conditions based on information available at the time of writing this report prior to excavation of the proposed basement. Unforeseen ground conditions may result in inflows different to those assessed here.

4.3 ASSESSED DRAWDOWNS

Figure 13 and Figure 14 presents the assessed groundwater drawdown versus distance from the excavation face based on the SEEP/W analysis for Sections 1 and 2. Table 5 summarises the estimated distances from excavation face for the 1m and 2m drawdown levels.

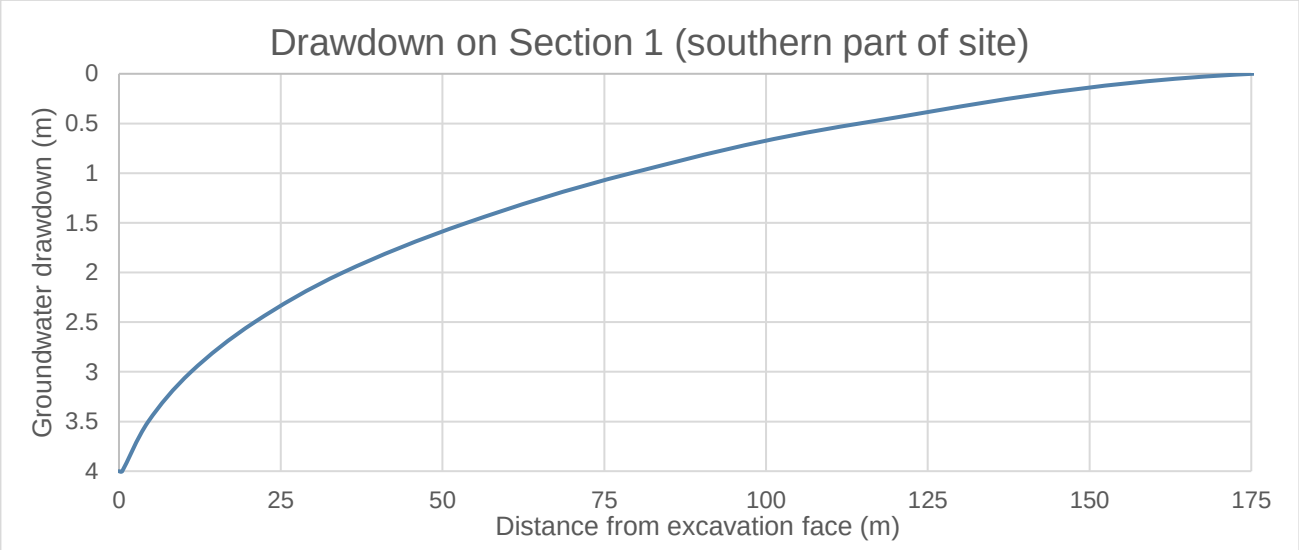


Figure 13: Drawdown curve for Section 1

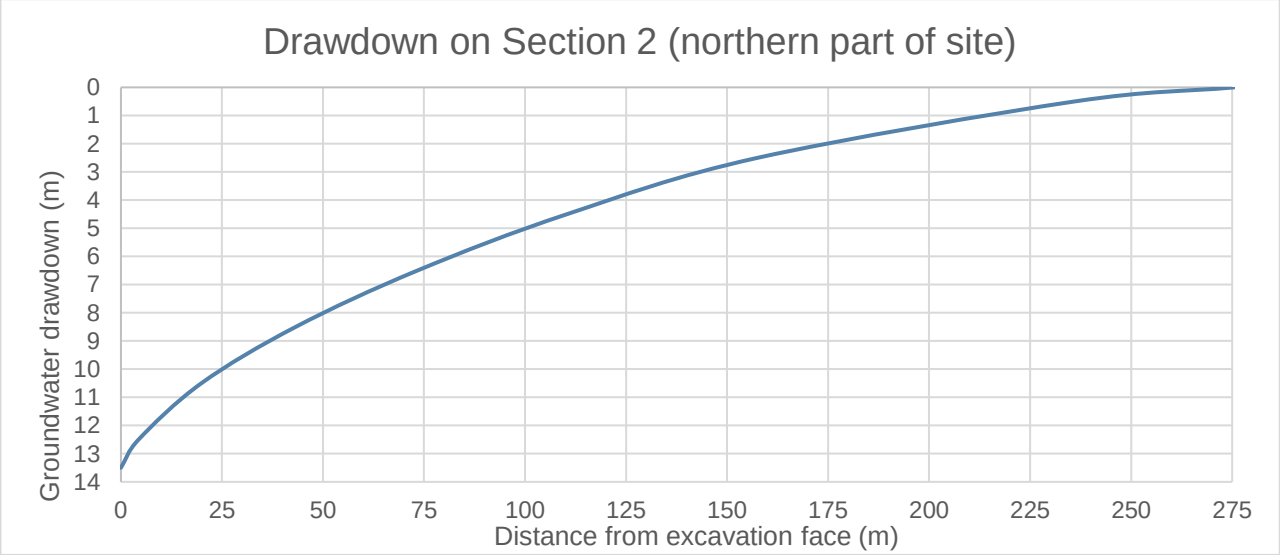


Figure 14: Drawdown curve for Section 2

Table 5: Summary of drawdown distances

	Distance from excavation face (m)	
	1m drawdown	2m drawdown
Section 1 - South	75	30
Section 2 - North	215	175

These assessed drawdowns are based on the analysis presented above and assumptions related to the zone of influence and rainfall infiltration. We consider the assessed drawdowns represent a reasonable assessment at the pre-construction stage of the site, noting that there is an unavoidable degree of uncertainty in predictions of drawdown prior to construction observations becoming available.

This assessment considers drawdown related to the site excavation and dewatering only. Should dewatering occur simultaneously at other locations, by other proponents, the effects may result in wider cumulative drawdowns.

5. RISK ASSESSMENT

5.1 EFFECTS ON NEARBY USERS

A search for nearby registered bores was made on 23 February 2023 using the Bureau of Meteorology Australian Groundwater Explorer database [7]. Based on the search results, no registered groundwater bores were found within 500m of the site. Registered bores outside this range are not expected to be influenced by drawdown effects from the proposed development.

Based on the assessed drawdowns shown in Figure 13 and Figure 14 the risk to nearby groundwater users is assessed to be negligible.

5.2 EFFECTS ON NEARBY GROUNDWATER DEPENDENT ECOSYSTEMS

The closest high priority groundwater dependent ecosystems (GDE) shown on the Bureau of Meteorology Groundwater Dependent Ecosystems Atlas [8] are the Coastal Sandstone Gulley Forest which is located approximately 2km to the south-west of the site and situated at a much lower elevation adjacent to the Woodford Bay area.

Due to the distance and elevation difference, the risk to this GDE is assessed to be negligible.

5.3 RISK OF INCREASED SALINITY

The closest saltwater source to the site is approximately 800 m away to the south at Gore Cove at an elevation of approximately 55 m below the base of the proposed excavation.

Based on the assessments presented in this report and the distance to the nearest saltwater source, the risk of saltwater intrusion into the aquifer as a result of the proposed development is considered to be negligible.

5.4 RISK OF INCREASED CONTAMINATION IN AQUIFERS

The development will act as a groundwater sink. A review of the preliminary contamination report prepared of the site by Tetra Tech Coffey (Ref. SYDGE304523, dated 19 July 2022) [9] indicates that there are no known sources of contamination within the site or in the surrounding area.

Therefore, the risk of increased contamination in aquifers is considered negligible.

5.5 SURFACE SETTLEMENT

A decrease in groundwater pressure in the soil due to drawdown results in an increase in effective stress, which may result in surface settlement due to compression of the soil. The magnitude of settlement depends on the soil/rock stiffness in one-dimensional compression E'_0, the magnitude of drawdown in groundwater levels, and the saturated thickness of the compressible layer. Table 6 (after Preene, Roberts and Powrie, 2016 [14]) shows the groundwater induced settlement for a 1 m drawdown in groundwater levels over a 1 m thick compressible layer.

Table 6: Groundwater induced settlement for a 1 m drawdown in groundwater levels over a 1 m thick compressible soil layer

The basic settlement is defined as the compression of a soil layer 1 m thick from an increase in vertical effective stress corresponding to a drawdown of 1 m. For a given situation, the total settlement in mm may be obtained by multiplying the basic settlement by the drawdown and the thickness of the soil layer (both in metres)

One-dimensional soil stiffness, E'_o (MPa)	1	5	10	15	20	25
Basic settlement (mm)	10.0	2.0	1.0	0.667	0.5	0.4
One-dimensional soil stiffness, E'_o (MPa)	40	50	75	100	150	200
Basic settlement (mm)	0.25	0.20	0.133	0.10	0.067	0.05

Considering there is expected to be approximately 3m of soil-like material across the site, and groundwater levels are generally at 3.5m or deeper below surface level, drawdown of the groundwater table is not expected to cause settlement of the overlying soil. In addition the underlying weathered rock material typically has a one-dimensional stiffness of over 1 Gpa (not shown in Table 6).

If we assume a drawdown of 10 m, a saturated thickness of 44m (refer to Figure 12), and a one-dimensional soil stiffness of 1 GPa for sandstone bedrock, then the assessed groundwater induced surface settlement is less than 10 mm.

Based on this assessment, the potential for adverse groundwater drawdown induced surface settlement outside the site due to the construction dewatering is assessed to be low.

5.6 MINIMAL IMPACT ASSESSMENT

According to the NSW Aquifer Interference Policy [10] the fractured rock groundwater source from which the site will be extracting water for the purposes of construction dewatering is classed as ‘less productive’ considering it does not contain water supply works that can yield water at a rate greater than 5 L/sec. Table 7 presents a ‘Minimal Impact Consideration’ for Aquifer Interference Activities for porous and fractured rock water sources following the NSW Aquifer Interference Policy [10]. Based on this we conclude that the development is a low risk for groundwater impacts.

Table 7: Minimal impact consideration – Less Productive – Porous and fractured rock water sources

Consideration	Response
WATER TABLE 1. Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan"(2) variations, 40m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan; or A maximum of a 2m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies(5) will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2m decline cumulatively at any water supply work then make good provisions should apply.	Refer to Section 5.2: Negligible water level decline is predicted within 40 m of any high priority groundwater dependent ecosystem. There is not known to be a high priority culturally significant site within 40 m from the site Refer to Section 5.1: No registered bores with the listed purpose of water supply are located within the predicted 2 m drawdown contour around the site.
WATER PRESSURE 1. A cumulative pressure head decline of not more than 2m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1. above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	Refer to Section 5.1: No registered bores with the listed purpose of water supply are located within the predicted 2 m drawdown contour around the site.
WATER QUALITY 1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 2. If condition 1. is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.	Refer to Section 5.4: The development will act as a groundwater sink, and injection/recharge of water to the groundwater system is not proposed. Therefore the risk of increased contamination in aquifers is considered negligible. Refer to Section 5.3: The closest salt water source to the site is over 1.0km away at a much lower elevation (Greenwich Bay) Based on the assessments presented in this report and the distance to the nearest salt water source, the risk of salt water intrusion into the aquifer as a result of the proposed development is considered to be negligible.

6. GROUNDWATER CHEMISTRY AND DISCHARGE

Groundwater samples were collected from two site piezometers (BH1 and BH9) along with a duplicate sample of BH9 for QA purposes on 21 February 2023 and were sent to the NATA accredited laboratory ALS for the following analyses:

- pH
- Electrical conductivity (EC);
- Total dissolved solids (TDS);
- Suspended Solids
- Dissolved metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc;

- Total Organic Carbon (TOC)
- Anions (chloride, sulfate) and cations (calcium, magnesium, potassium and sodium);
- Total Nitrogen including NO_2, NO_3, NH_3;
- Hydrocarbons (total recoverable hydrocarbons (TRH) and Polycyclic Aromatic Hydrocarbons).

The laboratory results and summary table are presented in Appendix D.

Based on stormwater catchment mapping provided by Sydney Water [11] stormwater from the site would drain to the south-east entering Berry Creek through a series of stormwater pipes and culverts which flows to the Gore Cove reserve wetland. As a result, groundwater released from the site to the stormwater system intersect estuary and marine habitat which may impact the marine water quality along the river.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) have been published as an interactive website [12]. The groundwater chemistry laboratory test results were evaluated against the ANZG 2018 default guideline values (DGVs) for protection of 95% of species within a marine receiving environment. The results of this are summarised below:

- Laboratory pH measurements indicated that the groundwater collected was acidic with a pH ranging from 4.9 to 5.5, a similar pH to slightly acidic rain.
- Laboratory EC ranged from 370 µS/cm to 590 µS/cm and TDS results ranged from 264 mg/L to 430 mg/L.
- Hydrocarbons including TRH, BTEX and PAHs were below laboratory detection limits at all samples.
- Concentrations of two metals (copper and zinc) exceeded the ANZG 2018 DGVs.

The reported metal concentrations are reflective of the regional urban groundwater quality in the area.

With reference to the laboratory test results and expected point of stormwater discharge from the site, it is considered that only routine groundwater treatment measures such as pH adjustment and sediment reduction will be necessary prior to groundwater being released directly to the stormwater system.

7. DEWATERING AND MONITORING METHODOLOGY

7.1 DEWATERING METHODOLOGY

Temporary groundwater containment during construction is required for the excavation works. Considering the size of the site, it is expected that a system of sump pits would be used to contain and direct collected groundwater from the site to temporary detention basins within the southern portion of the site during the excavation process. These basins would allow for storage of the collected groundwater with an aggregate capacity equal to the assessed inflow rate plus adequate redundancy to allow for settlement and treatment prior to discharge.

Temporary and permanent excavation support will be required for the excavation. The excavation support designs are currently in development and beyond the scope of this hydrogeological report.

7.2 TREATMENT OF DISCHARGED WATER

The quality of the groundwater prior to discharge to the stormwater network shall conform to the Protection of the Environment Operations Act 1997 (POEO Act) and ANZG (2018) guidelines.

Based on the identified groundwater quality presented in Appendix D, the groundwater may require treatment to increase pH levels and reduce turbidity prior to discharge. The following possible treatment measures are suggested, and should be installed and operational prior to the commencement of any excavation:

A groundwater filtration and pH buffering treatment system, which could comprise:

- A baffled treatment tank;
- Automated in-line chemical dosing systems for the addition of buffering solutions and coagulants;
- A flow metre to record extraction volumes and total flows;
- Emergency response alarms for non-routine situations; and
- A sedimentation tank to provide additional residence time and sedimentation.

Pumping to the stormwater system will be subject to the approval of the relevant authority, either Council or Sydney Water depending on the stormwater pits used.

8. MONITORING AND REPORTING REQUIREMENTS

8.1 VOLUME

The volume of water removed from site must be recorded daily using calibrated flow meters or records from appropriate waste disposal contractors. This information is to be recorded either in hard copy or in electronic format.

8.2 QUALITY

The discharge water must be tested onsite for pH and Turbidity (NTU) using a handheld or other testing meter prior to release into the stormwater system. This information is to be recorded either in hard copy or in electronic format.

At monthly intervals during construction, a sample of discharge water should be sampled and sent for testing at a NATA registered laboratory for the following:

- Turbidity
- Total suspended solids;
- Total dissolved solids;
- Metals: arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc;
- Total recoverable hydrocarbons;
- Benzene, toluene, ethylbenzene, xylene.

8.3 GROUNDWATER LEVELS

It is anticipated that any groundwater wells that have been installed or will be installed within the basement plan area are likely to be removed during the excavation process. Currently this only comprises BH5, however BH1, BH3 and BH7A may be affected and removed as part of the basement excavation process. BH9 which is installed outside of the site compound is expected to still be accessible for monitoring.

It is recommended that at least 2 additional groundwater wells are installed particularly within the northern portion of the site to understand the groundwater levels in this area. If there is insufficient space to install additional wells within the site boundary and outside of the excavation zone, these wells should be installed to the north of the proposed development, likely placed within the Council roadway or parking bays to allow for assessment of groundwater level upstream of the development site.

Continuous water level monitoring of installed wells could be completed using electronic data loggers installed in these boreholes. If electronic data loggers are not used, water levels at these bores must be manually measured at a minimum of once per month during construction.

8.4 REPORTING

During construction, a groundwater monitoring report should be prepared every three months by an experienced hydrogeologist providing factual data on the recorded inflow volumes, quality of discharged water, and groundwater levels at monitoring piezometers. The monitoring report must also comment on a comparison of observations versus the predictions in this report, in particular highlighting, where applicable:

- Whether observed groundwater discharge volumes are exceeding the predictions in this report
- Any increase in risk to existing groundwater users due to higher-than-expected drawdowns

9. CONCLUDING REMARKS

Based on our site observations, the site hydrogeological model and experience on similar projects, it is considered that a drained basement for the proposed development is feasible and presents a low risk to the groundwater system, provided that appropriate monitoring of groundwater discharge volumes and groundwater levels is carried out during construction.

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

10. REFERENCES

[1] Coffey Services Australia Pty Ltd, (2018) “Country Garden Australia - St Leonards Development - Geotechnical Assessment Report (SYDGE219558-GET-RPT-02),” Sydney, 19 October 2018.

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IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY REPORT

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

Your report is based on project specific criteria

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

Subsurface conditions can change

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

Interpretation of factual data

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

Your report will only give preliminary recommendations

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

Your report is prepared for specific purposes and persons

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

Interpretation by other design professionals

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

Data should not be separated from the report

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

Geoenvironmental concerns are not at issue

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

Rely on Tetra Tech Coffey for additional assistance

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

Responsibility

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

APPENDIX A: BOREHOLE LOGS

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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BH1 1.75 - 6.00 m

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

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client:	Country Garden Australia Pty Ltd
project:	St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH1**
project no: 754-SYDGE219558	fig no: **FIGURE 1** rev:

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BH1 6.00 - 10.02 m

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

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client:	Country Garden Australia Pty Ltd
project:	St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH1**
project no: 754-SYDGE219558	fig no: **FIGURE 2** rev:

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Piezometer Installation Log

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

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

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

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

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

AD/T

NMLC

N

04/09/18

66 | 64 | 62 | 60 | 58 | 56

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

TOPSOIL

FILL

RESIDUAL SOIL

HAWKESBURY SANDSTONE

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

BH1

Grout

Bentonite

Sand

3.00 m

3.50 m

4.02 m

10.02 m

method & support
see engineering log for details

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

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

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

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

consistency / relative density

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

coffey
A TETRA TECH COMPANY

Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating



BH2 3.00 - 8.00 m

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

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

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BH2 8.00 - 10.11 m

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

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client: Country Garden Australia Pty Ltd

project: St Leonards Development
St Leonards

title: **CORE PHOTOGRAPH**
BH2

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

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Engineering Log - Borehole

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

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

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

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating



BH3 1.90 - 6.00 m

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

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

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BH3 6.00 - 10.08 m

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

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

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Piezometer Installation Log

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

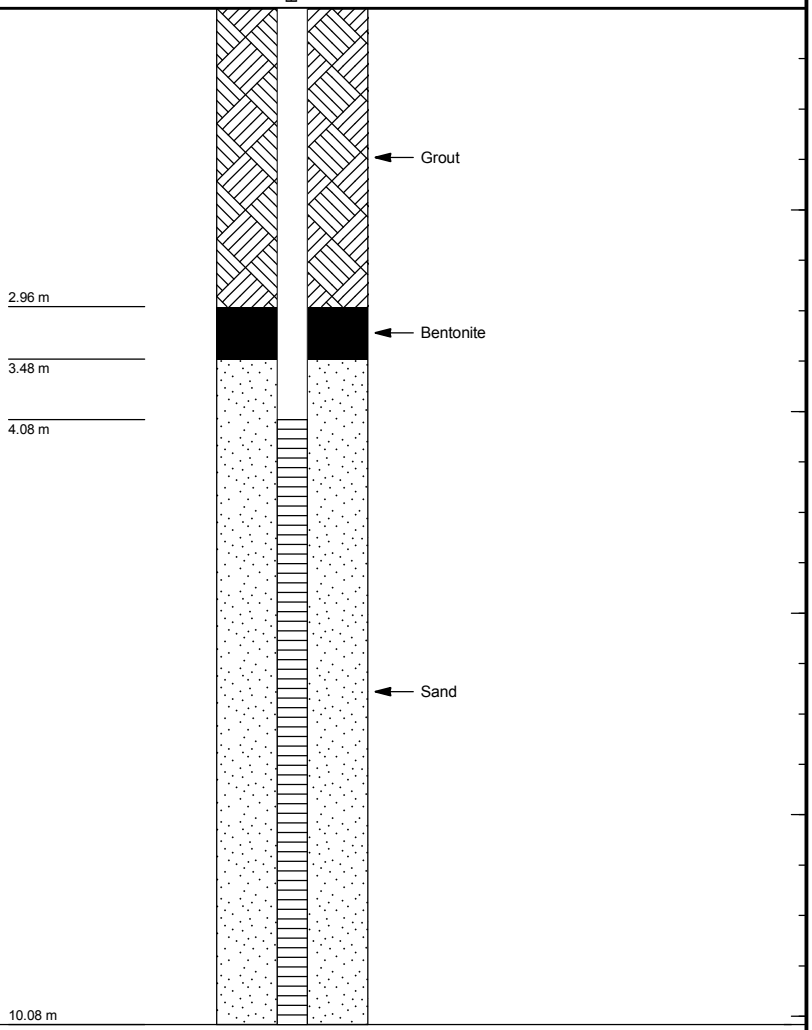
position: E: 332,663.83; N: 6,255,579.14 (MGA94) | surface elevation: 66.20 m (AHD) | angle from horizontal: 90°

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

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

method & support	water	RL (m)	depth (m)	graphic log	material name
HA		66	0		
			1		**FILL**
AD/T					**RESIDUAL SOIL**
		64	2		**HAWKESBURY SANDSTONE**
	04/09/18		3		
		62	4		
			5		
NMLC		60	6		
			7		
		58	8		
			9		
			10		
		56	11		

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



method & support
see engineering log for details

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

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

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

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

consistency / relative density

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

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Engineering Log - Cored Borehole

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

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

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

drilling information				material substance						rock mass defects		
method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general

63

62 — 1.0

61 — 2.0

started coring at 2.87m

NMLC

60 — 3.0

NO CORE: 0.13 m

SANDSTONE: fine to medium grained, orange-brown, (Class IV to V).

HW

a=0.92
d=0.88

a=0.83
d=0.84

Very low strength zone

PT, 0°, PL, RO, CN

SM, Clay, 58 mm

MW

59 — 4.0

PT, 8°, PL, RO, CN

SANDSTONE: fine to coarse grained, red-brown, distinctly bedded at 15-30° (Class IV).

a=0.98
d=0.68

83%

PT, 20°, PL, RO, CN

SM, Sandy clay, 11 mm

58 — 5.0

a=1.37
d=1.35

57 — 6.0

SANDSTONE: medium to coarse grained, pale grey, distinctly cross bedded at 5-25° (Class II).

FR

a=1.35
d=0.81
a=0.99
d=0.46
a=1.39
d=0.80
a=0.70
d=0.36

JT, 8°, PL, RO, CN

96%

56 — 7.0

a=0.87
d=0.40

PT, 10°, PL, RO, CN

JT, 8°, UN, RO, CN

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

coffey
A TETRA TECH COMPANY

Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

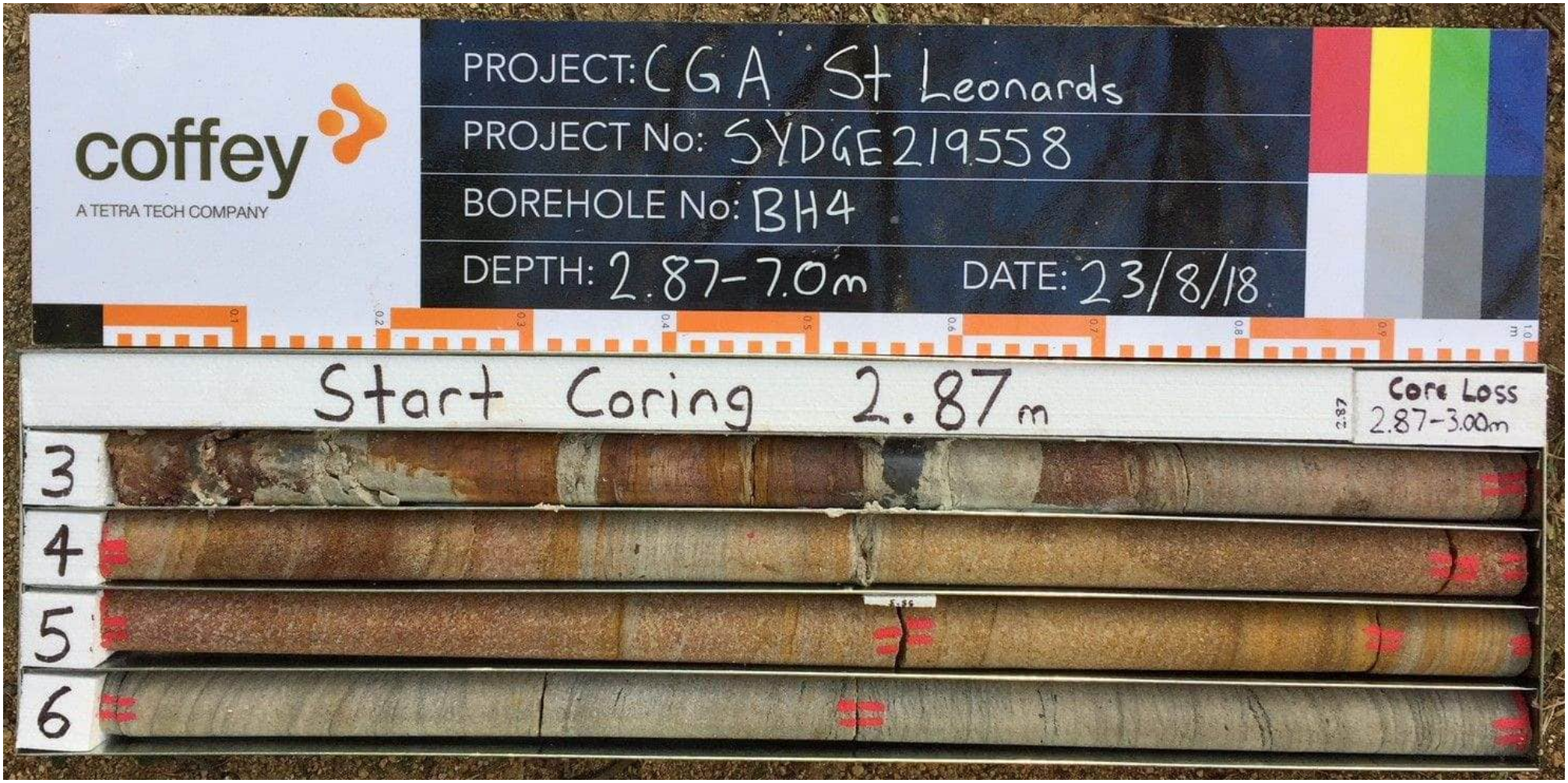
defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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BH4 2.87 - 7.00 m

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

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

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BH4 7.00 - 10.42 m

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

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

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

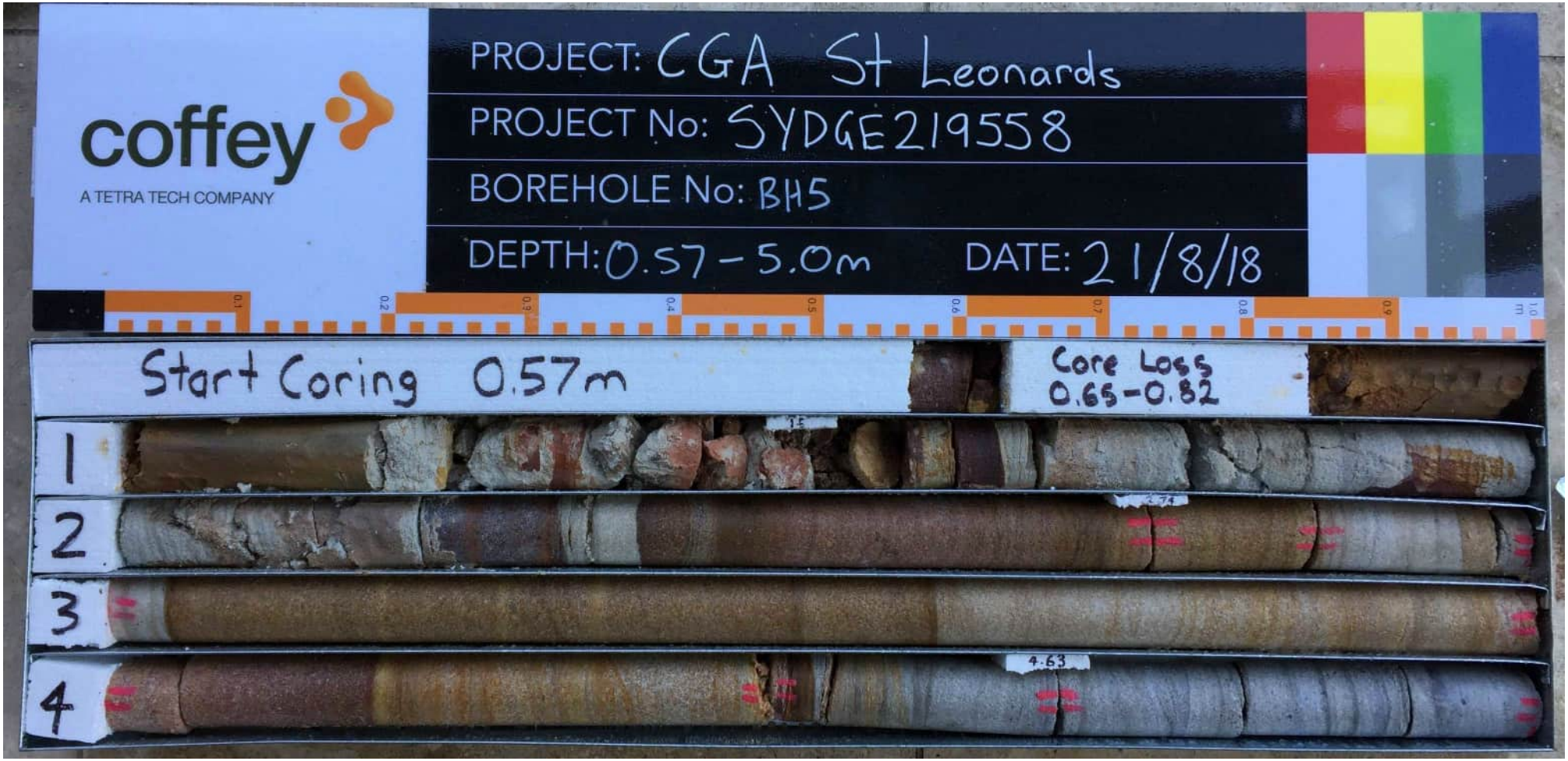
defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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BH5 0.57 - 5.00 m

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

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

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BH5 5.00 - 10.00 m

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

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

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Piezometer Installation Log

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

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

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

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

method & support: HA, CASING, NMLC

water: 27/08/18, 04/09/18

RL (m): 60, 58, 56, 54, 52, 50

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

graphic log

material name

- **FILL** — 0.30 m
- **RESIDUAL SOIL** — 0.60 m
- **HAWKESBURY SANDSTONE** — 1.00 m

10.00 m

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

BH5

Grout

Bentonite

Sand

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method & support
see engineering log for details

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

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

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

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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BH6 1.00 - 6.00 m

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

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client: Country Garden Australia PTY LTD

project: Country Garden St Leonards Development
St Leonards

title: **CORE PHOTOGRAPH**
BH6

project no:	fig no:	rev:
754-SYDGE219558		

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BH6 6.00 - 10.07 m

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

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

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

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

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

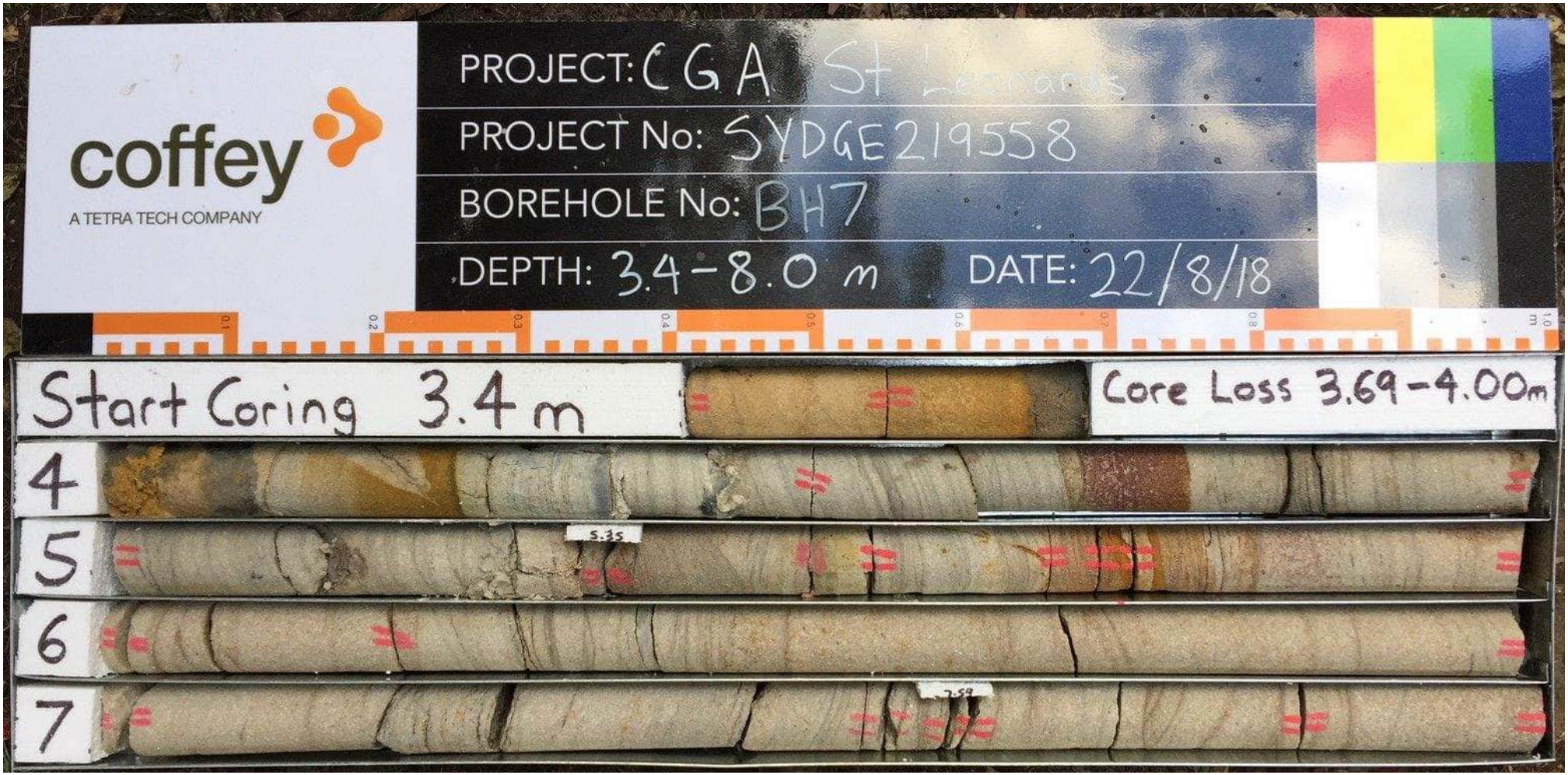
defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

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BH7A 3.40 - 8.00 m

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

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

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BH7A 8.00 - 10.26 m

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

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

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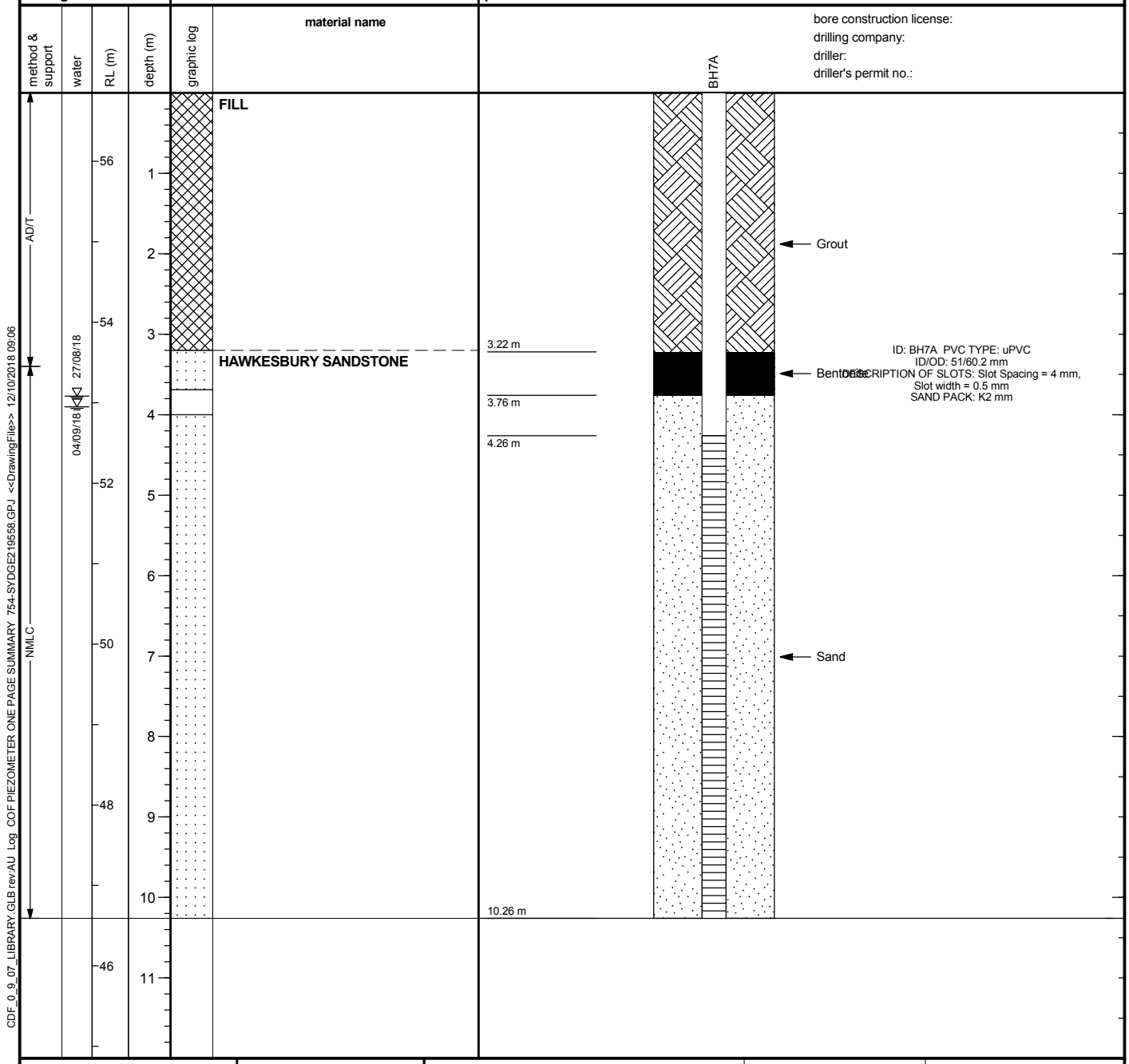
Piezometer Installation Log

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

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

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

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



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method & support
see engineering log for details

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

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

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

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Engineering Log - Borehole

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

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

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

drilling information | **material substance**

method & support	penetration (1 2 3)	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description (**SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components)	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA AD/T CASING								**BRICK PAVERS**.	D			**PAVEMENT**
								FILL: SAND: pale brown.				**FILL**
								FILL: SAND: dark brown, with coarse gravels.				
				54	1.0			**CLAY**: low plasticity, orange-brown, with fine grained sand.	<Wp	St		**RESIDUAL SOIL**
								Borehole BH8 continued as cored hole				
				53	2.0							
				52	3.0							
				51	4.0							
				50	5.0							
				49	6.0							
				48	7.0							
				47								

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

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

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

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

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

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

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

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

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Engineering Log - Cored Borehole

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

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

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

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

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

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

coating
CN clean
SN stained
VN veneer
CO coating

coffey
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Engineering Log - Cored Borehole

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

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

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

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

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

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

support
C casing M mud N none

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

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

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

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

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating



BH8 1.33 - 6.00 m

drawn	
approved	
date	**22-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH8**
project no:	754-SYDGE219558
fig no:	**FIGURE 1**
rev:	

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BH8 6.00 - 10.00 m

drawn	
approved	
date	**22-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH8**
project no:	754-SYDGE219558
fig no:	**FIGURE 2**
rev:	

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Engineering Log - Borehole

Borehole ID.	***BH9***
sheet:	1 of 3
project no.	***754-SYDGE219558***
client:	***Country Garden Australia Pty Ltd***
date started:	***20 Aug 2018***
principal:	
date completed:	***20 Aug 2018***
project:	***St Leonards Development***
logged by:	***AM***
location:	***St Leonards, NSW***
checked by:	***AB***

position: E: 332,666.75; N: 6,255,516.48 (MGA94) | surface elevation: 60.16 m (AHD) | angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information						material substance						
method & support	penetration 1 2 3	water	samples & field tests	RL (m)	depth (m)	graphic log	soil group symbol	material description **SOIL NAME**: plasticity or particle characteristic, colour, secondary and minor components	moisture condition	consistency / relative density	hand penetrometer (kPa) 100 200 300 400	structure and additional observations
HA AD/T — CASING			E	60				**TOPSOIL: SILTY SAND**: pale yellow brown.	D			**TOPSOIL** PID: 3.5 ppm
								SANDSTONE: orange brown, recovered as low strength clayey sand.	M			**HAWKESBURY SANDSTONE**
			SPT 2, 8, /100mm HB N*=R	59	1.0			Borehole BH9 continued as cored hole				
				58	2.0							
				57	3.0							
				56	4.0							
				55	5.0							
				54	6.0							
				53	7.0							

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method
- AD auger drilling*
- AS auger screwing*
- HA hand auger
- W washbore
- HA hand auger

* bit shown by suffix
e.g. AD/T
- B blank bit
- T TC bit
- V V bit

support
- M mud
- C casing
- N nil

penetration
1 2 3 — no resistance ranging to refusal

water
- 10-Oct-12 water level on date shown
- water inflow
- water outflow

samples & field tests
- B bulk disturbed sample
- D disturbed sample
- E environmental sample
- SS split spoon sample
- U## undisturbed sample ##mm diameter
- HP hand penetrometer (kPa)
- N standard penetration test (SPT)
- N* SPT - sample recovered
- Nc SPT with solid cone
- VS vane shear; peak/remouded (kPa)
- R refusal
- HB hammer bouncing

soil group symbol & soil description
based on AS 1726:2017

moisture condition
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl liquid limit

consistency / relative density

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

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Engineering Log - Cored Borehole

Borehole ID.	**BH9**
sheet:	2 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**20 Aug 2018**
principal:	
date completed:	**20 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,666.75; N: 6,255,516.48 (MGA94) surface elevation: 60.16 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
		60									
			1.0		started coring at 1.10m						
NMLC		59			**SANDSTONE**: medium to coarse grained, orange brown to dark red-brown, indistinctly bedded at 20-25° (Class V).	MW HW		a=1.72 d=1.90			JT, 5°, CU, RO, CN
			2.0			MW		a=0.44 d=0.44	76%		PT, 25°, PL, RO, CN JT, 2°, PL, RO, CN
		58			**NO CORE:** 0.25 m						
					SANDSTONE: medium to coarse grained, pale grey, indistinctly to distinctly cross bedded at 0-20° (Class V).	XW					Root Jacking, IR, roots Root Jacking, IR, roots JT, 5°, UN, RO, CN
			3.0		**NO CORE:** 0.24 m						
		57			**SANDSTONE**: medium to coarse grained, pale grey, indistinctly to distinctly cross bedded at 0-20° (Class II).	XW FR		a=0.54 d=0.51			SM, Clayey sand, roots PT, 8°, PL, RO, CN
			4.0								PT, 20°, PL, RO, CN
		56						a=0.80 d=0.44	77%		PT, 15°, PL, RO, CN PT, 3°, PL, RO, CN
	27/08/18		5.0								PT, 10°, PL, RO, CN
	04/09/18	55			5.45 m: orange brown to pale grey	SW					PT, 20°, PL, RO, CN PT, 20°, PL, RO, CN JT, 5°, ST, RO, CN PT, 18°, PL, RO, CN
			6.0		**NO CORE:** 0.35 m			a=0.36 d=0.21			
		54			**SANDSTONE**: as previous.	SW					JT
					SANDSTONE: medium to coarse grained, pale grey, massive (Class II).			a=0.25 d=0.26	79%		
			7.0								JT, 0°, PL, RO, CN JT, 0°, PL, RO, CN
		53						a=0.79 d=0.77			JT, 0°, PL, RO, CN
											PT, 2°, PL, RO, CN

Defects are: JT, 0 - 2°, PL, RO, CN, unless otherwise described

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method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

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Engineering Log - Cored Borehole

Borehole ID.	**BH9**
sheet:	3 of 3
project no.	**754-SYDGE219558**
client:	**Country Garden Australia Pty Ltd**
date started:	**20 Aug 2018**
principal:	
date completed:	**20 Aug 2018**
project:	**St Leonards Development**
logged by:	**AM**
location:	**St Leonards, NSW**
checked by:	**AB**

position: E: 332,666.75; N: 6,255,516.48 (MGA94) surface elevation: 60.16 m (AHD) angle from horizontal: 90°

drill model: Geoprobe 7822dt, Track mounted drilling fluid: Water hole diameter : 125 mm

drilling information | **material substance** | **rock mass defects**

method & support	water	RL (m)	depth (m)	graphic log	material description **ROCK TYPE**: grain characterisics, colour, structure, minor components	weathering & alteration	estimated strength & Is50 (X = axial; O = diametral) VL L M H VH EH	samples, field tests & Is(50) (MPa) a = axial; d = diametral	core run & RQD	defect spacing (mm) 30 100 300 1000 3000	additional observations and defect descriptions (type, inclination, planarity, roughness, coating, thickness, other) particular / general
NMLC		52			**SANDSTONE**: fine to medium grained, pale grey, distinctly bedded at 0-10° (Class II), carbonaceous laminae. *(continued)*	FR		a=0.57 d=0.75	98% 98%		SM, Clay, 8 mm
		51	9.0		**SANDSTONE**: fine to coarse grained, pale grey, massive (Class II).			a=1.26 d=0.99	100%		
		50	10.0					a=0.93 d=0.91			JT, 8°, ST, RO, CN JT, 25°, ST, RO, CN
					10.41 m: dark grey laminations Borehole BH9 terminated at 10.48 m Target depth						
		49	11.0								
		48	12.0								
		47	13.0								
		46	14.0								
		45	15.0								

method & support
AS auger screwing
AD auger drilling
CB claw or blade bit
W washbore
RR rock roller
NMLC NMLC core (51.9 mm)
NQ wireline core (47.6mm)
HQ wireline core (63.5mm)
PQ wireline core (85.0mm)
HA hand auger

support
C casing M mud N none

water
10/10/12, water level on date shown
water inflow
complete drilling fluid loss
partial drilling fluid loss
25uL water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
core recovered (graphic symbols indicate material)
no core recovered

core run & RQD
barrel withdrawn
RQD = Rock Quality Designation (%)

weathering & alteration*
RS residual soil
XW extremely weathered
HW highly weathered
MW moderately weathered
SW slightly weathered
FR fresh
*W replaced with A for alteration

strength
VL very low
L low
M medium
H high
VH very high
EH extremely high

defect type
PT parting
JT joint
SS shear surface
SZ shear zone
CO contact
CS crushed seam
SM seam

planarity
PL planar
CU curved
UN undulating
ST stepped
IR Irregular

roughness
VR very rough
RO rough
SO smooth
POL polished
SL slickensided

coating
CN clean
SN stained
VN veneer
CO coating

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BH9 1.18 - 6.00 m

drawn	
approved	
date	**27-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH9**
project no:	754-SYDGE219558
fig no:	
rev:	

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BH9 6.00 - 10.48 m

drawn	
approved	
date	**27-08-2018**
scale	**N.T.S.**
original size	**A4**

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client:	Country Garden Australia PTY LTD
project:	Country Garden St Leonards Development St Leonards
title:	**CORE PHOTOGRAPH** **BH9**
project no:	754-SYDGE219558
fig no:	
rev:	

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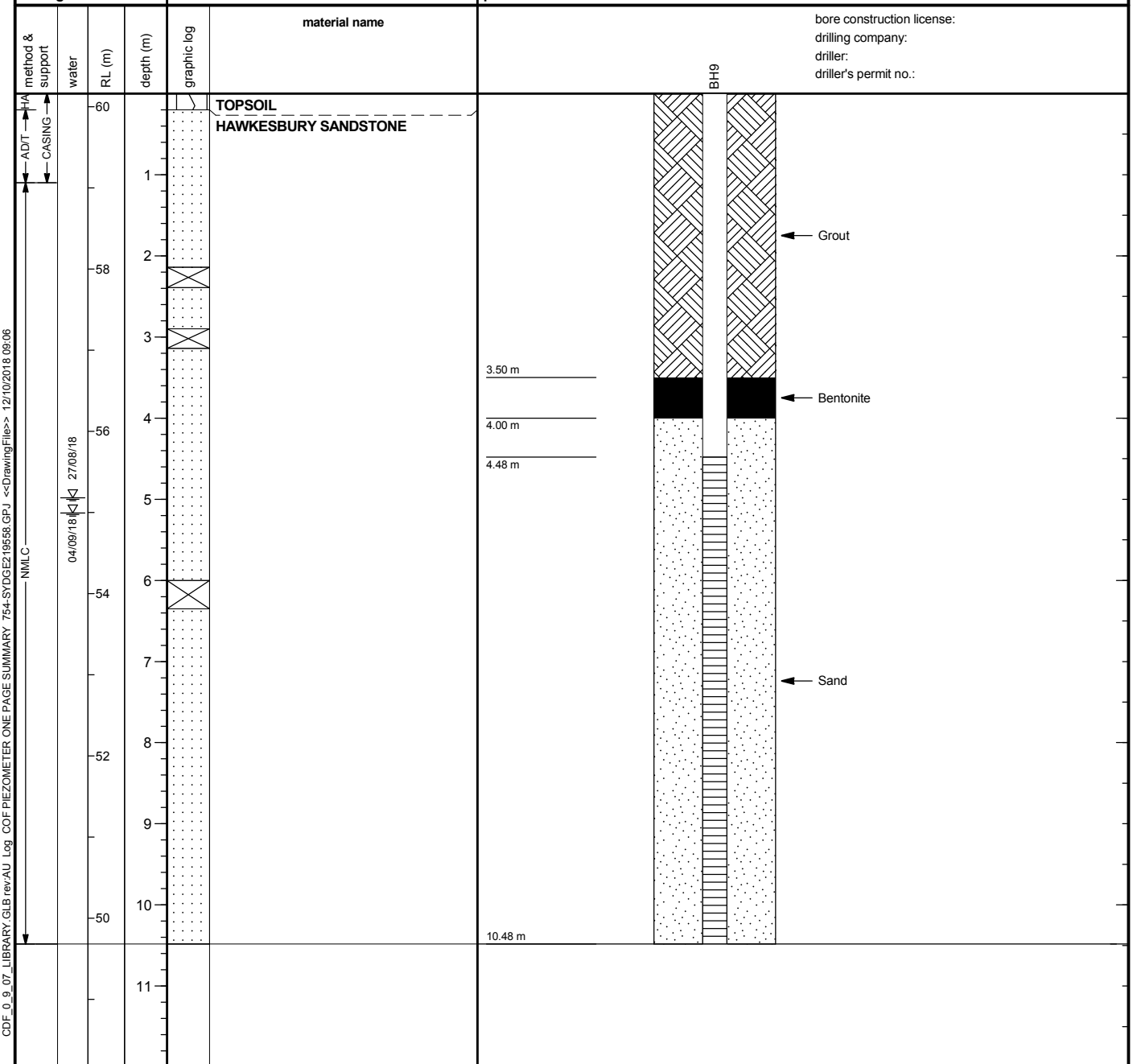
Piezometer Installation Log

Hole ID.	***BH9***
sheet:	1 of 1
project no.	***754-SYDGE219558***
client: ***Country Garden Australia Pty Ltd***	date started: ***20 Aug 2018***
principal:	date completed: ***20 Aug 2018***
project: ***St Leonards Development***	logged by: ***AM***
location: ***St Leonards, NSW***	checked by: ***AB***

position: E: 332,666.75; N: 6,255,516.48 (MGA94) | surface elevation: 60.16 m (AHD) | angle from horizontal: 90°

equipment type: Geoprobe 7822dt, Track mounted | drilling fluid: Water | hole diameter : 125 mm

drilling information | **material substance** | **piezometer construction details**



method & support
see engineering log for details

water
- 10-Oct-12, water level on date shown
- water inflow
- complete drilling fluid loss
- partial drilling fluid loss
- 25 water pressure test result (lugeons) for depth interval shown

graphic log / core recovery
- core recovered (graphic symbols indicate material)
- no core recovered

ID	type	installation date	stickup (m)	tip depth (m)	water level (m)	Relative Levels (AHD) stickup	tip	water level
BH9	standpipe			10.48 m			49.68	

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APPENDIX B: RISING HEAD TEST DATA

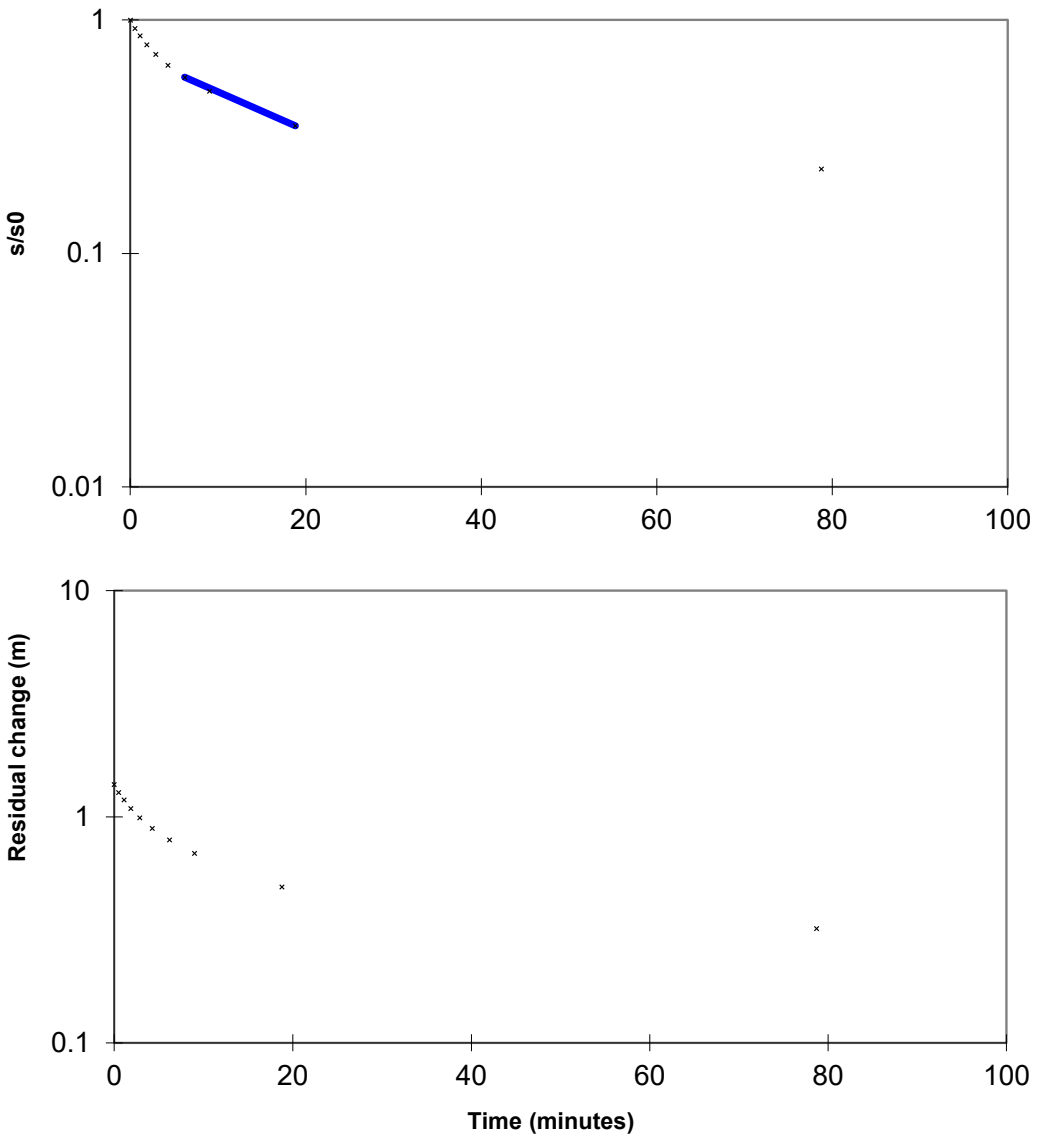
RISING OR FALLING HEAD TEST ANALYSIS

Bore Data	Units	Value
Initial groundwater level	m	3.81
Groundwater level at t=0	m	5.20
Casing radius (r)	m	0.025
Bore radius (R)	m	0.05
Screened interval length (L)	m	6
Match time start	min	5
Match time end	min	15
Characteristic Time (t_0)	**min**	**26.93**
Hydraulic Conductivity (K)	**m/day**	**0.01333**

Piezometer: BH1

Method Developed by Hvorslev (1951)

$$K = \frac{r^2 \ln(L/R)}{2Lt_0}$$



Reference: Hvorslev, M.J. (1951), Time lag and soil permeability in ground water observations. U.S. Army Corps of Engineers Waterway Experimentation Station, Bulletin 36.

drawn	BS	TETRA TECH COFFEY	client:	JQZ
approved	AO		project:	Park Road St Leonards
date	21 Feb 2023		title:	RISING HEAD TEST - BH1
scale	AS SHOWN		project no:	754-SYDGE304523-1
original size	A4			

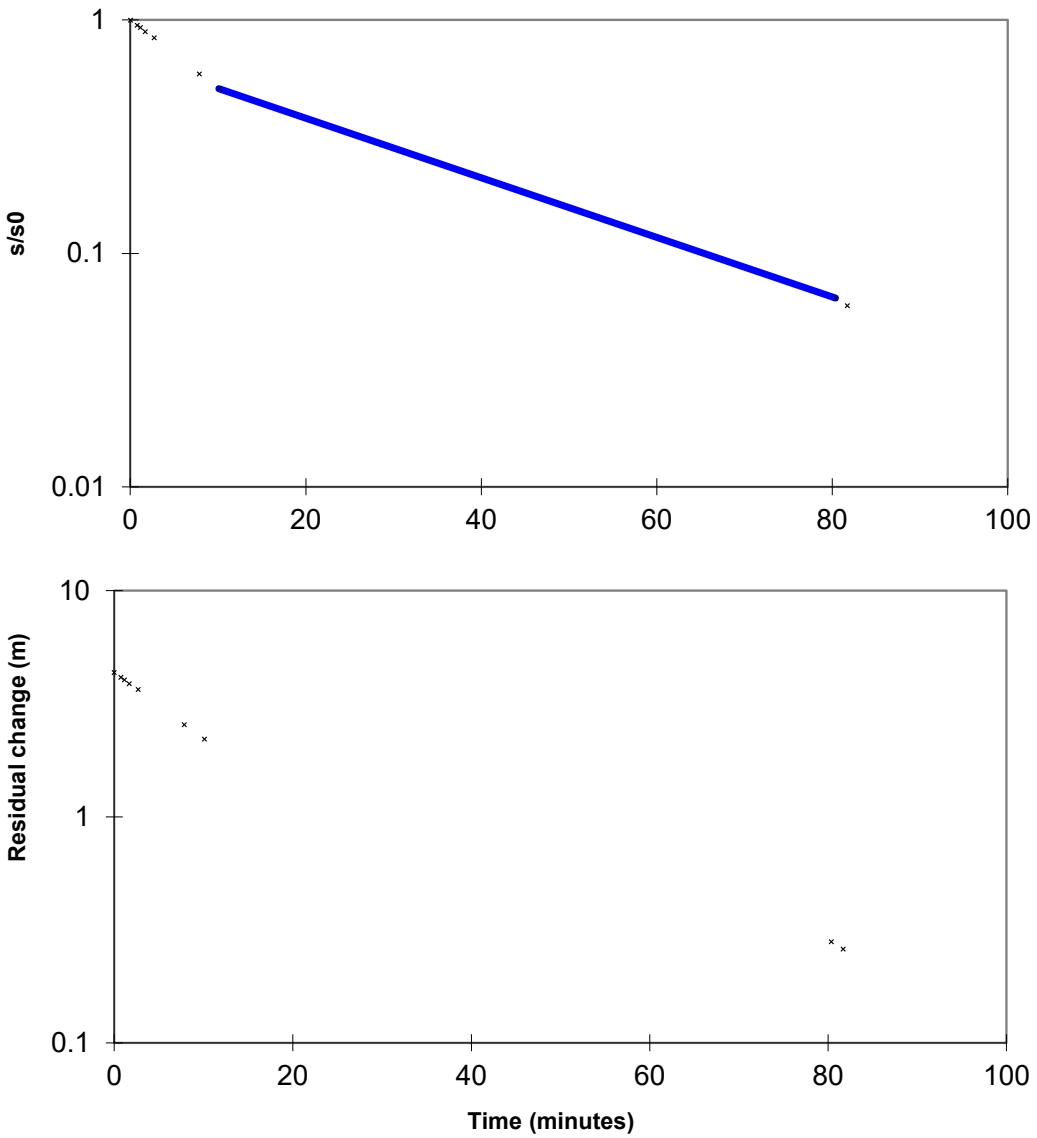
RISING OR FALLING HEAD TEST ANALYSIS

Bore Data	Units	Value
Initial groundwater level	m	3.34
Groundwater level at t=0	m	7.69
Casing radius (r)	m	0.025
Bore radius (R)	m	0.05
Screened interval length (L)	m	6
Match time start	min	10
Match time end	min	80
Characteristic Time (t_0)	**min**	**34.00**
Hydraulic Conductivity (K)	**m/day**	**0.01056**

Piezometer: BH7A

Method Developed by Hvorslev (1951)

$$K = \frac{r^2 \ln(L/R)}{2Lt_0}$$



Reference: Hvorslev, M.J. (1951), Time lag and soil permeability in ground water observations. U.S. Army Corps of Engineers Waterway Experimentation Station, Bulletin 36.

drawn	BS	TETRA TECH COFFEY	client:	JQZ
approved	AO		project:	Park Road St Leonards
date	14 Feb 2023			
scale	AS SHOWN		title:	RISING HEAD TEST - BH7A
original size	A4		project no:	754-SYDGE304523-1

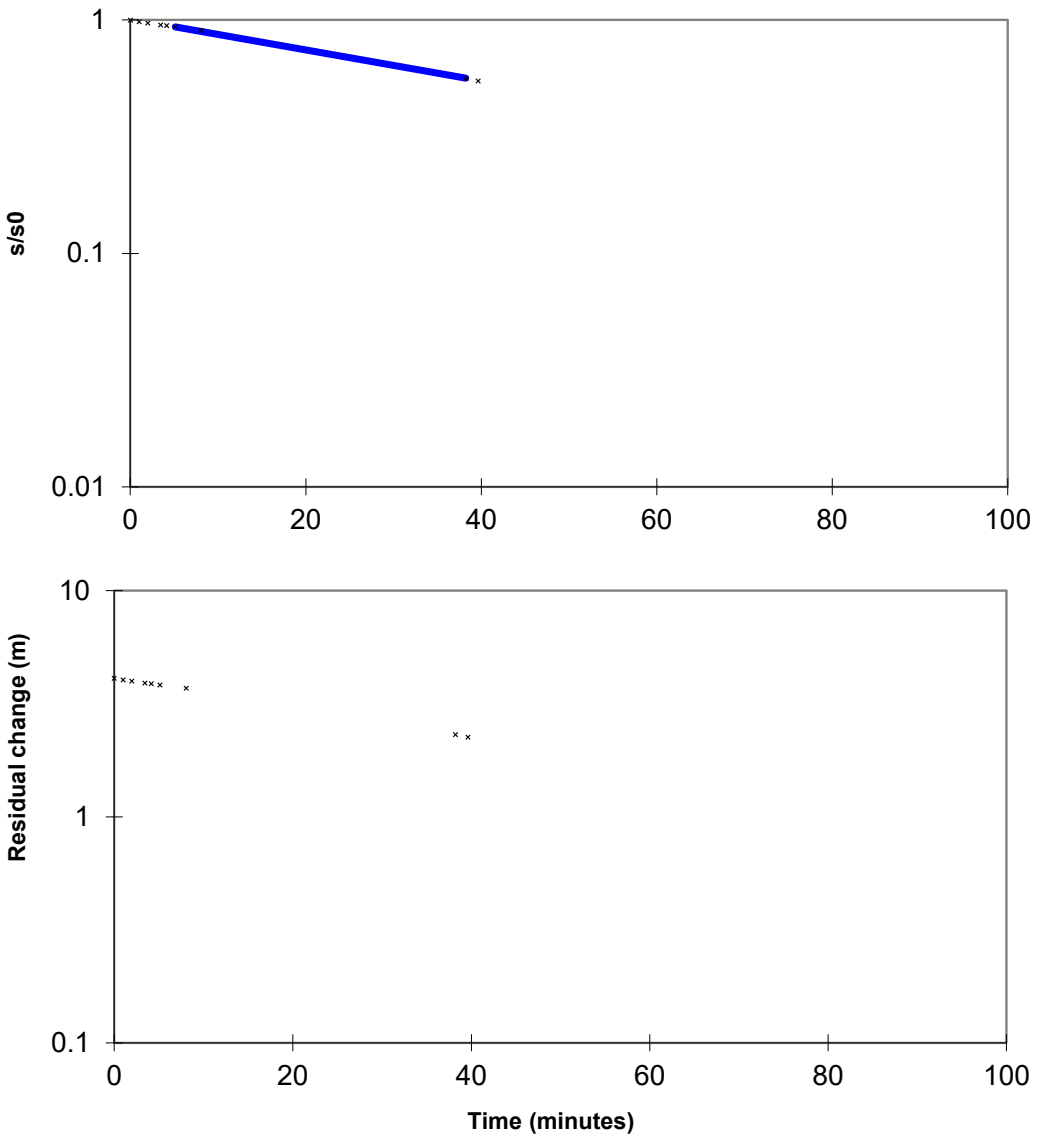
RISING OR FALLING HEAD TEST ANALYSIS

Bore Data	Units	Value
Initial groundwater level	m	4.42
Groundwater level at t=0	m	8.52
Casing radius (r)	m	0.025
Bore radius (R)	m	0.05
Screened interval length (L)	m	6
Match time start	min	5
Match time end	min	30
Characteristic Time (t_0)	**min**	**64.76**
Hydraulic Conductivity (K)	**m/day**	**0.00554**

Piezometer: BH9

Method Developed by Hvorslev (1951)

$$K = \frac{r^2 \ln(L/R)}{2Lt_0}$$



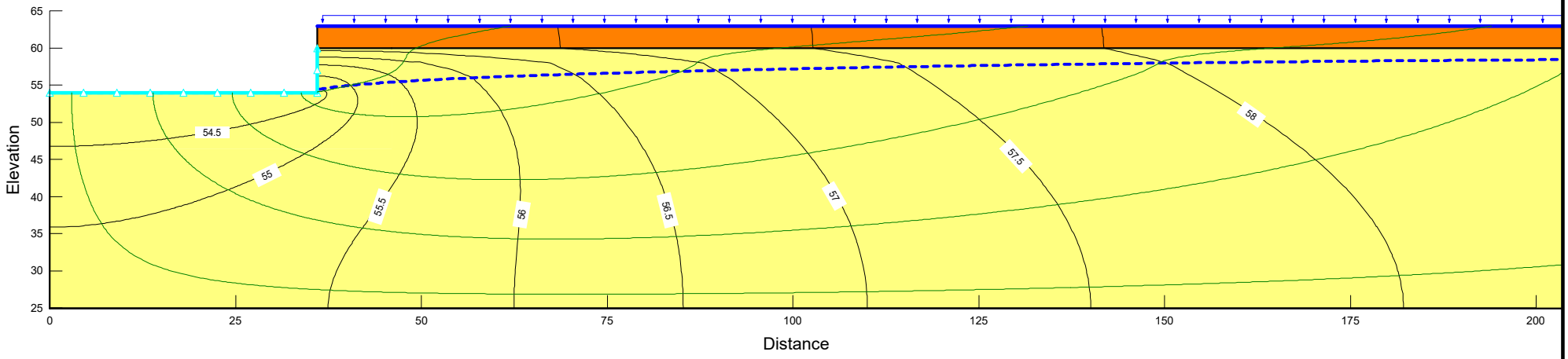
Reference: Hvorslev, M.J. (1951), Time lag and soil permeability in ground water observations. U.S. Army Corps of Engineers Waterway Experimentation Station, Bulletin 36.

drawn	BS	TETRA TECH COFFEY	client:	JQZ
approved	AO		project:	Park Road St Leonards
date	14 Feb 2023		title:	RISING HEAD TEST - BH9
scale	AS SHOWN		project no:	754-SYDGE304523-1
original size	A4			

APPENDIX C: SEEP/W RESULTS

Color	Name	Ky'/Kx' Ratio
	Fill	1
	Hawksbury Sandstone	0.2

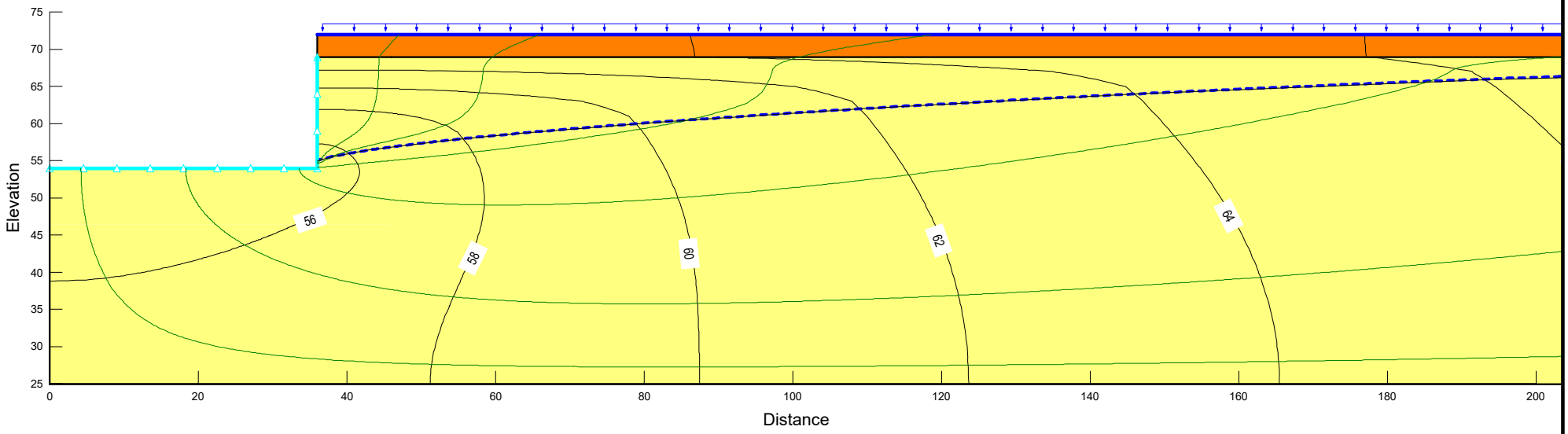
Color	Name	Kind	Parameters
	Head - 58.5 mAHD	Water Total Head	58.5 m
	Rainfall infiltration	Water Flux	7.6e-10 m/sec
	Seepage face	Water Rate	0 m³/sec



Section 1	
Section 1.gsz	
28/02/2023	1:800

Color	Name	Ky'/Kx' Ratio
	Fill	1
	Hawksbury Sandstone	0.2

Color	Name	Kind	Parameters
	Head - 68.5 mAHD	Water Total Head	68.5 m
	Rainfall infiltration	Water Flux	7.6e-10 m/sec
	Seepage face	Water Rate	0 m³/sec



Section 2	
Section 2.gsz	
28/02/2023	1:800

APPENDIX D: LABORATORY RESULTS

Analytes	Units	Limit of reporting (LOR)	ANZG 2018 DGVs	Notes	Sample IDs and Sampling date		
					BH1 (ALS)	BH9 (ALS)	BH9 Duplicate (ALS)
					21/02/2023	21/02/2023	21/02/2023
Physical Parameters							
Lab pH	pH	0.01	6.5 - 8	1	**4.9**	**5.5**	**5.5**
Lab Electrical Conductivity	µS/cm	1	-		590	376	370
Total Dissolved Solids	mg/L	10	-		430	264	293
Total Suspended Solids	mg/L	5	-		367	6080	4060
Cations							
Calcium	mg/L	1	-		1	13	13
Magnesium	mg/L	1	-		10	5	5
Potassium	mg/L	1	-		1	< LOR	< LOR
Sodium	mg/L	1	-		101	53	54
Anions							
Bicarbonate Alkalinity (as CaCO3)	mg/L	1	-		< LOR	20	12
Total Alkalinity (as CaCO3)	mg/L	1	-		< LOR	20	12
Chloride	mg/L	1	-		154	66	68
Sulfate (as SO4)	mg/L	1	-		73	62	61
Metals (total)							
Arsenic	mg/L	0.001	-		< LOR	0.003	0.003
Cadmium	mg/L	0.0001	0.0055		0.0002	< LOR	< LOR
Chromium	mg/L	0.001	0.0044	2	< LOR	0.001	0.001
Copper	mg/L	0.001	0.003		**0.009**	0.002	0.002
Lead	mg/L	0.001	0.0044		< LOR	< LOR	< LOR
Mercury	mg/L	0.0001	0.0004		< LOR	< LOR	< LOR
Nickel	mg/L	0.001	0.07		0.014	0.002	0.002
Zinc	mg/L	0.005	0.008		**0.089**	**0.03**	**0.027**
BTEX							
Benzene	µg/L	1	700		< LOR	< LOR	< LOR
Toluene	µg/L	2	180		< LOR	< LOR	< LOR
Ethylbenzene	µg/L	2	80		< LOR	< LOR	< LOR
m&p-Xylenes	µg/L	2	-		< LOR	< LOR	< LOR
o-Xylene	µg/L	2	-		< LOR	< LOR	< LOR
Xylenes - Total	µg/L	2	-		< LOR	< LOR	< LOR
Total Recoverable Hydrocarbons-1999 NEPM Fractions							
TRH C6-C9	mg/L	0.02	-		< LOR	< LOR	< LOR
TRH C10-C14	mg/L	0.05	-		< LOR	< LOR	< LOR
TRH C15-C28	mg/L	0.1	-		< LOR	< LOR	< LOR
TRH C29-C36	mg/L	0.05	-		< LOR	< LOR	< LOR
TRH C10-C36 (Total)	mg/L	0.05	-		< LOR	< LOR	< LOR
Total Recoverable Hydrocarbons-2013 NEPM Fractions							
TRH C6-C10	mg/L	0.02	-		< LOR	< LOR	< LOR
TRH >C10-C16	mg/L	0.1	-		< LOR	< LOR	< LOR
TRH >C16-C34	mg/L	0.1	-		< LOR	< LOR	< LOR
TRH >C34-C40	mg/L	0.1	-		< LOR	< LOR	< LOR
TRH >C10-C40 (Total)	mg/L	0.1	-		< LOR	< LOR	< LOR
Polycyclic Aromatic Hydrocarbons (Trace level)							
Acenaphthene	mg/L	0.001	-		< LOR	< LOR	< LOR
Acenaphthylene	mg/L	0.001	-		< LOR	< LOR	< LOR
Anthracene	mg/L	0.001	0.0004		< LOR	< LOR	< LOR
Benz(a)anthracene	mg/L	0.001	-		< LOR	< LOR	< LOR
Benzo(a)pyrene	mg/L	0.0005	0.0002		< LOR	< LOR	< LOR
Benzo(b&j)fluoranthene	mg/L	0.001	-		< LOR	< LOR	< LOR
Benzo(g.h.i)perylene	mg/L	0.001	-		< LOR	< LOR	< LOR
Benzo(k)fluoranthene	mg/L	0.001	-		< LOR	< LOR	< LOR
Chrysene	mg/L	0.001	-		< LOR	< LOR	< LOR
Dibenz(a.h)anthracene	mg/L	0.001	-		< LOR	< LOR	< LOR
Fluoranthene	mg/L	0.001	0.0014		< LOR	< LOR	< LOR
Fluorene	mg/L	0.001	-		< LOR	< LOR	< LOR
Indeno(1.2.3-cd)pyrene	mg/L	0.001	-		< LOR	< LOR	< LOR
Naphthalene	mg/L	0.005	0.07		< LOR	< LOR	< LOR
Phenanthrene	mg/L	0.001	0.002		< LOR	< LOR	< LOR
Pyrene	mg/L	0.001	-		< LOR	< LOR	< LOR
Total PAH	mg/L	0.0005	-		< LOR	< LOR	< LOR

ANZG. 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. ANZG 2018 default guideline values (DGVs) remain the same as the ANZECC 2000 trigger values for protection of 95% of species within a freshwater ecosystem.

Values exceeds ANZG 2018 DGVs

Notes:
1. pH range are values for lowland rivers
2. Guideline for chromium (Cr VI) in marine water

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2305718**	Page	: 1 of 7
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: ANTONY ORTON	Contact	: Khaleda Ataei
Address	: LEVEL 19, TOWER B- CITADEL TOWER 799 PACIFIC HIGHWAY CHATSWOOD NSW, AUSTRALIA 2067	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: + 61 2 8784 8555
Project	: SYDGE304523-1 Park Rd St Leonards	Date Samples Received	: 21-Feb-2023 17:00
Order number	: 304523	Date Analysis Commenced	: 22-Feb-2023
C-O-C number	: ----	Issue Date	: 27-Feb-2023 13:22
Sampler	: ANTONY ORTON		
Site	:		
Quote number	: EN/222		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP075 (SIM): Where reported, Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) per the NEPM (2013) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EP075(SIM): Where reported, Total Cresol is the sum of the reported concentrations of 2-Methylphenol and 3- & 4-Methylphenol at or above the LOR.
- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH1	BH9	DUP	----	----
			Sampling date / time	21-Feb-2023 15:30	21-Feb-2023 15:30	21-Feb-2023 15:30	----	----
Compound	CAS Number	LOR	Unit	ES2305718-001	ES2305718-002	ES2305718-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**4.85**	**5.53**	**5.51**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**590**	**376**	**370**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**430**	**264**	**293**	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**367**	**6080**	**4060**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	**20**	**12**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	<1	**20**	**12**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**73**	**62**	**61**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**154**	**66**	**68**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**1**	**13**	**13**	----	----
Magnesium	7439-95-4	1	mg/L	**10**	**5**	**5**	----	----
Sodium	7440-23-5	1	mg/L	**101**	**53**	**54**	----	----
Potassium	7440-09-7	1	mg/L	**1**	<1	<1	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.003**	**0.003**	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0002**	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.001**	**0.001**	----	----
Copper	7440-50-8	0.001	mg/L	**0.009**	**0.002**	**0.002**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L	**0.406**	**0.018**	**0.017**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.014**	**0.002**	**0.002**	----	----
Zinc	7440-66-6	0.005	mg/L	**0.089**	**0.030**	**0.027**	----	----
Iron	7439-89-6	0.05	mg/L	**0.08**	**1.17**	**1.16**	----	----
EG020T: Total Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	**0.414**	**0.030**	**0.027**	----	----
Iron	7439-89-6	0.05	mg/L	**5.75**	**10.0**	**7.38**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	BH1	BH9	DUP	----	----
				Sampling date / time	21-Feb-2023 15:30	21-Feb-2023 15:30	21-Feb-2023 15:30	----	----
Compound	CAS Number	LOR	Unit		ES2305718-001	ES2305718-002	ES2305718-003	--------	--------
					Result	Result	Result	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.07**	**0.18**	**0.17**	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**1.26**	**0.02**	**0.06**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**1.26**	**0.02**	**0.06**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**2.9**	**2.2**	**2.1**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**4.2**	**2.2**	**2.2**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.22**	**0.55**	**0.53**	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**5.86**	**3.55**	**3.43**	----	----
ø Total Cations	----	0.01	meq/L		**5.50**	----	----	----	----
ø Total Cations	----	0.01	meq/L		----	**3.36**	**3.41**	----	----
ø Ionic Balance	----	0.01	%		**3.21**	----	----	----	----
ø Ionic Balance	----	0.01	%		----	**2.70**	**0.28**	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**5**	**8**	**8**	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	BH1	BH9	DUP	----	----
			Sampling date / time	21-Feb-2023 15:30	21-Feb-2023 15:30	21-Feb-2023 15:30	----	----
Compound	CAS Number	LOR	Unit	ES2305718-001	ES2305718-002	ES2305718-003	--------	--------
				Result	Result	Result	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued								
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<0.5	<0.5	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	----	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100	<100	<100	----	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	----	----
Toluene	108-88-3	2	µg/L	<2	<2	<2	----	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	----	----
^ Total Xylenes	----	2	µg/L	<2	<2	<2	----	----
^ Sum of BTEX	----	1	µg/L	<1	<1	<1	----	----
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	BH1	BH9	DUP	----	----
				Sampling date / time	21-Feb-2023 15:30	21-Feb-2023 15:30	21-Feb-2023 15:30	----	----
Compound	CAS Number	LOR	Unit		ES2305718-001	ES2305718-002	ES2305718-003	--------	--------
					Result	Result	Result	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		30.8	26.1	29.7	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		56.8	62.6	55.6	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		63.9	71.8	63.0	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		58.2	65.2	61.7	----	----
Anthracene-d10	1719-06-8	1.0	%		75.4	80.2	74.0	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		90.5	94.4	86.6	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		117	118	123	----	----
Toluene-D8	2037-26-5	2	%		111	110	113	----	----
4-Bromofluorobenzene	460-00-4	2	%		104	103	106	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	44
2-Chlorophenol-D4	93951-73-6	14	94
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20	104
Anthracene-d10	1719-06-8	27	113
4-Terphenyl-d14	1718-51-0	32	112
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES2305718**	Page	: 1 of 10
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: ANTONY ORTON	Contact	: Khaleda Ataei
Address	: LEVEL 19, TOWER B- CITADEL TOWER 799 PACIFIC HIGHWAY CHATSWOOD NSW, AUSTRALIA 2067	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: + 61 2 8784 8555
Project	: SYDGE304523-1 Park Rd St Leonards	Date Samples Received	: 21-Feb-2023
Order number	: 304523	Date Analysis Commenced	: 22-Feb-2023
C-O-C number	: ----	Issue Date	: 27-Feb-2023
Sampler	: ANTONY ORTON		
Site	:		
Quote number	: EN/222		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
= Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EA005P: pH by PC Titrator (QC Lot: 4888652)									
ES2305482-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	4.90	4.71	4.0	0% - 20%
ES2305752-003	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.52	6.53	0.2	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 4888650)									
ES2305652-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	179	179	0.0	0% - 20%
ES2305838-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	2200	2200	0.1	0% - 20%
ES2305482-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	131	129	1.6	0% - 20%
ES2305832-004	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	27200	27500	0.8	0% - 20%
EW2300879-006	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	131	130	0.9	0% - 20%
ES2305752-003	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	18700	18900	1.3	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 4888503)									
ES2305482-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	123	114	7.6	0% - 50%
ES2305752-004	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	2810	2780	1.1	0% - 20%
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 4888504)									
ES2305482-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	<5	<5	0.0	No Limit
ES2305752-004	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	118	123	3.5	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 4888651)									
ES2305651-008	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	34	34	0.0	0% - 20%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	34	34	0.0	0% - 20%
ES2305482-001	Anonymous	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	1	<1	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
ED037P: Alkalinity by PC Titrator (QC Lot: 4888651) - continued									
ES2305482-001	Anonymous	ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	1	<1	0.0	No Limit
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 4887523)									
ES2305626-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2950	2910	1.4	0% - 20%
EW2300879-004	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	7	7	0.0	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 4887524)									
ES2305655-002	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	1060	1080	1.3	0% - 20%
ES2305626-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	17700	17700	0.4	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 4887557)									
ES2305718-001	BH1	ED093F: Calcium	7440-70-2	1	mg/L	1	1	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	10	10	0.0	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	101	99	2.6	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	1	1	0.0	No Limit
EW2300878-003	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	2	2	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	<1	<1	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	10	10	0.0	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.0	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 4887555)									
ES2305718-001	BH1	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0001	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.009	0.012	23.8	0% - 50%
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.406	0.407	0.2	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.014	0.015	0.0	0% - 50%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.089	0.101	13.0	0% - 20%
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.08	0.12	44.3	No Limit
EW2300878-003	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0002	0.0	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.004	0.004	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.016	0.016	0.0	0% - 50%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.108	0.106	1.0	0% - 20%
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 4888268)									
ME2300253-026	Anonymous	EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.368	0.365	0.6	0% - 20%
		EG020A-T: Iron	7439-89-6	0.05	mg/L	10.3	10.4	0.7	0% - 20%
ME2300253-014	Anonymous	EG020A-T: Manganese	7439-96-5	0.001	mg/L	2.13	2.14	0.1	0% - 20%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EG020T: Total Metals by ICP-MS (QC Lot: 4888268) - continued									
ME2300253-014	Anonymous	EG020A-T: Iron	7439-89-6	0.05	mg/L	15.4	15.2	1.5	0% - 20%
EG035F: Dissolved Mercury by FIMS (QC Lot: 4887556)									
EW2300878-004	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	0.0005	0.0005	0.0	No Limit
ES2305718-001	BH1	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 4888467)									
ES2305088-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	7.14	7.07	0.9	0% - 20%
ES2305324-011	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.33	0.30	10.5	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 4887521)									
ES2305626-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EW2300879-004	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 4888466)									
ES2305088-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.04	<0.01	126	No Limit
ES2305324-011	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.01	0.01	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 4888456)									
ES2305088-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	12.8	13.2	2.8	0% - 20%
ES2305359-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.3	2.0	45.9	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 4888458)									
ES2305718-001	BH1	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.22	0.20	6.6	No Limit
ES2305766-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 4889507)									
ES2305718-001	BH1	EP005: Total Organic Carbon	----	1	mg/L	5	4	0.0	No Limit
EW2300879-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	3	3	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 4888810)									
ES2305482-001	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
ES2305718-001	BH1	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.0	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 4888810)									
ES2305482-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.0	No Limit
ES2305718-001	BH1	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.0	No Limit
EP080: BTEXN (QC Lot: 4888810)									
ES2305482-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.0	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.0	No Limit
ES2305718-001	BH1	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.0	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EP080: BTEXN (QC Lot: 4888810) - continued									
ES2305718-001	BH1	EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.0	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.0	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.0	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 4888652)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	100	98.8	101
				----	7 pH Unit	99.7	99.2	101
EA010P: Conductivity by PC Titrator (QCLot: 4888650)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	220 µS/cm	90.6	89.9	110
				<1	2100 µS/cm	92.5	90.2	111
				<1	58301 µS/cm	100	93.3	106
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 4888503)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	91.1	87.0	109
				<10	293 mg/L	107	75.2	126
				<10	2340 mg/L	102	83.0	124
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 4888504)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	94.3	83.0	129
				<5	1000 mg/L	96.2	82.0	110
				<5	987 mg/L	98.0	83.0	118
ED037P: Alkalinity by PC Titrator (QCLot: 4888651)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	98.1	81.0	111
				----	50 mg/L	106	80.0	120
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 4887523)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	108	82.0	122
				<1	500 mg/L	113	82.0	122
ED045G: Chloride by Discrete Analyser (QCLot: 4887524)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	50 mg/L	107	80.9	127
				<1	1000 mg/L	101	80.9	127
ED093F: Dissolved Major Cations (QCLot: 4887557)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	99.6	80.0	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	99.2	90.0	116
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	100	82.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	96.7	85.0	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 4887555)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.9	85.0	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	100	84.0	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	93.8	85.0	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	97.0	81.0	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.4	83.0	111

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
				Result	Concentration	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 4887555) - continued								
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	95.9	82.0	110
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	97.8	82.0	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	99.7	81.0	117
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	94.8	82.0	112
EG020T: Total Metals by ICP-MS (QCLot: 4888268)								
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	98.6	85.0	113
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	85.0	117
EG035F: Dissolved Mercury by FIMS (QCLot: 4887556)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	98.4	83.0	105
EK055G: Ammonia as N by Discrete Analyser (QCLot: 4888467)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	99.8	90.0	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4887521)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	97.7	82.0	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 4888466)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	101	91.0	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4888456)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	87.5	69.0	101
				<0.1	1 mg/L	115	70.0	118
				<0.1	5 mg/L	103	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 4888458)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	92.8	71.3	126
				<0.01	0.442 mg/L	123	71.3	126
				<0.01	1 mg/L	103	71.3	126
EP005: Total Organic Carbon (TOC) (QCLot: 4889507)								
EP005: Total Organic Carbon	----	1	mg/L	<1	10 mg/L	96.6	72.0	120
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 4887384)								
EP075(SIM): Naphthalene	91-20-3	1	µg/L	<1.0	5 µg/L	68.2	50.0	94.0
EP075(SIM): Acenaphthylene	208-96-8	1	µg/L	<1.0	5 µg/L	67.2	63.6	114
EP075(SIM): Acenaphthene	83-32-9	1	µg/L	<1.0	5 µg/L	68.9	62.2	113
EP075(SIM): Fluorene	86-73-7	1	µg/L	<1.0	5 µg/L	73.7	63.9	115
EP075(SIM): Phenanthrene	85-01-8	1	µg/L	<1.0	5 µg/L	80.9	62.6	116
EP075(SIM): Anthracene	120-12-7	1	µg/L	<1.0	5 µg/L	78.9	64.3	116
EP075(SIM): Fluoranthene	206-44-0	1	µg/L	<1.0	5 µg/L	87.5	63.6	118
EP075(SIM): Pyrene	129-00-0	1	µg/L	<1.0	5 µg/L	89.2	63.1	118
EP075(SIM): Benz(a)anthracene	56-55-3	1	µg/L	<1.0	5 µg/L	92.0	64.1	117
EP075(SIM): Chrysene	218-01-9	1	µg/L	<1.0	5 µg/L	88.5	62.5	116
EP075(SIM): Benzo(b+j)fluoranthene	205-99-2	1	µg/L	<1.0	5 µg/L	88.6	61.7	119
	205-82-3							

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Acceptable Limits (%): Low	Acceptable Limits (%): High
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons (QCLot: 4887384) - continued								
EP075(SIM): Benzo(k)fluoranthene	207-08-9	1	µg/L	<1.0	5 µg/L	100	63.0	115
EP075(SIM): Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	5 µg/L	98.4	63.3	117
EP075(SIM): Indeno(1.2.3.cd)pyrene	193-39-5	1	µg/L	<1.0	5 µg/L	94.0	59.9	118
EP075(SIM): Dibenz(a.h)anthracene	53-70-3	1	µg/L	<1.0	5 µg/L	94.3	61.2	117
EP075(SIM): Benzo(g.h.i)perylene	191-24-2	1	µg/L	<1.0	5 µg/L	92.8	59.1	118
EP080/071: Total Petroleum Hydrocarbons (QCLot: 4887383)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	400 µg/L	78.3	53.7	97.0
EP071: C15 - C28 Fraction	----	100	µg/L	<100	600 µg/L	89.3	63.3	107
EP071: C29 - C36 Fraction	----	50	µg/L	<50	400 µg/L	96.8	58.3	120
EP080/071: Total Petroleum Hydrocarbons (QCLot: 4888810)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	260 µg/L	87.2	75.0	127
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4887383)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	500 µg/L	81.3	53.9	95.5
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	700 µg/L	93.9	57.8	110
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	300 µg/L	98.7	50.5	115
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4888810)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	310 µg/L	88.2	75.0	127
EP080: BTEXN (QCLot: 4888810)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	80.5	70.0	122
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	84.2	69.0	123
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	81.3	70.0	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	10 µg/L	84.0	69.0	121
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	84.0	72.0	122
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	86.8	70.0	120

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Acceptable Limits (%): Low	Acceptable Limits (%): High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 4887523)							
ES2305626-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	# Not Determined	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 4887524)							
ES2305626-001	Anonymous						

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 4887524) - continued							
ES2305626-001	Anonymous	ED045G: Chloride	16887-00-6	50 mg/L	# Not Determined	70.0	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 4887555)							
ES2305686-001	Anonymous	EG020A-F: Arsenic	7440-38-2	1 mg/L	99.1	70.0	130
		EG020A-F: Cadmium	7440-43-9	0.25 mg/L	100	70.0	130
		EG020A-F: Chromium	7440-47-3	1 mg/L	98.6	70.0	130
		EG020A-F: Copper	7440-50-8	1 mg/L	100	70.0	130
		EG020A-F: Lead	7439-92-1	1 mg/L	99.4	70.0	130
		EG020A-F: Manganese	7439-96-5	1 mg/L	101	70.0	130
		EG020A-F: Nickel	7440-02-0	1 mg/L	96.8	70.0	130
		EG020A-F: Zinc	7440-66-6	1 mg/L	99.0	70.0	130
EG020T: Total Metals by ICP-MS (QCLot: 4888268)							
ES2305718-002	BH9	EG020A-T: Manganese	7439-96-5	1 mg/L	99.8	70.0	130
EG035F: Dissolved Mercury by FIMS (QCLot: 4887556)							
ES2305686-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	102	70.0	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 4888467)							
ES2305088-001	Anonymous	EK055G: Ammonia as N	7664-41-7	1 mg/L	# Not Determined	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4887521)							
ES2305626-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	99.6	70.0	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 4888466)							
ES2305088-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	86.2	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4888456)							
ES2305096-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	# Not Determined	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 4888458)							
ES2305718-002	BH9	EK067G: Total Phosphorus as P	----	10 mg/L	99.3	70.0	130
EP005: Total Organic Carbon (TOC) (QCLot: 4889507)							
ES2305718-002	BH9	EP005: Total Organic Carbon	----	100 mg/L	102	70.0	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 4888810)							
ES2305482-001	Anonymous	EP080: C6 - C9 Fraction	----	325 µg/L	101	70.0	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 4888810)							
ES2305482-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	101	70.0	130
EP080: BTEXN (QCLot: 4888810)							
ES2305482-001	Anonymous	EP080: Benzene	71-43-2	25 µg/L	87.3	70.0	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EP080: BTEXN (QCLot: 4888810) - continued							
ES2305482-001	Anonymous	EP080: Toluene	108-88-3	25 µg/L	88.2	70.0	130
		EP080: Ethylbenzene	100-41-4	25 µg/L	88.8	70.0	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	87.1	70.0	130
		EP080: ortho-Xylene	95-47-6	25 µg/L	90.2	70.0	130
		EP080: Naphthalene	91-20-3	25 µg/L	84.4	70.0	130

Appendix D

Survey Plans

BH1

BH3

BH5

BH7A

BH9

BOREHOLES AND MONITORING WELLS ARE SHOWN IN RED

LTS CONTOUR AND DETAIL SURVEY, EASEMENT AND BOUNDARY INFORMATION SHOWN IN GREY ON THIS PLAN HAS NOT BEEN VERIFIED BY LANDPARTNERS AND LANDPARTNERS ACCEPTS NO RESPONSIBILITY FOR ITS ACCURACY

FOR CLARITY THIS PLAN CONTAINS FURTHER SURVEY INFORMATION THAT IS NOT SHOWN ON THE PRINTOUT BUT IS CONTAINED WITHIN THE AUTOCAD FILE

T-SB0.7/8
HEIGHT(m) ie 18 = 18m
TRUNK(m) ie 0.7 = 0.7m DIAMETER
SPREAD(m) ie S8 = 8m DIAMETER

68.89 LQA/4DB/QCB
QUALITY B
4XDB
1.2m DEEP
68.89 MEASURED AT SURFACE LEVEL

64.9 LQA/200/10.7/QCB
QUALITY B
0.7m DEEP
0.1m DIAMETER
WATER MAIN
64.9 MEASURED AT SURFACE LEVEL

70.28 HQA/200/1.0/QCA
QUALITY A
1.0m DEEP
0.2m DIAMETER
HIGH PRESSURE
70.28 MEASURED AT SURFACE LEVEL

REFER TO R1 IN CCTV FOOTAGE

REFER TO B1 IN CCTV FOOTAGE

REFER TO B2 IN CCTV FOOTAGE

REFER TO B3 IN CCTV FOOTAGE

REFER TO B4 IN CCTV FOOTAGE

REFER TO B5 IN CCTV FOOTAGE

REFER TO B2 IN CCTV FOOTAGE

BOREHOLE	EASTING (MGA2020)	NORTHING (MGA2020)	GROUND RL (AHD)
BH1	332594.37	6255593.64	64.47
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BH9A	332667.22	6255517.92	60.34
BH9A	332602.87	6255665.93	71.69
BH10	332651.06	6255657.89	74.17
BH10A	332650.51	6255657.04	74.25
BH11	332627.58	6255622.34	67.92
BH12	332639.82	6255620.78	69.80

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- SURVEY IS ON GDA2020 MAP PROJECTION

NOTES:

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LANDPARTNERS CAN NOT WARRANT THE ACCURACY OF THE DETECTED SERVICE NOR WHETHER THERE ARE OTHER SERVICES ON SITE THAT WERE NOT LOCATED BY UTILITY MAPPING.

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Before you dig australia ensure you have obtained all relevant information and approvals prior to excavation or work being carried out.

SCALE 1:250 (A1)

CLIENT

BERRY ROAD DEVELOPMENT PTY LTD

PROJECT

ADDITIONAL DETAIL SURVEY OF LOT 45 IN DP76740, LOT 1 IN DP195104, LOT 46 IN DP1103247, LOT 1&2 IN DP586272

BEING 24-18 PARK ROAD ST LEONARDS

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1	CLP	17/10/2022	INITIAL ISSUE

SYM	DESCRIPTION
	AUSPOST BOX
	BENCHMARK
	BIN
	BOLLARD
	BOREHOLE
	BUS STOP SIGN
	FLAG POLE
	GATE
	MAIL BOX
	SEAT
	UNKNOWN SERVICE
	DRAINAGE GULLY PIT
	DRAINAGE MANHOLE
	ELEC FUSE BOX
	ELEC GARDEN LIGHT
	ELEC GREEN PILLAR
	ELEC LIGHT POLE
	ELEC POLE & LIGHT
	ELEC POLE&TRANSFORMER
	ELEC POWER POLE
	ELEC SINGLE PIT
	ELEC STAY POLE
	ELEC TWIN PIT
	FUEL DIP

SYM	DESCRIPTION
	GAS MAIN
	GAS METER
	GAS VALVE
	SEWER LAMPHOLE
	SEWER MANHOLE
	SEWER VENT PIPE
	OPTICAL FIBRE MARKER
	OPTICAL FIBRE PIT
	TELECOM DIST PILLAR
	TELECOM POLE
	TELECOM SINGLE PIT
	TELECOM TWIN PIT
	TRAFFIC JUNCTION BOX
	TRAFFIC LIGHT
	TRAFFIC SIGN
	TRAF SIGNAL CONTROLLER
	SHRUB
	TREE
	WATER AIR VALVE
	WATER HYDRANT
	WATER METER
	WATER PUMP
	WATER STOP VALVE
	WATER TAP

Symbols shown are indicative only. The symbol size and orientation does not necessarily represent the real size or orientation of the feature.

DRAINAGE PIPE U/G
ELECT. LINE U/G
HV ELEC. LINE U/G
HOW PRESSURE GAS
HIGH PRESSURE GAS
FENCE LINE
SEWERAGE PIPE
TELSTRA CABLE
WATER MAIN

LANDPARTNERS surveyors and planners

Sydney Office
Level 2
23-29 South Street
Rydalmere NSW 2116
PO Box 1144
Dundas NSW 2117

p: (02) 9685 2000
e: info@landpartners.com.au
w: www.landpartners.com.au

bsi ISO 9001 Quality Management Systems CERTIFIED | ISO 45001 Occupational Health and Safety Management CERTIFIED | AS/NZS 4801 Occupational Health and Safety CERTIFIED

LEVEL DATUM AHD	LOCAL AUTHORITY LANE COVE
LEVEL ORIGIN SSM26101 RL57.313	SCALE 1:250 (A1)
MERIDIAN 56	CONTOUR INTERVAL 0.5 Metre
CO-ORD SYSTEM MGA2020	DRAWN JL / DATE 20/04/2023
SURVEYOR RL/GR/SL / DATE OF SURVEY 07/03/2023	CHECKED RL / DATE 20/04/2023
FIELD FILE SY074494_003_9_1	APPROVED RL / DATE 20/04/2023
UDN	SHEET 1 OF 2

SY074494_003_10_BHS

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FOR CLARITY THIS PLAN CONTAINS FURTHER SURVEY INFORMATION THAT IS NOT SHOWN ON THE PRINTOUT BUT IS CONTAINED WITHIN THE AUTOCAD FILE

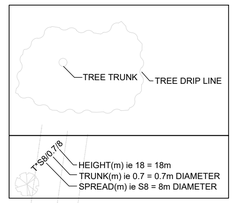
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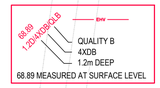
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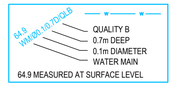
NOTES:

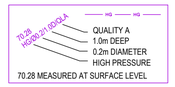
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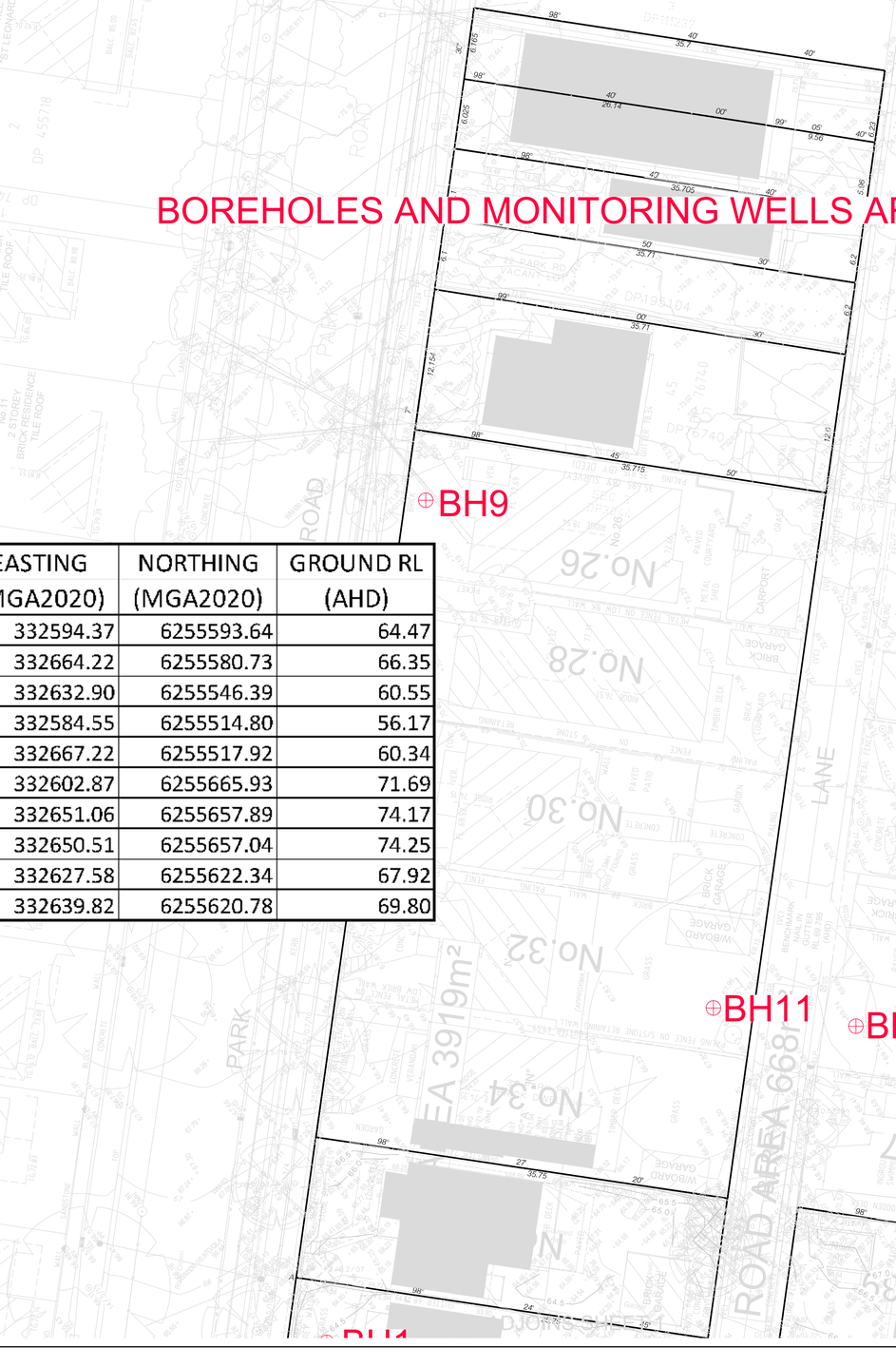
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A Before You Dig enquiry must be lodged at least two business days prior to starting any excavation or work site project.

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PROJECT

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BEING 24-18 PARK ROAD ST LEONARDS

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	ELEC GREEN PILLAR
	ELEC LIGHT POLE
	ELEC POLE & LIGHT
	ELEC POLE&TRANSFORMER
	ELEC POWER POLE
	ELEC SINGLE PIT
	ELEC STAY POLE
	ELEC TWIN PIT
	FUEL DIP

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	GAS METER
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bsi ISO 9001 Quality Management Systems CERTIFIED; ISO 45001 Occupational Health and Safety Management CERTIFIED; AS/NZS 4801 Occupational Health and Safety CERTIFIED

LEVEL DATUM AHD	LOCAL AUTHORITY LANE COVE
LEVEL ORIGIN SSM26101 RL57.313	SCALE 1:250 (A1)
MERIDIAN 56	CONTOUR INTERVAL 0.5 Metre
CO-ORD SYSTEM MGA2020	DRAWN JL / DATE 20/04/2023
SURVEYOR RL/GR/SL / DATE OF SURVEY 07/03/2023	CHECKED RL / DATE 20/04/2023
FIELD FILE SY074494_003_9_1	APPROVED RL / DATE 20/04/2023
UDN	SHEET 2 OF 2

SY074494_003_10_BHS

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Appendix E

Well Development Records

MONITORING WELL DEVELOPMENT RECORD

GOLDER

PROJECT: St Leonard development | DATE: 30/5/23 & 31/5/23

PROJ. NUMBER: PS201997 | CONTRACTOR:

GOLDER STAFF: MS | MON. WELL NAME: BH9

WEATHER (Temp/Cloud Cover/Precip.):

DEVEL. METHOD: Bailer

CALCULATION OF MINIMUM DEVELOPMENT VOLUME

All depths measured below top of PVC casing (TOC)

Time	Depth to Water (m)	Measured Depth of Well (m)	Depth of Well from TOC, from Mon. Well Report Sheet (m)	Metres of Standing Water	1 Well Casing Volume (assuming 50 mm casing) (L)	Min. Total Volume to be Pumped during Development (L)	
15:55	16.100 A	22.010 B	C	5.910 D = B - A or C - A, whichever is the greater	11.82 E = D x 2.0	F = E x 10	35.4L 3V 59.1 5V

DEVELOPMENT RECORDS

Field Measurements

Time	Cumulative Vol. Purged (L)	Cumulative No. of Surge Cycles	Redox (mV)	pH	Temp (C)	Conductivity (µS/cm)	Appearance (Colour/Clarity)	Odour	DO%	DO PPM
16:00	5		87.4	5.11	17.5	1348	Slightly cloudy, dirty white	No smell	42.6	4.05
16:10	9.8		84.8	5.12	17.5	1316	Med turbid	"	46.3	4.40
16:15	16.3		85.0	5.11	17.6	1270	"	"	45.0	4.17
16:25	21.3		86.0	5.15	17.5	1265	Light brown, med turbid	"	51.0	4.86
		~	Almost dry				Recovery			
12:50	26.3		103.6	5.02	17.7	1265	Clear, less turbid	Slight bitter egg smell	32.8	3.11
13:00	35.8		99.2	4.95	17.7	1290	Light grey/ish	"	47.4	4.50
13:10	36.8									
13:15	37.0		94.9	5.11	17.6	1238	"	"	45.6	4.33

~ Almost dry ~

Final Measured Depth of Well from TOC (m)

GAP FORM 38 / RL0 / FEBRUARY 2018

1/1

* unable to purge completely dry.
* water love values are in Mbgl
* Have already purged 150L after drilling work

Time | Water level

16:00 ▽17.510
16:10 ▽18.785
16:15 ▽20.320
16:25 ▽21.640
16:30 ▽21.910

TD = 22.110 mbgl

31/5/23 12:35 ▽17.60
TD 22.110
12:50 ▽18.670
13:00 ▽21.450
13:15 ▽21.80
▽21.82

TD 22.010

BH20

MONITORING WELL DEVELOPMENT RECORD

GOLDER

Page 1

PROJECT St. Leonard development DATE 30/5/23 & 31/5/23

PROJ. NUMBER PS201997 CONTRACTOR

GOLDER STAFF MS MON. WELL NAME BH10A

WEATHER (Temp/Cloud Cover/Precip.) Sunny

DEVEL. METHOD Bailer

CALCULATION OF MINIMUM DEVELOPMENT VOLUME

All depths measured below top of PVC casing (TOC)

Time	Depth to Water (m) A	Measured Depth of Well (m) B	Depth of Well from TOC, from Mon. Well Report Sheet (m) C	Metres of Standing Water D = B - A or C - A, whichever is the greater	1 Well Casing Volume (assuming 50 mm casing) (L) E = D x 2.0	Min. Total Volume to be Pumped during Development (L) F = E x 10
13:15	20.490	25.460		4.970	9.94	29.82 3V ~~49.70~~ 5V

DEVELOPMENT RECORDS

Field Measurements

Sp. Conductivity

Time	Cumulative Vol. Purged (L)	Cumulative No. of Surge Cycles	Redox (mV)	pH	Temp (C)	Conductivity (µS/cm)	Appearance (Colour/Clarity)	Odour	DO %	DO PPM
13:20	3.4		42.6	6.32	17.5	502	dirty white, mod turbid	NO SMELL	12.7	1.21
13:35	9.6		36.1	6.30	17.7	509	" "	"	14.8	1.40
13:45	15.6		32.9	6.29	17.8	496	" "	"	15.3	1.44
13:50	21.2		28.7	6.29	17.6	464	" "	"	17.7	1.69
14:05	26.5		27.0	6.38	17.7	455	Slightly cloudy moderate	"	37.2	3.54
14:15	30.3		23.8	6.38	17.6	447	" "	"	41.0	3.90
14:25	31.50		28.4	6.37	17.7	449	" "	"	38.7	3.68
				Reading Stabilised						
11:15	36.50		57.4	6.17	17.7	459	Slightly cloudy, dirty white	"	31.4	2.99
11:20	43.3		57.8	6.14	17.7	453	Mod turbid	"	27.2	2.66
11:30	53.1		57.8	6.02	17.7	423.6	"	"	24.3	2.31
11:40	58.1		49.0	6.08	17.7	384	"	"	28.5	2.71
11:50	64.1		44.1	6.14	17.7	374	"	"		

Final Measured Depth of Well from TOC (m) 25.590 45

Time water Level

13:25 ▽21.240
13:35 ▽22.530
13:45 ▽23.420
13:50 ▽24.360
14:05 ▽25.040
14:15 ▽25.030
14:25 ▽24.836
ID=25.590

14:30 ▽24.400

TD 24.450 ▽19.950
31/5/23 11:05 ▽21.510
11:20 ▽22.730
11:30 ▽24.280
11:40 ▽25.020
11:50 ▽25.020

TD= 24.450

GAP FORM 38 / RL0 / FEBRUARY 2018

1/1

* Slowly recovery during development
* Have already purged 140 L after drilling work completed
* Water level values are mbgl.

MONITORING WELL DEVELOPMENT RECORD

GOLDER

PROJECT St. Leonard development DATE 30/5/23 & 31/5/23

PROJ. NUMBER PS201997 CONTRACTOR

GOLDER STAFF MS MON. WELL NAME BH10B

WEATHER (Temp/Cloud Cover/Precip.) Sunny

DEVEL. METHOD Bailer

CALCULATION OF MINIMUM DEVELOPMENT VOLUME

All depths measured below top of PVC casing (TOC)

Time	Depth to Water (m) A	Measured Depth of Well (m) B	Depth of Well from TOC, from Mon. Well Report Sheet (m) C	Metres of Standing Water D = B - A or C - A, whichever is the greater	1 Well Casing Volume (assuming 50 mm casing) (L) E = D x 2.0	Min. Total Volume to be Pumped during Development (L) F = E x 10
14:50	4.127	5.495		1.368	2.736	8.2 3V / 13.7 5V

DEVELOPMENT RECORDS

Field Measurements

Sp.Cond

Time	Cumulative Vol. Purged (L)	Cumulative No. of Surge Cycles	Redox (mV)	pH	Temp (C)	Conductivity (µS/cm)	Appearance (Colour/Clarity)	Odour	DO%	DO ppm
14:15	1.8		51.6	4.78	17.9	365	Slightly cloudy, Med turbid	NO SMELL	17.6	1.62
15:20	4.3		70.4	5.12	17.9	370	Brownish, high turbid	NO SMELL	27.9	2.64
15:30	5.8									
							leave for			
	~		Almost	dry	~		Be Clear by.			
12:10	8.3		62.0	4.54	17.8	367	Slightly Clear, light brown,	NO SMELL	33.3	3.15
12:15	10.3		82.0	4.78	19.8	364	Med turbid	"	45.3	4.27
	~		dry	~	~					

Time / Water Level

15:20 ▽ 5.190
▽ 5.385
15:30 ▽ 5.285
TD=5.485
TD= 5.490 ▽ 4.140
31/5/23 12:05
12:10 ▽ 4.750
12:15 ▽ 5.250
12:20 ▽ 5.400
TD 5.480

Final Measured Depth of Well from TOC (m)

GAP FORM 38 / RL0 / FEBRUARY 2018

1/1

* water level values are in mbgl.
* Harry already purged 40L after drilling work completed last week
* TD- total depth.

MONITORING WELL DEVELOPMENT RECORD

GOLDER

Page 1

PROJECT St. Leonard development DATE 30/5/23 & 31/5/23

PROJ. NUMBER PS 201997 CONTRACTOR

GOLDER STAFF MS MON. WELL NAME BH11

WEATHER (Temp/Cloud Cover/Precip.) Sunny

DEVEL. METHOD Bailer

CALCULATION OF MINIMUM DEVELOPMENT VOLUME

All depths measured below top of PVC casing (TOC)

Time	Depth to Water (m)	Measured Depth of Well (m)	Depth of Well from TOC, from Mon. Well Report Sheet (m)	Metres of Standing Water	1 Well Casing Volume (assuming 50 mm casing) (L)	Min. Total Volume to be Pumped during Development (L)
	A	B	C	D = B-A or C-A, whichever is the greater	E = D x 2.0	F = E x 10
11:40	11.260	16.570		5.310	10.620	31.26 3V / 53.1 5V

DEVELOPMENT RECORDS

Field Measurements

Sp. Conductivity

Time	Cumulative Vol. Purged (L)	Cumulative No. of Surge Cycles	Redox (mV)	pH	Temp (C)	~~Conductivity~~ (µS/cm)	Appearance (Colour/Clarity)	Odour	DO%	DO PPM
11:50	2		32.0	6.18	17.6	546	dirty white, med turbid	NO SMELL	20.4	1.94
11:55	5		28.4	6.14	17.6	525	" high turbid		22.4	2.13
12:00	9.8		31.6	6.13	17.6	557	" med turbid		26.5	2.56
12:10	14.8		35.8	6.13	17.6	559	" "	"	31.3	2.95
12:20	18.4		40.5	6.30	17.5	576	" high turbid	"	39.8	3.78
12:25	19.0			Almost	dry	—	Whilst gwl Recovery.	No water removed purged out		
10:20	24.0		47.6	5.88	17.6	711	dirty white, Med turbid	NO SMELL	43.0	4.10
10:25	29.0		57.8	5.82	17.6	689	"	"	42.6	4.06
10:35	34.0		62.1	5.98	17.6	670	"	"	39.6	3.77
10:45	35.0	—	DRY	—	—	—	—			

Time water level

11:50 ▽ 12.590
11:55 ▽ "
12:05 ▽ 13.840
12:15 ▽ 15.080
12:20 ▽ 16.090
12:25 ▽ 16.360
TO → 16.450 ▽ 16.370
TO: 16.570 ▽ 11.915
31/5/23 10:10
10:20 ▽ 13.200
10:25 ▽ 14.710
10:35 ▽ 16.160
10:45 ▽ 16.370

Final Measured Depth of Well from TOC (m) 16.450

GAP FORM 38 / RL0 / FEBRUARY 2018

1/1

* Many already purged 140L after drilling work
* Water level values are in Mbgl

MONITORING WELL DEVELOPMENT RECORD

GOLDER

Page 1.

PROJECT St. Leonard development DATE 30/5/23 & 31/5/23

PROJ. NUMBER PS 201997 CONTRACTOR

GOLDER STAFF MS MON. WELL NAME BH11

WEATHER (Temp/Cloud Cover/Precip.) Sunny

DEVEL. METHOD Bailer

CALCULATION OF MINIMUM DEVELOPMENT VOLUME

All depths measured below top of PVC casing (TOC)

Time	Depth to Water (m)	Measured Depth of Well (m)	Depth of Well from TOC, from Mon. Well Report Sheet (m)	Metres of Standing Water	1 Well Casing Volume (assuming 50 mm casing) (L)	Min. Total Volume to be Pumped during Development (L)
11:40	11.260 A	16.570 B	C	5.310 D = B - A or C - A, whichever is the greater	10.620 E = D x 2.0	F = E x 10 31.86 3V / 53.1 5V

DEVELOPMENT RECORDS

Field Measurements

Sp. Conductivity

Time	Cumulative Vol. Purged (L)	Cumulative No. of Surge Cycles	Redox (mV)	pH	Temp (C)	~~Conductivity~~ (uS/cm)	Appearance (Colour/Clarity)	Odour	Do%	Do ppm
11:50	2		32.0	6.18	17.6	546	dirty white, med turbid	NO smell	26.4	1.94
11:55	5		28.4	6.14	17.6	525	" High turbid		22.4	2.13
12:00	9.8		31.6	6.13	17.6	557	" Med turbid		26.5	2.56
12:10	14.8		35.8	6.13	17.6	559	" "	"	31.3	2.95
12:20	18.4		40.5	6.30	17.5	576	" High turbid	"	39.8	3.72
12:25	19.0			Pump off	dry	—	Whilst gas recovery.	No water can purge out		
—		*	—	*	—	*	— *	* —		
10:20	24.0		47.6	5.88	17.2	711	dirty white, Med turbid	NO SMELL	43.0	4.10
10:25	29.0		37.8	5.82	17.6	689	"	"	42.6	4.06
10:35	34.0		62.1	5.98	17.6	670	"	"	39.6	3.77
10:45	35.0	—	pump off	—	—	—				

Time water level

11:50 ▽ 12.590
11:55 ▽ ↓
12:05 ▽ 13.840
12:15 ▽ 15.080
12:20 ▽ 16.090
12:25 ▽ 16.360
TO → 16.450 ▽ 16.300
— * — * — *
TO: 16.570 ▽ 11.915
31/5/23 10:10
10:20 ▽ 13.200
10:25 ▽ 14.710
10:35 ▽ 16.160
10:45 ▽ 16.370

Final Measured Depth of Well from TOC (m) 16.450

GAP FORM 36 / RL0 / FEBRUARY 2018

1/1

* Harry slowly purged 140L after drilling work
* Water level values are in mbgl

MONITORING WELL DEVELOPMENT RECORD

GOLDER

Page 1

PROJECT: St. Leonard development — DATE: 30/5/23 & 31/5/23

PROJ. NUMBER: PS201997 — CONTRACTOR:

GOLDER STAFF: MS — MON. WELL NAME: BH12

WEATHER (Temp/Cloud Cover/Precip.): Sunny

DEVEL. METHOD: Bailer

CALCULATION OF MINIMUM DEVELOPMENT VOLUME

All depths measured below top of PVC casing (TOC)

Time	Depth to Water (m) A	Measured Depth of Well (m) B	Depth of Well from TOC, from Mon. Well Report Sheet (m)	Metres of Standing Water D = B - A or C - A, whichever is the greater	1 Well Casing Volume (assuming 50 mm casing) (L) E = D x 2.0	Min. Total Volume to be Pumped during Development (L) F = E x 10
09:25	14.730	23.750	14.635	9.02 m	18.04	57.03V / 90.25V

DEVELOPMENT RECORDS

Field Measurements

Time	Cumulative Vol. Purged (L)	Cumulative No. of Surge Cycles	Redox (mV)	pH	Temp (C)	Conductivity (µS/cm) (sp.cond)	Appearance (Colour/Clarity)	Odour	DO %	DO ppm
09:40	3		156.4	9.07	17.3	1567	Light brown water, high turbid	NO SMELL	40.4	3.85
09:55	6.4		113.2	7.15	17.7	1737	"	NO SMELL	42.4	4.03
10:05	11.2		95.1	9.37	17.5	1396	Light brown, Mod turbid	"	38.6	3.66
10:15	17.0		81.6	8.51	17.3	1478	Light brown, Mod turbid	"	34.0	3.22
10:25	18.6		77.0	8.44	17.6	1414	"	"	37.3	3.53
10:30	21.1		75.2	8.03	17.5	1455	"	"	36.7	3.48
10:40	26.1		71.5	7.39	17.6	1504	"	"	32.0	3.01
10:50	30.6		61.4	7.33	17.2	1766	"	"	53.6	5.08
10:55	31.8									
		✓	Almost dry	—	✓	—	— " —	—		
08:30	37.6		94.3	7.05	16.8	1831	Slightly cloudy, slight dirty white	NO SMELL	40.5	3.94
08:45	43.4		92.0	6.71	17.3	1805	Low turbid	"	40.3	3.85
08:55	49.6		103.0	6.18	17.5	1809	"	"	35.3	3.40
09:05	54.8		100.0	5.92	17.6	1795	"	"	37.9	3.60
09:10	60.5		78.3	6.05	17.5	1784	"	"	28.0	2.66

Final Measured Depth of Well from TOC (m):

GAP FORM 38 / RL0 / FEBRUARY 2016

1/1

Time — water level

- @ 9:50 — ▽16.030 mbgl
- @ 10:05 — ▽18.770 "
- @ 10:20 — ▽20.110 "
- @ 10:30 — ▽21.110
- @ 10:40 — ▽22.150
- @ 10:50 — ▽23.300
- @ 11:06 — ▽23.500

31/5/23

- @ 08:10 — ▽14.790
- @ 08:30 — ▽17.455
- @ 08:45 — ▽19.110
- @ 08:55 — ▽20.550
- @ 09:05 — ▽22.150
- @ 09:10 — ▽23.390
- @ 09:20 — ▽23.34
- TD = 23.740

* Have already purged 30L
* Water levels values are in mbgl

09:20 60.7 — x almost dry — + — x — x

Appendix F

Hydraulic Conductivity Testing

WATER PRESSURE TEST RESULTS

Client :	JQZ	**Project No. :**	PS201997
Project :	Berry Road Development	**Bore :**	BH9
Location :	Park Road St Leonards	**Test section :**	19.40 m - 26.20 m

Test Details

Date:	19-May-23	Bottom of packer (m):	19.40	Height of pressure gauge (m):	0.5	Drum Area (m^2):	
Bore diameter (mm):	96	Bore depth (m):	26.20	Vertical Depth to groundwater (m):	5.5		0.264
Bore inclination (deg):	90	Section length (m):	6.80	(or depth to base of packer)			

Hg = gauge pressure, Hl = head loss in rods and packer, Hw = (gauge height + groundwater depth)x 9.81, Total = Hg+Hw-Hl

PRESSURE			Test	FLOW RATES								Water	Lugeons	Approx
				Flowmeter			Drum readings			Leakage	Assigned	Loss		Permeability
Hg	Hl	Total	Duration	Initial	Final	Total	Initial	Final	Equivalent		Flow		(l/m/min at	
(kPa)	(kPa)	(kPa)	(min)	(litres)	(litres)	(litres)	(mm)	(mm)	litres	(litres)	(litres)	(l/m/min)	1000 kPa)	(m/sec)
70	0	129	2	9080.0	9083.0	3.0				0.0	3.0	0.2	1.7	1.7E-07
70	0	129	2	9083.0	9083.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	129	2	9083.0	9083.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	129	2	9083.0	9083.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	129	2	9083.0	9083.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	179	2	9083.0	9083.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	179	2	9083.0	9083.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	179	2	9083.0	9083.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	179	2	9083.0	9083.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	179	2	9083.0	9083.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
210	0	269	2	9083.0	9084.5	1.5				0.0	1.5	0.1	0.4	4.1E-08
210	0	269	2	9084.5	9085.5	1.0				0.0	1.0	0.1	0.3	2.7E-08
210	0	269	2	9085.5	9086.5	1.0				0.0	1.0	0.1	0.3	2.7E-08
210	0	269	2	9086.5	9087.5	1.0				0.0	1.0	0.1	0.3	2.7E-08
210	0	269	2	9087.5	9088.5	1.0				0.0	1.0	0.1	0.3	2.7E-08
120	0	179	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	179	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	179	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	179	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	129	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	129	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	129	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	129	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	129	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00

Notes

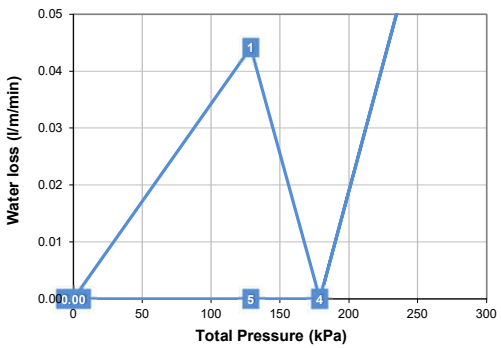
No flow recorded in Stages 2, 4 or 5.

Equipment checked on completion of test - water able to flow through packer and pump in working order.

Last dial of flow gauge difficult to read owing to plastic cover.

No movement of flow meter observed during Stages 2, 4 or 5.

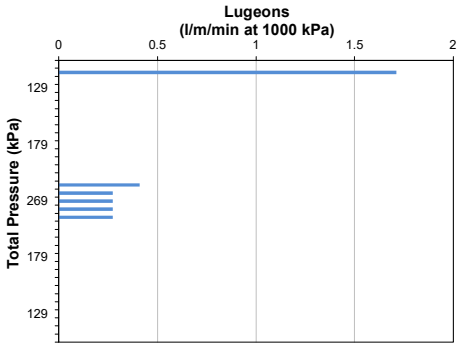
Test pressures increased to targetted pressure prior to the start of each test stage.



Averages			
Stage	Pressure (kPa)	Water Loss (l/m/min)	Lugeons (l/m/min at 1000kPa)
1	129	0.04	0.34
2	179	0.00	0.00
3	269	0.08	0.30
4	179	0.00	0.00
5	129	0.00	0.00

Houlsby Flow Pattern	Laminar Flow
Houlsby Lugeon value	0.1
Burgess Lugeon value	<0.1

Calculated: NR
Checked: CBW
Date: 25-Jul-22



WATER PRESSURE TEST RESULTS

Client :	JQZ	**Project No. :**	PS201997
Project :	Berry Road Development	**Bore :**	BH9
Location :	Park Road St Leonards	**Test section :**	11.40 m - 26.20 m

Test Details

Date:	19-May-23	Bottom of packer (m):	11.40	Height of pressure gauge (m):	0.5	Drum Area (m^2):	
Bore diameter (mm):	96	Bore depth (m):	26.20	Vertical Depth to groundwater (m):	4.8		0.264
Bore inclination (deg):	90	Section length (m):	14.80	(or depth to base of packer)			

Hg = gauge pressure, Hl = head loss in rods and packer, Hw = (gauge height + groundwater depth)x 9.81, Total = Hg+Hw-Hl

PRESSURE			Test	FLOW RATES								Water	Lugeons	Approx
				Flowmeter			Drum readings			Leakage	Assigned	Loss		Permeability
Hg	Hl	Total	Duration	Initial	Final	Total	Initial	Final	Equivalent		Flow		(l/m/min at	
(kPa)	(kPa)	(kPa)	(min)	(litres)	(litres)	(litres)	(mm)	(mm)	litres	(litres)	(litres)	(l/m/min)	1000 kPa)	(m/sec)
70	0	122	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	122	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	122	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	122	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	122	2	9088.5	9088.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	172	2	9088.5	9089.0	0.5				0.0	0.5	0.0	0.1	9.8E-09
120	0	172	2	9089.0	9089.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	172	2	9089.0	9089.5	0.5				0.0	0.5	0.0	0.1	9.8E-09
120	0	172	2	9089.5	9089.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	172	2	9089.5	9090.0	0.5				0.0	0.5	0.0	0.1	9.8E-09
210	0	262	2	9090.5	9091.0	0.5				0.0	0.5	0.0	0.1	6.4E-09
210	0	262	2	9091.0	9091.5	0.5				0.0	0.5	0.0	0.1	6.4E-09
210	0	262	2	9091.5	9092.5	1.0				0.0	1.0	0.0	0.1	1.3E-08
210	0	262	2	9092.5	9093.5	1.0				0.0	1.0	0.0	0.1	1.3E-08
210	0	262	2	9093.5	9094.0	0.5				0.0	0.5	0.0	0.1	6.4E-09
210	0	262	2	9094.0	9095.0	1.0				0.0	1.0	0.0	0.1	1.3E-08
120	0	172	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	172	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	172	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	172	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
120	0	172	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	122	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	122	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	122	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	122	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	122	2	9095.0	9095.0	0.0				0.0	0.0	0.0	0.0	0.0E+00

Notes

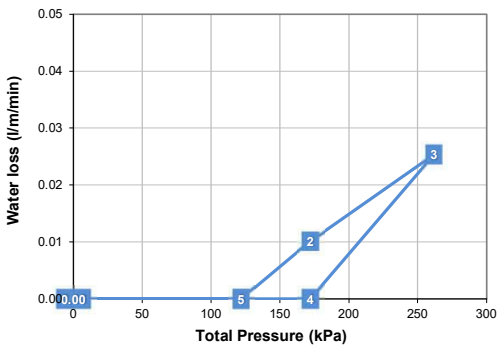
No flow recorded in Stages 1, 4 or 5.

Equipment checked on completion of test - water able to flow through packer and pump in working order.

Last dial of flow gauge difficult to read owing to plastic cover.

No movement of flow meter observed during Stages 1, 4 or 5.

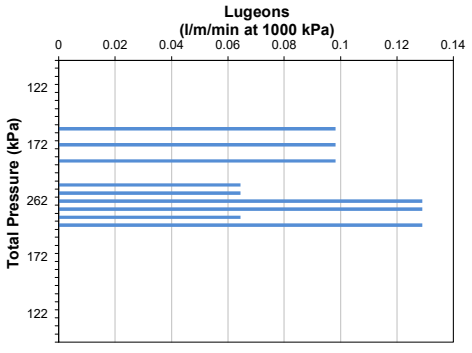
Test pressures increased to targetted pressure prior to the start of each test stage.



Averages			
Stage	Pressure (kPa)	Water Loss (l/m/min)	Lugeons (l/m/min at 1000kPa)
1	122	0.00	0.00
2	172	0.01	0.06
3	262	0.03	0.10
4	172	0.00	0.00
5	122	0.00	0.00

Houlsby Flow Pattern	Laminar Flow
Houlsby Lugeon value	<0.1
Burgess Lugeon value	<0.1

Calculated: MS
Checked: CBW
Date: 19-May-23



WATER PRESSURE TEST RESULTS

Client :	JQZ	**Project No. :**	PS201997
Project :	St. Leonards Development	**Bore :**	BH10A
Location :	Park Rd	**Test section :**	22.50 m - 36.50 m

Test Details

Date:	23-May-23	Bottom of packer (m):	22.50	Height of pressure gauge (m):	0.5	Drum Area (m^2):	
Bore diameter (mm):	96	Bore depth (m):	36.50	Vertical Depth to groundwater (m):	5.1		0.264
Bore inclination (deg):	90	Section length (m):	14.00	(or depth to base of packer)			

Hg = gauge pressure, Hl = head loss in rods and packer, Hw = (gauge height + groundwater depth)x 9.81, Total = Hg+Hw-Hl

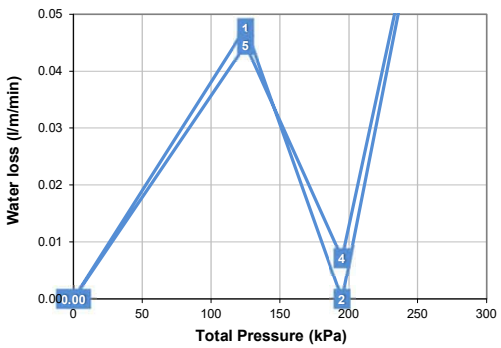
PRESSURE			Test	FLOW RATES								Water	Lugeons	Approx
				Flowmeter			Drum readings			Leakage	Assigned	Loss		Permeability
Hg	Hl	Total	Duration	Initial	Final	Total	Initial	Final	Equivalent		Flow		(l/m/min at	
(kPa)	(kPa)	(kPa)	(min)	(litres)	(litres)	(litres)	(mm)	(mm)	litres	(litres)	(litres)	(l/m/min)	1000 kPa)	(m/sec)
70	0	125	2	9097.0	9098.5	1.5				0.0	1.5	0.1	0.4	4.3E-08
70	0	125	2	9098.5	9099.5	1.0				0.0	1.0	0.0	0.3	2.9E-08
70	0	125	2	9100.0	9101.0	1.0				0.0	1.0	0.0	0.3	2.9E-08
70	0	125	2	9105.5	9107.0	1.5				0.0	1.5	0.1	0.4	4.3E-08
70	0	125	2	9107.0	9109.0	2.0				0.0	2.0	0.1	0.6	5.7E-08
70	0	125	2	9109.0	9110.0	1.0				0.0	1.0	0.0	0.3	2.9E-08
140	0	195	2	9111.5	9111.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	195	2	9111.5	9111.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	195	2	9111.5	9111.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	195	2	9111.5	9111.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	195	2	9111.5	9111.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
210	0	265	2	9112.5	9114.5	2.0				0.0	2.0	0.1	0.3	2.7E-08
210	0	265	2	9114.5	9116.5	2.0				0.0	2.0	0.1	0.3	2.7E-08
210	0	265	2	9116.5	9119.0	2.5				0.0	2.5	0.1	0.3	3.4E-08
210	0	265	2	9119.0	9121.5	2.5				0.0	2.5	0.1	0.3	3.4E-08
210	0	265	2	9121.5	9124.5	3.0				0.0	3.0	0.1	0.4	4.0E-08
140	0	195	2	9130.0	9131.0	1.0				0.0	1.0	0.0	0.2	1.8E-08
140	0	195	2	9131.0	9131.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	195	2	9131.0	9131.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	195	2	9131.0	9131.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	195	2	9131.0	9131.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	125	2	9131.0	9132.5	1.5				0.0	1.5	0.1	0.4	4.3E-08
70	0	125	2	9132.5	9133.5	1.0				0.0	1.0	0.0	0.3	2.9E-08
70	0	125	2	9133.5	9134.5	1.0				0.0	1.0	0.0	0.3	2.9E-08
70	0	125	2	9134.5	9135.5	1.0				0.0	1.0	0.0	0.3	2.9E-08
70	0	125	2	9135.5	9137.0	1.5				0.0	1.5	0.1	0.4	4.3E-08
70	0	125	2	9137.0	9138.5	1.5				0.0	1.5	0.1	0.4	4.3E-08

Notes

Equipment checked on completion of test - water able to flow through packer and pump in working order.

Last dial of flow gauge difficult to read owing to plastic cover.

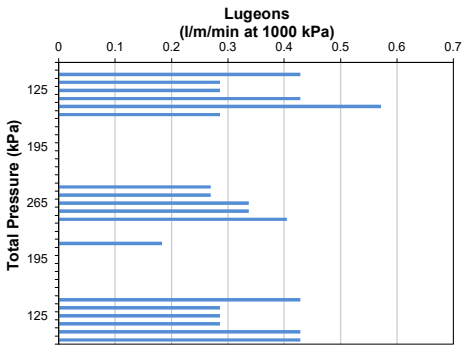
Test pressures increased to targetted pressure prior to the start of each test stage.



Averages			
Stage	Pressure (kPa)	Water Loss (l/m/min)	Lugeons (l/m/min at 1000kPa)
1	125	0.05	0.38
2	195	0.00	0.00
3	265	0.09	0.32
4	195	0.01	0.04
5	125	0.04	0.36

Houlsby Flow Pattern	No Result Obtained
Houlsby Lugeon value	0.2
Burgess Lugeon value	<0.1

Calculated: MS
Checked: CBW
Date: 23-May-23



WATER PRESSURE TEST RESULTS

Client :	JQZ	**Project No. :**	PS201997
Project :	St. Leonards Development	**Bore :**	BH10A
Location :	Park Rd	**Test section :**	22.50 m - 28.50 m

Test Details

Date:	23-May-23	Bottom of packer (m):	22.50	Height of pressure gauge (m):	0.5	Drum Area (m^2):
Bore diameter (mm):	96	Bore depth (m):	28.50	Vertical Depth to groundwater (m):	4.7	0.264
Bore inclination (deg):	90	Section length (m):	6.00	(or depth to base of packer)		

Hg = gauge pressure, Hl = head loss in rods and packer, Hw = (gauge height + groundwater depth)x 9.81, Total = Hg+Hw-Hl

PRESSURE			Test	FLOW RATES								Water	Lugeons	Approx
				Flowmeter			Drum readings			Leakage	Assigned	Loss		Permeability
Hg	Hl	Total	Duration	Initial	Final	Total	Initial	Final	Equivalent		Flow		(l/m/min at	
(kPa)	(kPa)	(kPa)	(min)	(litres)	(litres)	(litres)	(mm)	(mm)	litres	(litres)	(litres)	(l/m/min)	1000 kPa)	(m/sec)
70	0	121	3	9148.5	9150.0	1.5				0.0	1.5	0.1	0.7	6.9E-08
70	0	121	3	9150.0	9151.0	1.0				0.0	1.0	0.1	0.5	4.6E-08
70	0	121	3	9151.0	9152.5	1.5				0.0	1.5	0.1	0.7	6.9E-08
70	0	121	3	9152.5	9153.5	1.0				0.0	1.0	0.1	0.5	4.6E-08
70	0	121	3	9153.5	9155.0	1.5				0.0	1.5	0.1	0.7	6.9E-08
70	0	121	3	9155.0	9156.5	1.5				0.0	1.5	0.1	0.7	6.9E-08
140	0	191	3	9158.5	9159.5	1.0				0.0	1.0	0.1	0.3	2.9E-08
140	0	191	3	9159.5	9160.0	0.5				0.0	0.5	0.0	0.1	1.5E-08
140	0	191	3	9160.0	9160.5	0.5				0.0	0.5	0.0	0.1	1.5E-08
140	0	191	3	9160.5	9162.0	1.5				0.0	1.5	0.1	0.4	4.4E-08
140	0	191	3	9162.0	9164.0	2.0				0.0	2.0	0.1	0.6	5.8E-08
140	0	191	3	9164.0	9166.5	2.5				0.0	2.5	0.1	0.7	7.3E-08
210	0	261	3	9171.0	9175.5	4.5				0.0	4.5	0.3	1.0	9.6E-08
210	0	261	3	9175.5	9180.0	4.5				0.0	4.5	0.3	1.0	9.6E-08
210	0	261	3	9180.0	9184.5	4.5				0.0	4.5	0.3	1.0	9.6E-08
210	0	261	3	9184.5	9189.0	4.5				0.0	4.5	0.3	1.0	9.6E-08
210	0	261	3	9189.0	9193.5	4.5				0.0	4.5	0.3	1.0	9.6E-08
140	0	191	3	9195.5	9199.0	3.5				0.0	3.5	0.2	1.0	1.0E-07
140	0	191	3	9199.0	9201.5	2.5				0.0	2.5	0.1	0.7	7.3E-08
140	0	191	3	9201.5	9204.5	3.0				0.0	3.0	0.2	0.9	8.7E-08
140	0	191	3	9204.5	9207.5	3.0				0.0	3.0	0.2	0.9	8.7E-08
140	0	191	3	9207.5	9210.5	3.0				0.0	3.0	0.2	0.9	8.7E-08
70	0	121	3	9212.5	9213.5	1.0				0.0	1.0	0.1	0.5	4.6E-08
70	0	121	3	9213.5	9213.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	121	3	9213.5	9213.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	121	3	9213.5	9213.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	121	3	9213.5	9213.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	121	3	9213.5	9213.5	0.0				0.0	0.0	0.0	0.0	0.0E+00

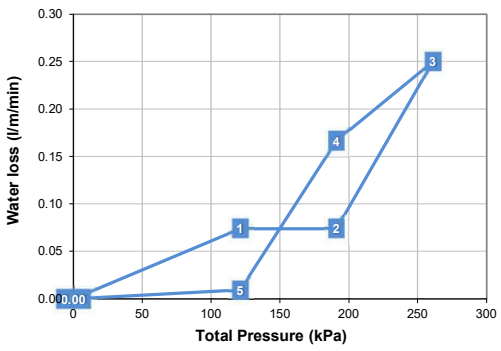
Notes

Equipment checked on completion of test - water able to flow through packer and pump in working order.

Last dial of flow gauge difficult to read owing to plastic cover.

Test pressures increased to targetted pressure prior to the start of each test stage.

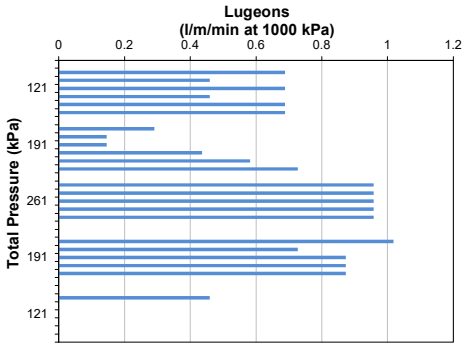
No flow noted in final stage of test.



Averages			
Stage	Pressure (kPa)	Water Loss (l/m/min)	Lugeons (l/m/min at 1000kPa)
1	121	0.07	0.61
2	191	0.07	0.39
3	261	0.25	0.96
4	191	0.17	0.87
5	121	0.01	0.08

Houlsby Flow Pattern	Laminar Flow
Houlsby Lugeon value	0.6
Burgess Lugeon value	<0.1

Calculated: HW
Checked: CBW
Date: 29-May-23



WATER PRESSURE TEST RESULTS

Client :	JQZ	**Project No. :**	PS201997
Project :	Berry Road Development	**Bore :**	BH10A
Location :	Berry Road St Leonards	**Test section :**	16.60 m - 22.60 m

Test Details

Date:	23-May-23	Bottom of packer (m):	16.60	Height of pressure gauge (m):	1.0	Drum Area (m^2):
Bore diameter (mm):	96	Bore depth (m):	22.60	Vertical Depth to groundwater (m):	4.4	0.264
Bore inclination (deg):	90	Section length (m):	6.00	(or depth to base of packer)		

Hg = gauge pressure, Hl = head loss in rods and packer, Hw = (gauge height + groundwater depth)x 9.81, Total = Hg+Hw-Hl

PRESSURE			Test	FLOW RATES								Water	Lugeons	Approx
				Flowmeter			Drum readings			Leakage	Assigned	Loss		Permeability
Hg	Hl	Total	Duration	Initial	Final	Total	Initial	Final	Equivalent		Flow		(l/m/min at	
(kPa)	(kPa)	(kPa)	(min)	(litres)	(litres)	(litres)	(mm)	(mm)	litres	(litres)	(litres)	(l/m/min)	1000 kPa)	(m/sec)
50	0	103	2	9216.5	9218.0	1.5				0.2	1.3	0.1	1.1	1.1E-07
50	0	103	2	9218.0	9219.0	1.0				0.2	0.8	0.1	0.6	6.5E-08
50	0	103	2	9219.0	9220.5	1.5				0.2	1.3	0.1	1.1	1.1E-07
50	0	103	2	9220.5	9221.5	1.0				0.3	0.7	0.1	0.6	5.7E-08
50	0	103	2	9221.5	9222.8	1.3				0.4	0.9	0.1	0.7	7.3E-08
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
150	0	203	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
150	0	203	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
150	0	203	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
150	0	203	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
150	0	203	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	153	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	103	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	103	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	103	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	103	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	103	2	9226.8	9226.8	0.0				0.0	0.0	0.0	0.0	0.0E+00

Notes

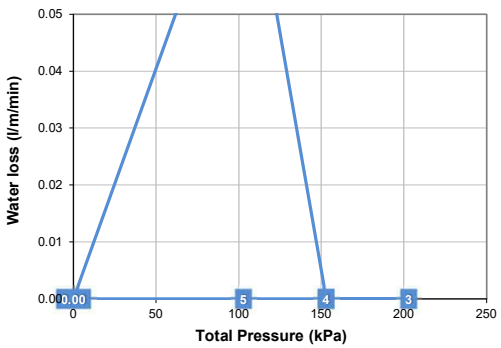
No flow recorded in Stages 2, 3, 4 or 5.

Equipment checked on completion of test - water able to flow through packer and pump in working order.

Last dial of flow gauge difficult to read owing to plastic cover.

No movement of flow meter observed during Stages 2, 3, 4 or 5.

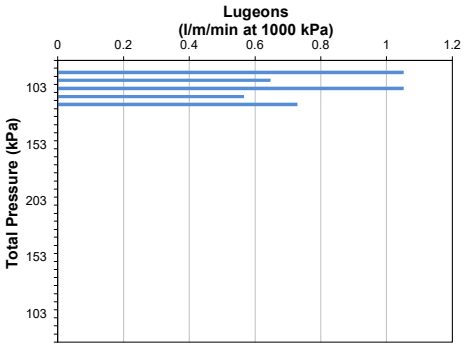
Test pressures increased to targetted pressure prior to the start of each test stage.



Averages			
Stage	Pressure (kPa)	Water Loss (l/m/min)	Lugeons (l/m/min at 1000kPa)
1	103	0.08	0.81
2	153	0.00	0.00
3	203	0.00	0.00
4	153	0.00	0.00
5	103	0.00	0.00

Houlsby Flow Pattern	Laminar Flow
Houlsby Lugeon value	0.2
Burgess Lugeon value	<0.1

Calculated: CBW
Checked: CBW
Date: 25-Jul-22



WATER PRESSURE TEST RESULTS

Client :	JQZ	**Project No. :**	PS201997
Project :	Berry Road Development	**Bore :**	BH10A
Location :	Berry Road St Leonards	**Test section :**	10.60 m - 16.60 m

Test Details

Date:	23-May-23	Bottom of packer (m):	10.60	Height of pressure gauge (m):	1.0	Drum Area (m^2):	
Bore diameter (mm):	96	Bore depth (m):	16.60	Vertical Depth to groundwater (m):	2.3		0.264
Bore inclination (deg):	90	Section length (m):	6.00	(or depth to base of packer)			

Hg = gauge pressure, Hl = head loss in rods and packer, Hw = (gauge height + groundwater depth)x 9.81, Total = Hg+Hw-Hl

PRESSURE			Test	FLOW RATES								Water	Lugeons	Approx
				Flowmeter			Drum readings			Leakage	Assigned	Loss		Permeability
Hg	Hl	Total	Duration	Initial	Final	Total	Initial	Final	Equivalent		Flow		(l/m/min at	
(kPa)	(kPa)	(kPa)	(min)	(litres)	(litres)	(litres)	(mm)	(mm)	litres	(litres)	(litres)	(l/m/min)	1000 kPa)	(m/sec)
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	132	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	132	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	132	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	132	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
100	0	132	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	102	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
40	0	72	2	9315.5	9315.5	0.0				0.0	0.0	0.0	0.0	0.0E+00

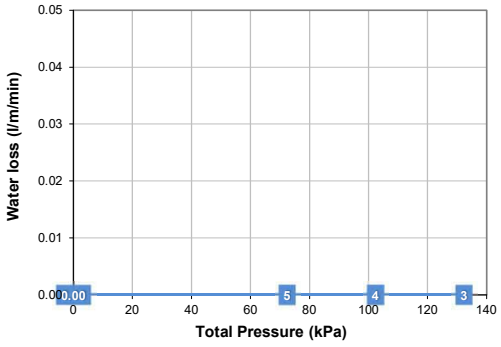
Notes

No flow recorded during test.

Equipment checked on completion of test - water able to flow through packer and pump in working order.

Last dial of flow gauge difficult to read owing to plastic cover.

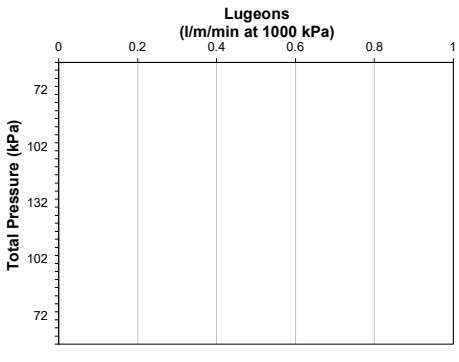
Test pressures increased to targetted pressure prior to the start of each test stage.



Averages			
Stage	Pressure (kPa)	Water Loss (l/m/min)	Lugeons (l/m/min at 1000kPa)
1	72	0.00	0.00
2	102	0.00	0.00
3	132	0.00	0.00
4	102	0.00	0.00
5	72	0.00	0.00

Houlsby Flow Pattern	
Houlsby Lugeon value	<0.1
Burgess Lugeon value	<0.1

Calculated: MS
Checked: CBW
Date: 25-Jul-22



WATER PRESSURE TEST RESULTS

Client :	JQZ	**Project No. :**	PS201997
Project :	St Leonards Development	**Bore :**	BH11
Location :	26 Park Rd	**Test section :**	13.30 m - 19.30 m

Test Details

Date:	25-May-23	Bottom of packer (m):	13.30	Height of pressure gauge (m):	0.0	Drum Area (m^2):	
Bore diameter (mm):	96	Bore depth (m):	19.30	Vertical Depth to groundwater (m):	0.0		0.264
Bore inclination (deg):	90	Section length (m):	6.00	(or depth to base of packer)			

Hg = gauge pressure, Hl = head loss in rods and packer, Hw = (gauge height + groundwater depth)x 9.81, Total = Hg+Hw-Hl

PRESSURE			Test	FLOW RATES								Water	Lugeons	Approx
				Flowmeter			Drum readings			Leakage	Assigned	Loss		Permeability
Hg	Hl	Total	Duration	Initial	Final	Total	Initial	Final	Equivalent		Flow		(l/m/min at	
(kPa)	(kPa)	(kPa)	(min)	(litres)	(litres)	(litres)	(mm)	(mm)	litres	(litres)	(litres)	(l/m/min)	1000 kPa)	(m/sec)
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
130	0	130	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
130	0	130	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
130	0	130	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
130	0	130	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
130	0	130	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
90	0	90	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
50	0	50	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00

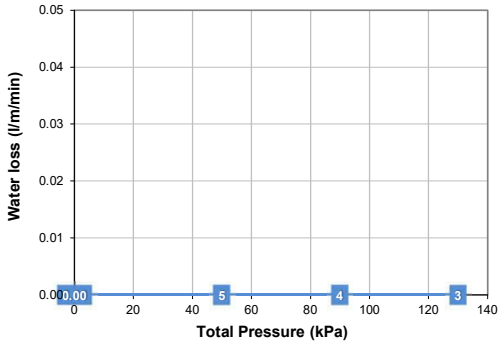
Notes

No flow recorded in any stage test.

Equipment checked on completion of test - water able to flow through packer and pump in working order.

Last dial of flow gauge difficult to read owing to plastic cover.

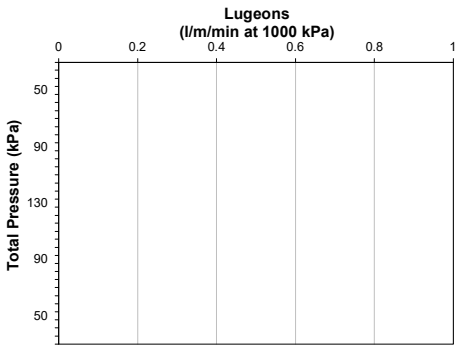
Test pressures increased to targetted pressure prior to the start of each test stage.



Averages			
Stage	Pressure (kPa)	Water Loss (l/m/min)	Lugeons (l/m/min at 1000kPa)
1	50	0.00	0.00
2	90	0.00	0.00
3	130	0.00	0.00
4	90	0.00	0.00
5	50	0.00	0.00

Houlsby Flow Pattern	Laminar Flow
Houlsby Lugeon value	<0.1
Burgess Lugeon value	<0.1

Calculated: HW
Checked: CBW
Date: 25-Jul-22



WATER PRESSURE TEST RESULTS

Client :	JQZ	**Project No. :**	PS201997
Project :	Berry Road Development	**Bore :**	BH11
Location :	Park Road St Leonards	**Test section :**	7.30 m - 13.30 m

Test Details

Date:	25-May-23	Bottom of packer (m):	7.30	Height of pressure gauge (m):	0.0	Drum Area (m^2):
Bore diameter (mm):	96	Bore depth (m):	13.30	Vertical Depth to groundwater (m):	0.0	0.264
Bore inclination (deg):	90	Section length (m):	6.00	(or depth to base of packer)		

Hg = gauge pressure, Hl = head loss in rods and packer, Hw = (gauge height + groundwater depth)x 9.81, Total = Hg+Hw-Hl

PRESSURE			Test	FLOW RATES								Water	Lugeons	Approx
				Flowmeter			Drum readings			Leakage	Assigned	Loss		Permeability
Hg	Hl	Total	Duration	Initial	Final	Total	Initial	Final	Equivalent		Flow		(l/m/min at	
(kPa)	(kPa)	(kPa)	(min)	(litres)	(litres)	(litres)	(mm)	(mm)	litres	(litres)	(litres)	(l/m/min)	1000 kPa)	(m/sec)
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
75	0	75	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
75	0	75	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
75	0	75	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
75	0	75	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
75	0	75	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
55	0	55	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00
35	0	35	2	9334.5	9334.5	0.0				0.0	0.0	0.0	0.0	0.0E+00

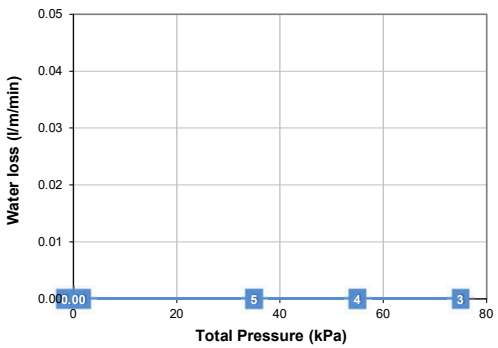
Notes

No flow recorded in any stage test.

Equipment checked on completion of test - water able to flow through packer and pump in working order.

Last dial of flow gauge difficult to read owing to plastic cover.

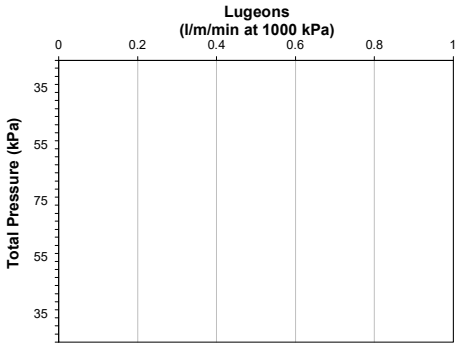
Test pressures increased to targetted pressure prior to the start of each test stage.



Averages			
Stage	Pressure (kPa)	Water Loss (l/m/min)	Lugeons (l/m/min at 1000kPa)
1	35	0.00	0.00
2	55	0.00	0.00
3	75	0.00	0.00
4	55	0.00	0.00
5	35	0.00	0.00

Houlsby Flow Pattern	Laminar Flow
Houlsby Lugeon value	<0.1
Burgess Lugeon value	<0.1

Calculated: HW
Checked: CBW
Date: 25-Jul-22



WATER PRESSURE TEST RESULTS

Client :	JQZ	**Project No. :**	PS201997
Project :	Berry Road Development	**Bore :**	BH12
Location :	Berry Road St Leonards	**Test section :**	21.00 m - 25.21 m

Test Details

Date:	23-May-23	Bottom of packer (m):	21.00	Height of pressure gauge (m):	0.5	Drum Area (m^2):
Bore diameter (mm):	96	Bore depth (m):	25.21	Vertical Depth to groundwater (m):	4.7	0.264
Bore inclination (deg):	90	Section length (m):	4.21	(or depth to base of packer)		

Hg = gauge pressure, Hl = head loss in rods and packer, Hw = (gauge height + groundwater depth)x 9.81, Total = Hg+Hw-Hl

PRESSURE			Test	FLOW RATES								Water	Lugeons	Approx
				Flowmeter			Drum readings			Leakage	Assigned	Loss		Permeability
Hg	Hl	Total	Duration	Initial	Final	Total	Initial	Final	Equivalent		Flow		(l/m/min at	
(kPa)	(kPa)	(kPa)	(min)	(litres)	(litres)	(litres)	(mm)	(mm)	litres	(litres)	(litres)	(l/m/min)	1000 kPa)	(m/sec)
70	0	121	2	9006.6	9007.0	0.4				0.0	0.4	0.0	0.4	3.9E-08
70	0	121	2	9007.0	9008.0	1.0				0.0	1.0	0.1	1.0	9.8E-08
70	0	121	2	9008.0	9008.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	121	2	9008.0	9008.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
70	0	121	2	9008.0	9008.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	191	2	9008.0	9008.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	191	2	9008.0	9008.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	191	2	9008.0	9008.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	191	2	9008.0	9008.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
140	0	191	2	9008.0	9008.0	0.0				0.0	0.0	0.0	0.0	0.0E+00
200	0	251	2	9060.9	9063.0	2.1				0.0	2.1	0.2	1.0	9.9E-08
200	0	251	2	9063.0	9063.5	0.5				0.0	0.5	0.1	0.2	2.4E-08
200	0	251	2	9063.5	9065.0	1.5				0.0	1.5	0.2	0.7	7.1E-08
200	0	251	2	9065.0	9067.0	2.0				0.0	2.0	0.2	0.9	9.5E-08
200	0	251	2	9067.0	9068.3	1.3				0.0	1.3	0.2	0.6	6.2E-08
140	0	191	2	9070.8	9072.0	1.2				0.0	1.2	0.1	0.7	7.5E-08
140	0	191	2	9072.0	9073.0	1.0				0.0	1.0	0.1	0.6	6.2E-08
140	0	191	2	9073.0	9074.0	1.0				0.0	1.0	0.1	0.6	6.2E-08
140	0	191	2	9074.0	9075.0	1.0				0.0	1.0	0.1	0.6	6.2E-08
70	0	121	2	9076.0	9077.0	1.0				0.0	1.0	0.1	1.0	9.8E-08
70	0	121	2	9077.0	9078.0	1.0				0.0	1.0	0.1	1.0	9.8E-08
70	0	121	2	9078.0	9078.5	0.5				0.0	0.5	0.1	0.5	4.9E-08
70	0	121	2	9078.5	9079.0	0.5				0.0	0.5	0.1	0.5	4.9E-08
70	0	121	2	9079.0	9079.5	0.5				0.0	0.5	0.1	0.5	4.9E-08

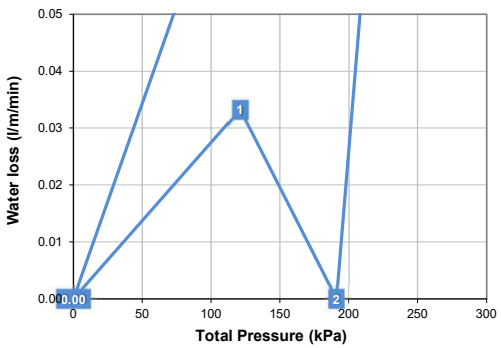
Notes

No flow recorded in Stage 2.

Equipment checked on completion of test - water able to flow through packer and pump in working order.

Last dial of flow gauge difficult to read owing to plastic cover.

Test pressures increased to targetted pressure prior to the start of each test stage.



Averages			
Stage	Pressure (kPa)	Water Loss (l/m/min)	Lugeons (l/m/min at 1000kPa)
1	121	0.03	0.27
2	191	0.00	0.00
3	251	0.18	0.70
4	191	0.12	0.65
5	121	0.08	0.69

Houlsby Flow Pattern	Laminar Flow
Houlsby Lugeon value	0.5
Burgess Lugeon value	<0.1

Calculated: MS
Checked: CBW
Date: 29-May-23

