ENVIRONMENTAL CONSULTING SERVICES

# DEWATERING MANAGEMENT PLAN

Proposed Commercial Development
8-10 Lee Street
Haymarket NSW 2000

ENVIRONMENTAL CONSULTING SERVICES PTY LTD
E: simon@ecsgroup.com.au | P: 0415 225 474 | ABN 75 073 668 425

## Disclaimer

This report has been prepared for the exclusive use of Rainbow Group Pty Ltd. Use or copying this document without the permission of Environmental Consulting Services Group Pty Ltd is not permitted.

| **Register of Amendments** | | |
|---|---|---|
| **Revision** | **Date** | **Description** |
| **1** | 22.04.2022 | Initial draft for review |
| **2** | 10.05.2022 | Issued for use |
| **3** | 16.05.2022 | Revised to include greater pump rate |
| **4** | 27.05.2022 | Revised to include Douglas Partners Comments (20.05.2022) |

| **Document Approval** | | |
|---|---|---|
| **Approved by** | **Date** | **Signed** |
| **Simon Caples**<br>**Principal Consultant** | 10.05.2022 | |

**Environmental Consulting Services Pty Ltd**

**Address:** 10 Fort Street
Petersham NSW 2049

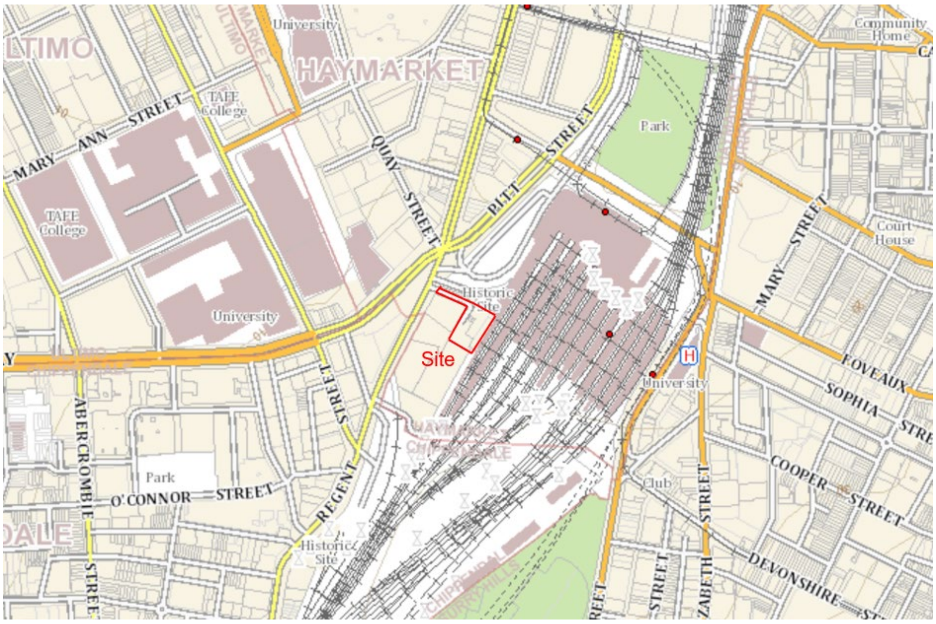
**Phone:** 0415 225 474
**Email:** simon@ecsgroup.com.au

# TABLE OF CONTENTS

## 1.0 INTRODUCTION

Environmental Consulting Services Pty Ltd (ECS) was engaged by Rainbow Group to prepare a Dewatering Management Plan (DMP) for the proposed construction of a 38-storey mixed-use tower over a two-level basement at 8-10 Lee Street in Haymarket (the Site). The location of the Site is shown on Figure 1.

**Figure 1 – Site Location**




Dewatering will be required to allow the excavation of the basement associated with the proposed development of the Site. This DMP will be used as the basis for approval for the required dewatering by the Sydney Water. It is understood that discharge to City of Sydney stormwater drainage system is not accessible at this location.

Based on the investigations conducted at the Site the expected volume of water that will be extracted during the development will be 4.1 ML (during the six month construction phase of the project) and thus an aquifer interference approval from Water NSW will be required.

## 2.0 SITE DESCRIPTION

The Site is known as 8 – 10 Lee Street in Haymarket and is described as:

- Lot 116 in DP 1078271;
- Lot 117 in DP 1078271; and
- Lot 13 in DP 1062447.

All the lots are in the freehold ownership of Transport for NSW (TNSW) and subject to various leasing arrangements.

The total Site is approximately 3,400m$^2$ in area and the development will include a basement of approximately 1800m$^2$.

The Site is in an area that is predominantly used for commercial purposes and is bounded by the Adina Hotel (former Parcel Post Office) to the west and the ‘CountryLink’ and ‘Intercity’ railway platforms to the east.

Current improvements on the Site include the Parcels Shed, which operated in association with the former Parcels Post Office (now the Adina Hotel). The Site is currently used as the Sydney Railway Square Youth Hostel (YHA). The Site also includes the western entryway to the Devonshire Tunnel, which runs east-west through Central Station under the existing railway lines.

Surface levels on the Site fall gently to the north-west with existing surface elevations from RL21.2m to RL15.5m relative to AHD.

Stormwater runoff form the Site is anticipated to drain following the regional topography towards the north-west.

The inferred groundwater flow direction is north to north westerly towards Darling Harbour which is located approximately 1.1 km northwest of the Site.

## 2.1 Regional Geology and Hydrogeology

The Sydney 1:100,000 geological map sheet (Sheet 9130 Edition 1, dated 1983) indicates the Site is located on Ashfield Shale overlying Hawkesbury sandstone.

Investigation completed at the Site (Douglas Partners) have reported subsurface conditions that consists of the following:

| | |
|---|---|
| Concrete | Single or multiple concrete slabs, with or without a brick pavement, asphalt layer, or surface ballast layer<br>Over |
| Fill | Gravel, sand or clay fill to depths ranging between 4.7 m and 6.3 m on the eastern side of the YHA, or 0.0-2.2 m depth within the access corridor and Gate |
| Alluvial Sand | Loose to medium dense, alluvial sand, 0.4-1.2 m thick; over |
| Residual Silty Clay | Soft to hard, residual silty clay, with some ironstone gravel (0.75-2.2 m thick)<br>Over |
| Residual Sandy Clay | Very stiff to hard, residual sandy clay (0.2-0.6 m thick); over |
| Sandstone (Fine to Medium) | Very low to low strength, fine to medium grained sandstone with some medium or high strength, iron-cemented bands (0.65-1.8 m thick). Numerous clay<br>seams were encountered;<br>over |
| Sandstone (Medium) | Medium or high strength, medium grained sandstone |

## 3.0 PROPOSED DEVELOPMENT

It is proposed to redevelop the Site for commercial purposes including multi-level commercial buildings with a common two level basement. A copy of development plans included in Appendix A.

The elevation of the ground surface at Lee Street adjacent to the Site is approximately 16m AHD. Following development the lower basement floor slab level will be at a level of 5m AHD.

Consent for the proposed development has been provided in the State Significant Development (SSD 10405) instrument of consent. This consent includes the following conditions that are relevant to the proposed dewatering activities:

**Condition E26** – *Prior to the commencement of any demolition, earthworks or construction works, the Applicant must prepare a Groundwater Management Plan for the construction phase in consultation with Department of Planning, Industry and Environment, and Water NSW that includes the following:*

*a) Trigger levels (levels, quality, flow, volume and ground surface settlement) to manage any potential impacts;*
*b) Details of monitoring (groundwater levels, quality as required, rate of inflow, metered pumping);*
*c) Where a risk of ground settlement is identified due to the proposed dewatering, the proponent is to provide a program of monitoring, trigger and response to relevant consent authorities as well as the relevant transport (rail) authority; and*
*d) Details on the installation of metering of ongoing groundwater where metering instruments should meet the NSW Government's requirements for water meters and relevant Australian Standards, or the prescribed process to be applied for measuring take.*

**Condition E27** - *Prior to the commencement of any demolition, earthworks or construction works, the Applicant must develop a dewatering reporting schedule covering the duration of construction in consultation with Department of Planning, Industry and Environment, and Water NSW that includes the following:*

*a) collation of monitoring records;*
*b) analysis of actual impacts compared to predicted impacts, noting that some impacts may be delayed;*
*c) magnitude and extent of potential long-term effects from the completed structure; and*
*d) arrangements for reporting (measurements, technical analysis and future predictions) to relevant authorities.*

## 4.0 GROUNDWATER CHARACTERISTICS

The Site has been the subject of environmental investigations undertaken to assess soil and groundwater conditions at the Site. The findings of these investigations were presented in the following reports:

- Preliminary Contamination Site Investigation (Douglas Partners Report 86767.01.R.001.DftB, dated 29 August 2019) ;
- Supplementary Contamination Site Investigation (Douglas Partners Report 86767.03.R.001.DftA, dated 18 June 2020);
- Groundwater Modelling (Douglas Partners Report 86767.04.R.003.Rev0, dated 6 October 2020); and
- Addendum to Groundwater Modelling Report Proposed Commercial Development 8-10 Lee Street, Haymarket (Douglas Partners Report 86767.04. R.014.Rev0, dated 4 March 2022).

Groundwater permeability testing and long-term monitoring of groundwater levels in standpipes has been carried out at the Site since July 2019. This monitoring has reported groundwater at between 12.3m and 14.3m AHD at various monitoring locations and dates.

The groundwater modelling completed reported cumulative inflows during the first year of basement construction are predicted to be about 6.9 ML. In the long-term, inflows are predicted to be less than 3.8 ML per year. The predicted inflow rates are summarised in Table 5 of the Groundwater Modelling report.

During the early stages of construction, inflow rates will be higher and will then gradually decrease as the groundwater storage in the aquifer around the excavation decreases and the cone of depression in the potentiometric surface expands out from the basement.

Groundwater sampling has indicated the presence of copper and zinc at concentrations above the groundwater site assessment criteria (SAC). These elevated levels of copper and zinc in groundwater were considered common in heavily urbanised areas. Elevated levels of copper and zinc were identified in both the up-gradient and down-gradient groundwater wells. The source of the copper and zinc is uncertain but considered likely to represent regional background levels rather than site-specific levels.

The monitoring reports concluded that *on the basis of the current information, any water collected on site should be stored in a holding tank for further assessment of contaminants (including iron), pH, oil and grease, suspended solids, volatile organic compounds (VOC) and hardness prior to disposal. It is anticipated that the groundwater will be suitable for disposal following appropriate treatment (subject to monitoring results)*.

It was anticipated that water treatment may include:

- Settlement tanks, to remove suspended solids from the tail water prior to discharge;
- Oil-water separator vessels, to recover floating product and separate sinking product (if any); and/or
- Sand filtration, to remove fine sediment from the water stream.

## 5.0 DEWATERING

The proposed development includes the construction of a two level basement with the lower floor slab level at 5m AHD. The construction of the basement will be through the construction of a contiguous pile wall with piles extending below the basement excavation level and socketed into sandstone. There will be drainage installed behind sections of the pile wall covered by shotcrete. The basement will be free draining.

Dewatering will be required at this Site to remove the entrapped groundwater within the pile wall during excavation activities and minor inflow during the construction process. The proposed dewatering system will consist of sump pumps within the excavation that will be moved to allow effective dewatering during excavation.

It is intended to pump the water to the Sydney Water owned stormwater drainage system as City of Sydney drains are not accessible for this project. Water quality is expected to meet discharge requirements for stormwater.

The tail water will be directed to the stormwater pit at the intersection of the access to the Site and Lee Street. This pit is a Sydney Water asset and is connected to a Sydney Water stormwater pipe. A plan showing this location is included in Appendix A.

Dewatering pumps and associated equipment must meet all conditions in the development consent and the requirements of EPA "Interim Construction Noise Guidelines July 2009" and "Draft Construction Noise Guidelines 2020" noting that dewatering has potential to work 24 hours a day seven days a week.

To allow construction of the basement the groundwater needs to be lowered by approximately 9m. The expected yield from the groundwater extraction has been completed (Douglas Partners October 2020 & March 2022). A copy of these assessment are included in Appendix B.

The calculated initial yield from the dewatering system at commencement is approximately 26.7 $m^3$ per day (0.31 L/second).

The expected duration of operation of the dewatering system is 12 months. The estimated volume of water extracted during the project over the 12 month (360 days) period is approximately 6.9 ML. The quantity of water discharges will be measured by the use of a calibrated meter.

## 5.1 Discharge Quality Requirements

Shallow groundwater at this Site is currently considered to be discharging to the Darling Harbour which is approximately 1 km to the West of the Site. The extracted groundwater will be discharge to established stormwater drains on Site if the water quality of the extracted water is suitable.

Water quality requirements for disposal of tail water to storm water drains are as follows:

- Turbidity / Total suspended solids - water is to be clear and free of visible suspended soils (< 50 mg/L);
- Oils and greases - no visible oil or grease film (< 10mg/L);
- pH Level - to be between 6.5 and 8.5; and
- Threshold criteria for aquatic ecosystems.

Groundwater sampling will be conducted at the start of dewatering and during dewatering to establish the quality of the discharge water. Results of analysis will be evaluated using background water quality values and also the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

In the event concentrations of contaminants within the groundwater exceed threshold criteria acceptable for discharge to freshwater environments, the water will be stored and treated in a specifically designed treatment system before discharge.

Storage tanks (3 x 20000 litres) are to be used to filter silt and also aid in the treatment of water if required. Treatment may include the adding lime to increase the pH or diluted hydrochloric acid to reduce the ph. Also lime softening for the treatment of zinc.

If VOCs are detected in the discharge water, treatment will include the use of an air stripper to remove the VOCs and/or the use of activated carbon filters.

Retention within the Site will be utilised as a short-term option until the treatment facility is commissioned and operating. The contaminated water may require various remedial techniques depending on the contaminants of concern encountered.

All discharges of water will be via a Sydney Water registered flow meter that will record daily and total discharges of water from Site in accordance with condition E26(b).

It is understood that the stormwater drainage system at this location discharges to the Darling Harbour. Water quality requirements for disposal of water to storm water drains are presented in Table 1.

### Table 1 – Discharge Water Quality Guidelines

| Contaminant | Trigger Levels | Monitoring Frequency |
|---|---|---|
| Turbidity/suspended solids | Water is to be clear (<10 NTU / < 50mg/l) | Daily during discharge |
| Oils and greases | no visible oil (< 10mg/L) | Daily |
| pH | between 6.5 and 8.5 | Daily |
| Arsenic | 2.3 µg/l | Weekly |
| Cadmium | 0.2 µg/l | Weekly |
| Chromium | No guideline | Weekly |
| Copper | 1.4 µg/l | Weekly |
| Lead | 3.4 µg/l | Weekly |
| Mercury | 0.6 µg/l | Weekly |
| Nickel | 11 µg/l | Weekly |
| Zinc | 8 µg/l | Weekly |
| Chlorinated Solvents | Drinking water guidelines / < Laboratory Level of Reporting | Weekly |

Note: frequency is based on continuous discharge

Groundwater sampling will be conducted at the start of dewatering and during dewatering to establish the quality of the discharge water. Results of analysis will be evaluated using background water quality values and also the Australian and New Zealand Guidelines for Fresh and Marine Water Quality

Initial discharge water sampling will be conducted once the dewatering system is installed but with tail water directed onto the Site (no off-site discharge). Once the water quality has been confirmed as suitable for discharge then water testing for pH, turbidity and oil & grease will be conducted by Site personnel daily and sampling for chemical analysis weekly for four weeks. Monthly sampling for chemical analysis will then be conducted as long as results from the weekly sampling have shown the water is suitable for ongoing discharge (and subject to Council approval).

In the event concentrations of contaminants within the groundwater exceed threshold criteria acceptable for discharge, the contaminated water will be stored and treated in a specifically designed treatment system before discharge. Discharge of water to Sydney Water 1500 culvert must be halted immediately where the water quality is found to not meet the referenced guidelines.

## 5.2 Anticipated Impacts

There are no neighbouring groundwater users and no spring dependent ecosystems in the vicinity of the Site. In addition the dewatering will be conducted within a contiguous pile wall which is expected to restrict the ingress of groundwater which in turn will minimise the potential for subsidence on neighbouring properties although monitoring the water levels outside the pile wall (but on the Site) will be undertaken.

Four external monitoring well (outside the pile wall) will be installed around the perimeter of the excavation to a minimum depth of 16 metres (4 m below proposed excavation depth of RL 5). These wells would be monitored daily during the basement construction period (which is anticipated to be approximately 12 months) and recorded in a spreadsheet that would be forwarded to geotechnical engineer if groundwater levels move drop than 100 mm per day for 3 consecutive days (equalling 300mm or more in any 3 day period) to confirm groundwater drawdown levels are in compliance with geotechnical recommendations. In the event that unacceptable drawdown is observed (greater than 300mm consecutively over 3 days or 500mm during the course of excavation dewatering works) then additional geotechnical investigation should be undertaken.

Monitoring also needs to meet the specified in the report entitled Structural Monitoring Alert and Response Plan (TTW (NSW) Pty Ltd. 191797 Revision D. 11 February 2022). This report includes predicted settlement/movements associated with the development.

The Site has been the subject of various engineering investigation that consider the potential impacts from the development. This DMP must be implemented in conjunction with the following:

- Impact Assessment - TfNSW Assets Proposed Commercial Development 8-10 Lee Street, Haymarket (Douglas Partners Document No. DP-RPT-0023. Project 86767.04 February 2022); and
- Structural Monitoring Alert and Response Plan Atlassian Central (TTW (NSW) PTY LTD Document No 191797 February 2022).

The Structural Monitoring and Alert Response Plan has established trigger levels for movement of adjoining assets and nominated monitoring requirements during and post construction.

## 6.0 REPORTING

Development Consent Condition E27 requires that dewatering reporting schedule for the duration of construction is developed. This schedule must include:

a) collation of monitoring records;
b) analysis of actual impacts compared to predicted impacts, noting that some impacts may be delayed;
c) magnitude and extent of potential long-term effects from the completed structure; and
d) arrangements for reporting (measurements, technical analysis and future predictions) to relevant authorities.

Water quality monitoring will be undertaken by an experienced environmental consultant with results of monitoring reviewed on receipt from the analytical laboratory.

In accordance with the consent conditions, monitoring reports will be prepared weekly initially and then extended to monthly (consecutive with the sampling regime) where applicable and provided to the contractor undertaking the dewatering.

The reports will record actual results against predicted level and guideline criteria, record total volume discharged in reporting period and also total volume discharge to date. The report will also include groundwater draw down levels.

The report will identify actions that needs to be undertaken potentially including but not limited requiring to halt discharge.

Copies of the weekly reports will be submitted to Water NSW in accordance with their normal requirements included on the Statement of Approval – Water NSW licence for groundwater extinction.

The reporting schedule based on dewatering activities is summarised in Table 2.

**Table 2 – Reporting Schedule**

| Aspect | Frequency | Analysis | Reporting |
|---|---|---|---|
| Discharge rate | Daily | Comparison with predicted rate in Table 3 of the Addendum to Groundwater Modelling report (4 March 2022) | Where discharge rates exceed the Groundwater Model, Douglas Partners must be notified |
| | | Comparison with predicted rate in Table 3 of the Addendum to Groundwater Modelling report (4 March 2022) | Where discharge rates exceed the predicted flows notify Water NSW |
| Drawdown | Daily | Where drawdown in any perimeter monitoring well is greater than 100mm | Notify Douglas Partners |
| Water Quality | Daily | Monitor Turbidity, pH and oil & grease | Notify the project environmental consultant |
| | Weekly then monthly | Collect discharge water samples for evaluation against water quality trigger levels | Notify project manager of exceedances and where necessary stop discharge. |
| Structural Impacts | To be established | Comparison with Structural Monitoring and Alert Response Plan | Undertake notification in accordance with Structural Monitoring and Alert Response Plan |

The weekly/monthly reports will be available onsite for inspection by Sydney Water, City of Sydney and TfNSW representatives if requested.

Reports must also be prepared in accordance with all and any conditions imposed by regulating authorities.

## 7.0 STORMWATER MANAGEMENT

Condition E20 of the development consent requires management of infiltration of stormwater (either from direct precipitation or overland flow) into the excavation.

Site limitations, including the proposed area of excavation (that encompasses most of the total site area) and existing level and drainage will required the collection and temporary storage of stormwater within the basement excavation. On this basis the stormwater will be managed concurrently with groundwater.

It is anticipated that the excavation can be bunded along the Ambulance Avenue frontage via concrete F type kerbs with associated pedestrian fence. The base of these kerbs will have a asphalt kerb placed to provide a gutter to drain water from Lee Street (approx. 1900 sq m area) to stormwater system located to east (refer to Appendix A).

Ambulance Avenue will be isolated from Lee Street by a bund built at entrance located east of existing City of Sydney stormwater pits. This will extend across the Adina entry to inhibit stormwater from Lee Street entering the excavation (refer to the Sediment and Erosion Control Plan).

The Site is surrounded by facilities/area with hard surfaces. These existing hard surfaces will be maintained as required and the stormwater drainage system will be upgraded in accordance with the project plans. Enviropods will be installed in place of sediment socks. Broken/damaged sections of pavements/hard surfaces will be repaired/sealed to the extent practicable during the excavation activities. It is intended to install the new stormwater drainage system prior to commencement of the basement excavation activities.

In the event of 1 in 5 year or 1 in 100 year ARI's the water will be collected within the excavation, either within bunds or in severe rain fall events in the total excavation.

Once the immediate rainfall event is concluded, treatment and water discharge will commence in accordance with the DMP.

## 8.0 CONCLUSIONS

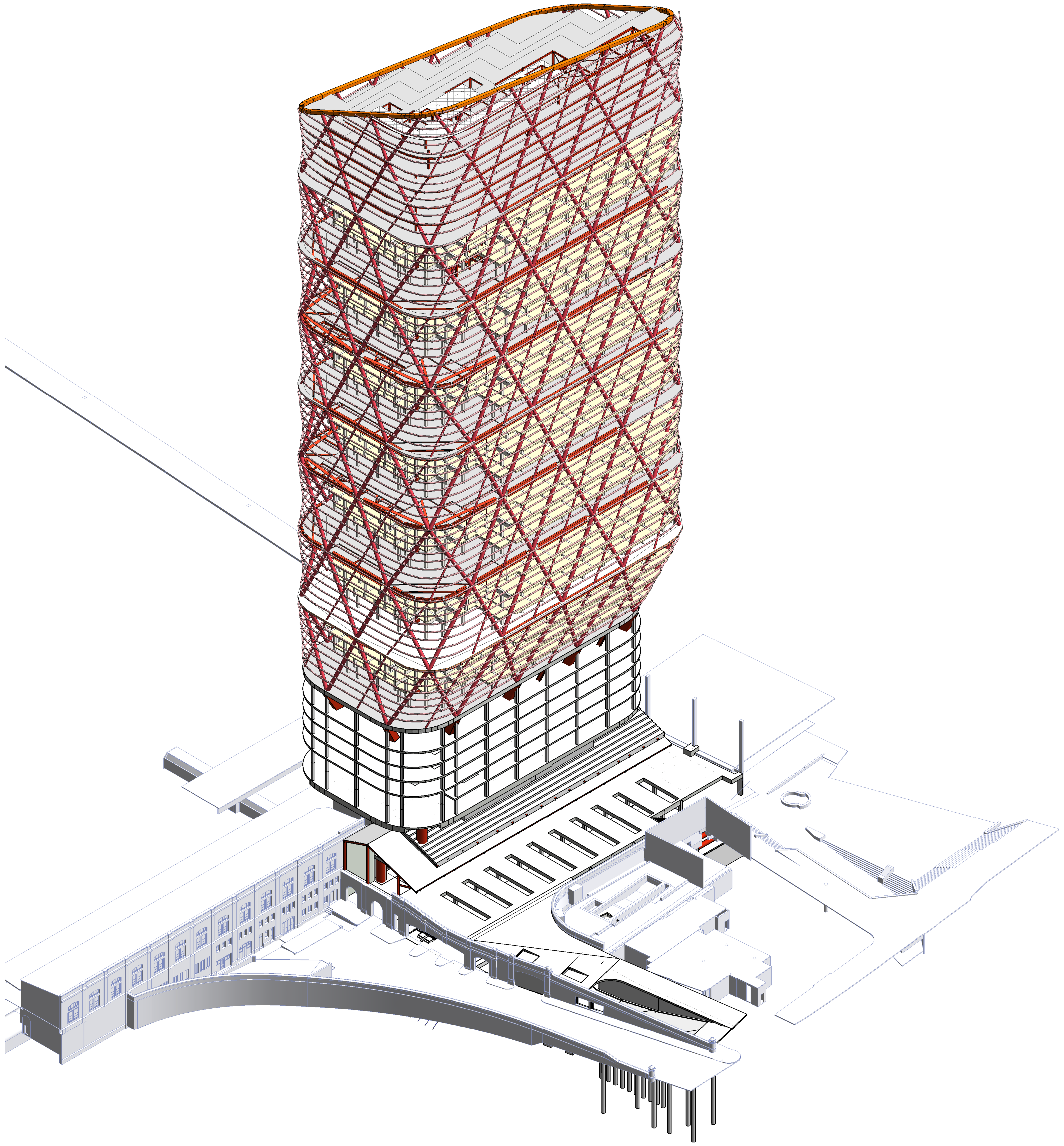
The management of dewatering activities in accordance with this DMP will ensure that water discharged from the Site, to the stormwater drainage system will comply with relevant EPA (NSW) water quality guidelines.

It is noted that discharge of water that does not meet the nominated criteria is not to be discharged to the stormwater system.

APPENDIX 1

# ATLASSIAN CENTRAL

## N0.8-10 LEE STREET, HAYMARKET



### DRAWING LIST

| Drawing No. | Drawing Name |
|---|---|
| ST-00A-00-00 | COVER SHEET |
| ST-00A-00-01 | NOTES SHEET |
| ST-30B-B01-00 | BASEMENT 1 CONTEXT PLAN |
| ST-30B-B01-01 | BASEMENT 1 OUTLINE PLAN - PART 1 |
| ST-30B-B01-02 | BASEMENT 1 OUTLINE PLAN - PART 2 |
| ST-30B-B01-10 | BASEMENT 1 - SUBSTATION 1 ACCESS ROUTE PART PLAN |
| ST-30B-B02-00 | BASEMENT 2 CONTEXT PLAN |
| ST-30B-B02-01 | BASEMENT 2 OUTLINE PLAN - PART 1 |
| ST-30B-B02-02 | BASEMENT 2 OUTLINE PLAN - PART 2 |
| ST-30B-B03-00 | FOOTING AND SHORING CONTEXT PLAN |
| ST-30B-B03-01 | FOOTING AND SHORING PLAN - PART 1 |
| ST-30B-B03-02 | FOOTING AND SHORING PLAN - PART 2 |
| ST-30B-G00-00 | LOWER GROUND CONTEXT PLAN |
| ST-30B-G00-01 | LOWER GROUND OUTLINE PLAN - PART 1 |
| ST-30B-G00-02 | LOWER GROUND OUTLINE PLAN - PART 2 |
| ST-30B-G01-00 | UPPER GROUND CONTEXT PLAN |
| ST-30B-G01-01 | UPPER GROUND OUTLINE PLAN - PART 1 |
| ST-30B-G01-02 | UPPER GROUND OUTLINE PLAN - PART 2 |
| ST-30B-G02-01 | MEZZANINE OUTLINE PLAN |
| ST-30B-G02-02 | MEZZANINE STEELWORK MARKING PLAN |
| ST-30B-G03-01 | OSD LEVEL OUTLINE PLAN |
| ST-30B-G03-11 | OSD LEVEL STEELWORK MARKING PLAN |
| ST-30B-G04-01 | CORE PLANT LEVEL 01 OUTLINE PLAN |
| ST-30B-G05-01 | CORE PLANT LEVEL 02 OUTLINE PLAN |
| ST-30B-T01-01 | TOWER LEVEL 1 OUTLINE PLAN |
| ST-30B-T02-01 | TOWER LEVEL 2 OUTLINE PLAN |
| ST-30B-T03-01 | TOWER LEVEL 3 OUTLINE PLAN |
| ST-30B-T04-01 | TOWER LEVEL 4 OUTLINE PLAN |
| ST-30B-T05-01 | TOWER LEVEL 5 OUTLINE PLAN |
| ST-30B-T06-01 | TOWER LEVEL 6 OUTLINE PLAN |
| ST-30B-T07-01 | TOWER LEVEL 7 OUTLINE PLAN |
| ST-30B-XXX-00 | SITE PLAN |
| ST-30C-B03-01 | SHORING ELEVATION - SHEET 1 |
| ST-30C-B03-02 | SHORING ELEVATION - SHEET 2 |
| ST-30C-B03-03 | SHORING ELEVATION - SHEET 3 |
| ST-30C-B03-04 | SHORING ELEVATION - SHEET 4 |
| ST-30C-B03-05 | SHORING ELEVATION - SHEET 5 |
| ST-30C-B03-06 | SHORING ELEVATION - SHEET 6 |
| ST-30C-B03-07 | SHORING ELEVATION - SHEET 7 |
| ST-30C-B03-20 | TUNNEL CONSTRUCTION METHODOLOGY - SHEET |
| ST-30C-B03-21 | TUNNEL CONSTRUCTION METHODOLOGY - SHEET 2 |
| ST-30D-B03-01 | SHORING SECTIONS - SHEET 1 |
| ST-30D-B03-02 | SHORING SECTIONS - SHEET 2 |
| ST-30D-B03-03 | SHORING SECTIONS - SHEET 3 |
| ST-30D-B03-04 | SHORING SECTIONS - SHEET 4 |
| ST-30D-B03-05 | SHORING SECTIONS - SHEET 5 |
| ST-30D-B03-06 | SHORING SECTIONS - SHEET 6 |
| ST-30D-B03-07 | SHORING SECTIONS - SHEET 7 |
| ST-30D-B03-21 | FOOTING SECTIONS - SHEET 1 |
| ST-30D-G01-21 | SRA UPPER GROUND SUPPORT - SHEET 1 |
| ST-30D-G01-22 | SRA UPPER GROUND SUPPORT - SHEET 2 |
| ST-30D-G01-23 | SRA UPPER GROUND SUPPORT - SHEET 3 |
| ST-30D-G01-24 | SRA UPPER GROUND SUPPORT - SHEET 4 |

### DRAWING LIST

| Drawing No. | Drawing Name |
|---|---|
| ST-30D-XXX-01 | BUILDING SECTIONS - SHEET 1 |
| ST-30D-XXX-02 | BUILDING SECTIONS - SHEET 2 |
| ST-30D-XXX-03 | BUILDING SECTIONS - SHEET 3 |
| ST-30D-XXX-04 | BUILDING SECTIONS - SHEET 4 |
| ST-30D-XXX-05 | BUILDING SECTIONS - SHEET 5 |
| ST-30T-BXX-01 | LOADING DIAGRAMS - SHEET 1 |
| ST-30T-BXX-02 | LOADING DIAGRAMS - SHEET 2 |
| ST-30T-BXX-03 | LOADING DIAGRAMS - SHEET 3 |
| ST-30T-BXX-04 | LOADING DIAGRAMS - SHEET 4 |
| ST-30T-BXX-05 | LOADING DIAGRAMS - SHEET 5 |
| ST-30T-BXX-20 | CONSTRUCTION LOADING DIAGRAMS - SHEET 1 |
| ST-30T-BXX-21 | CONSTRUCTION LOADING DIAGRAMS - SHEET 2 |
| ST-31C-TXX-01 | STAIR ELEVATIONS - SHEET 1 |
| ST-31C-XXX-01 | INSITU WALL ELEVATIONS - SHEET 1 |
| ST-31C-XXX-02 | INSITU WALL ELEVATIONS - SHEET 2 |
| ST-31C-XXX-03 | INSITU WALL ELEVATIONS - SHEET 3 |
| ST-31C-XXX-04 | INSITU WALL ELEVATIONS - SHEET 4 |
| ST-31C-XXX-05 | INSITU WALL ELEVATIONS - SHEET 5 |
| ST-31C-XXX-06 | INSITU WALL ELEVATIONS - SHEET 6 |
| ST-31C-XXX-07 | INSITU WALL ELEVATIONS - SHEET 7 |
| ST-31C-XXX-08 | INSITU WALL ELEVATIONS - SHEET 8 |
| ST-31C-XXX-09 | INSITU WALL ELEVATIONS - SHEET 9 |
| ST-31C-XXX-10 | INSITU WALL ELEVATIONS - SHEET 10 |
| ST-31C-XXX-11 | INSITU WALL ELEVATIONS - SHEET 11 |
| ST-31C-XXX-12 | INSITU WALL ELEVATIONS - SHEET 12 |
| ST-31C-XXX-13 | INSITU WALL ELEVATIONS - SHEET 13 |
| ST-31C-XXX-14 | INSITU WALL ELEVATIONS - SHEET 14 |
| ST-31C-XXX-15 | INSITU WALL ELEVATIONS - SHEET 15 |
| ST-31C-XXX-16 | INSITU WALL ELEVATIONS - SHEET 16 |
| ST-31C-XXX-17 | INSITU WALL ELEVATIONS - SHEET 17 |
| ST-31C-XXX-18 | INSITU WALL ELEVATIONS - SHEET 18 |
| ST-31C-XXX-19 | INSITU WALL ELEVATIONS - SHEET 19 |
| ST-31C-XXX-20 | INSITU WALL ELEVATIONS - SHEET 20 |
| ST-31C-XXX-21 | INSITU WALL ELEVATIONS - SHEET 21 |
| ST-31C-XXX-22 | INSITU WALL ELEVATIONS - SHEET 22 |
| ST-31C-XXX-23 | INSITU WALL ELEVATIONS - SHEET 23 |
| ST-31C-XXX-24 | INSITU WALL ELEVATIONS - SHEET 24 |
| ST-31C-XXX-25 | INSITU WALL ELEVATIONS - SHEET 25 |
| ST-31C-XXX-26 | INSITU WALL ELEVATIONS - SHEET 26 |
| ST-31C-XXX-27 | INSITU WALL ELEVATIONS - SHEET 27 |
| ST-31C-XXX-28 | INSITU WALL ELEVATIONS - SHEET 28 |
| ST-31C-XXX-29 | INSITU WALL ELEVATIONS - SHEET 29 |
| ST-31E-TXX-01 | CORE PART PLANS - SHEET 1 |
| ST-31E-TXX-02 | CORE PART PLANS - SHEET 2 |
| ST-31E-TXX-03 | CORE PART PLANS - SHEET 3 |
| ST-31E-TXX-04 | CORE PART PLANS - SHEET 4 |
| ST-31E-TXX-05 | CORE PART PLANS - SHEET 5 |
| ST-31E-TXX-06 | CORE PART PLANS - SHEET 6 |
| ST-31E-TXX-07 | CORE PART PLANS - SHEET 7 |
| ST-31E-TXX-08 | CORE PART PLANS - SHEET 8 |
| ST-31E-TXX-09 | CORE PART PLANS - SHEET 9 |
| ST-31E-TXX-10 | CORE PART PLANS - SHEET 10 |
| ST-31E-TXX-11 | CORE PART PLANS - SHEET 11 |
| ST-31E-TXX-12 | CORE PART PLANS - SHEET 12 |
| ST-31E-TXX-13 | CORE PART PLANS - SHEET 13 |
| ST-31E-TXX-14 | CORE PART PLANS - SHEET 14 |
| ST-31E-TXX-15 | CORE PART PLANS - SHEET 15 |
| ST-31E-TXX-16 | CORE PART PLANS - SHEET 16 |
| ST-31E-TXX-17 | CORE PART PLANS - SHEET 17 |
| ST-31Y-TXX-01 | CONCRETE ELEMENT SCHEDULE |
| ST-34Y-TXX-00 | STEEL MEMBER SCHEDULE |
| ST-35B-B03-03 | TYPICAL SLAB ON GROUND DETAILS - SHEET 1 |
| ST-35B-B03-04 | TYPICAL SLAB ON GROUND DETAILS - SHEET 2 |
| ST-35B-B03-05 | TYPICAL SUSPENDED SLAB DETAILS |
| ST-35B-B03-06 | TYPICAL STAIR DETAILS |
| ST-35B-B03-07 | TYPICAL SHORING DETAILS |
| ST-35B-B03-08 | TYPICAL FOOTING DETAILS |
| ST-35B-B03-10 | TYPICAL WALL DETAILS - SHEET 1 |
| ST-35B-B03-11 | TYPICAL WALL DETAILS - SHEET 2 |
| ST-35B-B03-12 | TYPICAL WALL DETAILS - SHEET 3 |
| ST-35B-B03-20 | TYPICAL BLOCKWORK WALL DETAILS - SHEET 1 |
| ST-35B-B03-21 | TYPICAL BLOCKWORK WALL DETAILS - SHEET 2 |
| ST-35B-B03-22 | TYPICAL BLOCKWORK WALL DETAILS - SHEET 3 |
| ST-35B-B03-23 | TYPICAL BLOCKWORK WALL DETAILS - SHEET 4 |
| ST-35B-B03-30 | TYPICAL PRECAST CONCRETE WALL DETAILS |
| ST-35K-T04-01 | LEVEL T04 POST-TENSIONING PLAN |
| ST-35K-T07-01 | LEVEL T07 POST-TENSIONING PLAN |
| ST-38D-XXX-00 | YHA SECTIONS SHEET 1 |
| ST-38D-XXX-01 | YHA SECTIONS SHEET |
| ST-38D-XXX-10 | YHA PRIMARY STRUT ELEVATIONS - SHEET 1 |
| ST-38D-XXX-11 | YHA PRIMARY STRUT ELEVATIONS - SHEET 2 |
| ST-38D-XXX-20 | YHA SECONDARY STRUT ELEVATIONS |
| ST-38D-XXX-21 | YHA MEGA COLUMN STRUT ELEVATIONS |
| ST-39D-G01-01 | L7 STEEL STEEL INSERT DETAIL - SHEET 1 |
| ST-39D-G01-02 | L7 STEEL STEEL INSERT DETAIL - SHEET 2 |
| ST-39D-G01-03 | L7 STEEL STEEL INSERT DETAIL - SHEET 3 |
| ST-39D-G01-04 | L7 STEEL STEEL INSERT DETAIL - SHEET 4 |
| ST-39D-G02-01 | TYPICAL MAJOR STRUT SLAB JOINT DETAIL |
| ST-39D-G02-02 | TYPICAL MINOR STRUT SLAB JOINT DETAIL |
| ST-39D-YHA-01 | YHA NODE - MEGA COLUMN - SHEET 1 |
| ST-39D-YHA-02 | YHA NODE - MEGA COLUMN - SHEET 2 |

ST-00A00-00
Printed : 1/07/2021 12:02:16 AM

1/07/2021 12:02:16 AM


Eckersley O'Callaghan

TTW Structural Civil Traffic Façade

London Office 9th Floor, 236 Gray's Inn Rd, London WC1X 8HB
+44 (0) 20 7354 5402 eocengineers.com

Sydney Office 48 Chandos Street St. Leonards NSW 2065
+61 (2) 9439 7288 ttw.com.au



INTELLECTUAL PROPERTY
This drawing is copyright and is the property of TAYLOR THOMSON WHITTING (NSW) Pty Ltd and must not be used without authorisation.


NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS & SPECIFICATIONS.
THE CONTRACTOR IS TO BE RESPONSIBLE FOR ALL DIMENSIONS & FOR THE CORRECT SETTING OUT OF THE WORKS ON SITE.
DO NOT SCALE FROM THIS DRAWING.

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|
| 01 | 20.08.20 | REVISED CONCEPT DESIGN | JRV | RB |
| 02 | 04.09.20 | 50% SD ISSUE | JRV | RB |
| 03 | 30.09.20 | 100% SD ISSUE | JRV | RB |
| 04 | 16.04.21 | FOR INFORMATION - SD | KPB | RB |
| 05 | 23.04.21 | ISSUED FOR SD 2.0 | KPB | RB |
| 06 | 12.05.21 | REFERENCES REVISED | JVR | RB |
| 07 | 30.06.21 | 25%DD D&C TENDER ISSUE | JVR | RB |
| | | | | |
| | | | | |
| | | | | |

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

KEY PLAN

CONSULTANT

CONSULTANT

CONSULTANT

CONSULTANT

CLIENT
ATLASSIAN

CLIENT NUMBER

PROJECT MANAGER

PROJECT
ATLASSIAN CENTRAL
No.8-10 LEE STREET, HAYMARKET

TTW PROJECT NUMBER
191797

TRUE NORTH PROJECT NORTH

GRAPHIC SCALE
0 2000 5000

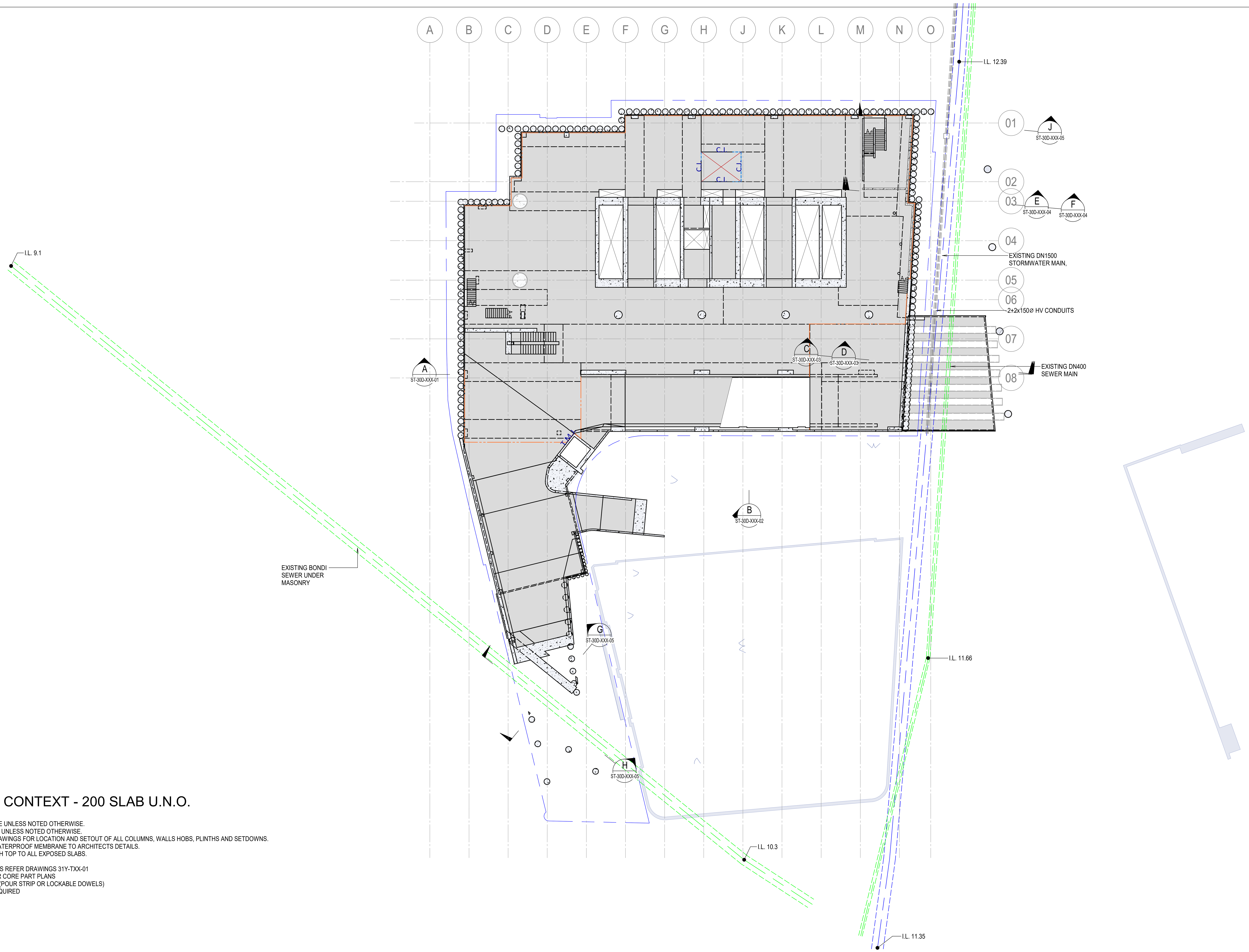
Scale : A1 DRAWN RB AUTHORISED KPB

STATUS
NOT TO BE USED FOR CONSTRUCTION
PRELIMINARY

DRAWING
COVER SHEET

DRAWING NUMBER ST-00A-00-00

ISSUE 07




# BASEMENT 1 CONTEXT - 200 SLAB U.N.O.

Scale: 1 : 250

1. ALL BANDS TO BE 1800 WIDE UNLESS NOTED OTHERWISE.
2. ALL BANDS TO BE 650 DEEP UNLESS NOTED OTHERWISE.
3. REFER TO ARCHITECTS DRAWINGS FOR LOCATION AND SETOUT OF ALL COLUMNS, WALLS HOBS, PLINTHS AND SETDOWNS.
4. ALL LEVELS, FALLS AND WATERPROOF MEMBRANE TO ARCHITECTS DETAILS.
5. PROVIDE GALVANISED MESH TOP TO ALL EXPOSED SLABS.
6. ALL SLABS PT U.N.O.
7. FOR REINFORCEMENT RATES REFER DRAWINGS 31Y-TXX-01
8. REFER 31E-TXX- SERIES FOR CORE PART PLANS
9. TMJ - PROPPING REQUIRED (POUR STRIP OR LOCKABLE DOWELS)
10. TMJ/NP - NO PROPPING REQUIRED

ST-30B-B01-00
Printed : 1/07/2021 12:02:25 AM
BIM 360://Atlassian Sydney/ATC-TTW-XX-ST-M3D-00000

1/07/2021 12:02:25 AM

Eckersley O'Callaghan
London Office 9th Floor, 236 Gray's Inn Rd, London WC1X 8HB
+44 (0) 20 7354 5402 eocengineers.com

TTW Structural Civil Traffic Façade
Sydney Office 48 Chandos Street St. Leonards NSW 2065
+61 (2) 9439 7288 ttw.com.au

INTELLECTUAL PROPERTY
This drawing is copyright and is the property of TAYLOR THOMSON WHITTING (NSW) Pty Ltd and must not be used without authorisation.

NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS & SPECIFICATIONS.
THE CONTRACTOR IS TO BE RESPONSIBLE FOR ALL DIMENSIONS & FOR THE CORRECT SETTING OUT OF THE WORKS ON SITE.
DO NOT SCALE FROM THIS DRAWING.

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|
| 01 | 20.08.20 | REVISED CONCEPT DESIGN | JRV | RB |
| 02 | 04.09.20 | 50% SD ISSUE | JRV | RB |
| 03 | 30.09.20 | 100% SD ISSUE | JRV | RB |
| 04 | 16.04.21 | FOR INFORMATION - SD | KPB | RB |
| 05 | 23.04.21 | ISSUED FOR SD 2.0 | KPB | RB |
| 06 | 12.05.21 | REFERENCES REVISED | JVR | RB |
| 07 | 30.06.21 | 25%DD D&C TENDER ISSUE | JVR | RB |
| | | | | |
| | | | | |
| | | | | |

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|
| | | | | |

KEY PLAN

CONSULTANT

CONSULTANT

CONSULTANT

CONSULTANT

CLIENT
ATLASSIAN
CLIENT NUMBER
PROJECT MANAGER

PROJECT
ATLASSIAN CENTRAL
No.8-10 LEE STREET, HAYMARKET
TTW PROJECT NUMBER
191797

TRUE NORTH PROJECT NORTH
GRAPHIC SCALE
0 2000 5000
Scale : A1 DRAWN AUTHORISED
As indicated RB KPB
STATUS
**NOT TO BE USED FOR CONSTRUCTION**
PRELIMINARY

DRAWING
BASEMENT 1 CONTEXT PLAN
DRAWING NUMBER ST-30B-B01-00
ISSUE 07


# LOWER GROUND CONTEXT - 200 SLAB U.N.O.

Scale: 1 : 250

1. ALL BANDS TO BE 1800 WIDE UNLESS NOTED OTHERWISE.
2. ALL BANDS TO BE 650 DEEP UNLESS NOTED OTHERWISE.
3. REFER TO ARCHITECTS DRAWINGS FOR LOCATION AND SETOUT OF ALL COLUMNS, WALLS HOBS, PLINTHS AND SETDOWNS.
4. ALL LEVELS, FALLS AND WATERPROOF MEMBRANE TO ARCHITECTS DETAILS.
5. PROVIDE GALVANISED MESH TOP TO ALL EXPOSED SLABS.
6. ALL SLABS PT U.N.O.
7. FOR REINFORCEMENT RATES REFER DRAWINGS 31Y-TXX-01
8. REFER 31E-TXX- SERIES FOR CORE PART PLANS

ST-30B-G00-00
Printed : 1/07/2021 12:03:14 AM
BIM 360://Atlassian Sydney/ATC-TTW-XX-ST-M3D-000001 - BUILDING.rvt

1/07/2021 12:03:14 AM

Eckersley O'Callaghan

TTW Structural Civil Traffic Façade

London Office 9th Floor, 236 Gray's Inn Rd, London WC1X 8HB
+44 (0) 20 7354 5402 eocengineers.com

Sydney Office 48 Chandos Street St. Leonards NSW 2065
+61 (2) 9439 7288 ttw.com.au

INTELLECTUAL PROPERTY

This drawing is copyright and is the property of TAYLOR THOMSON WHITTING (NSW) Pty Ltd and must not be used without authorisation.

NOTE

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS & SPECIFICATIONS.
THE CONTRACTOR IS TO BE RESPONSIBLE FOR ALL DIMENSIONS & FOR THE CORRECT SETTING OUT OF THE WORKS ON SITE.
DO NOT SCALE FROM THIS DRAWING.

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|
| 01 | 20.08.20 | REVISED CONCEPT DESIGN | JRV | RB |
| 02 | 04.09.20 | 50% SD ISSUE | JRV | RB |
| 03 | 30.09.20 | 100% SD ISSUE | JRV | RB |
| 04 | 16.04.21 | FOR INFORMATION - SD | KPB | RB |
| 05 | 23.04.21 | ISSUED FOR SD 2.0 | KPB | RB |
| 06 | 12.05.21 | REFERENCES REVISED | JVR | RB |
| 07 | 30.06.21 | 25%DD D&C TENDER ISSUE | JVR | RB |
| | | | | |
| | | | | |
| | | | | |

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|
| | | | | |

KEY PLAN

CONSULTANT

CONSULTANT

CONSULTANT

CONSULTANT

CLIENT

ATLASSIAN

CLIENT NUMBER

PROJECT MANAGER

PROJECT

ATLASSIAN CENTRAL
No.8-10 LEE STREET, HAYMARKET

TTW PROJECT NUMBER

191797

TRUE NORTH

PROJECT NORTH

GRAPHIC SCALE

0 2000 5000

Scale : A1 As indicated

DRAWN RB

AUTHORISED KPB

STATUS

**NOT TO BE USED FOR CONSTRUCTION**

PRELIMINARY

DRAWING

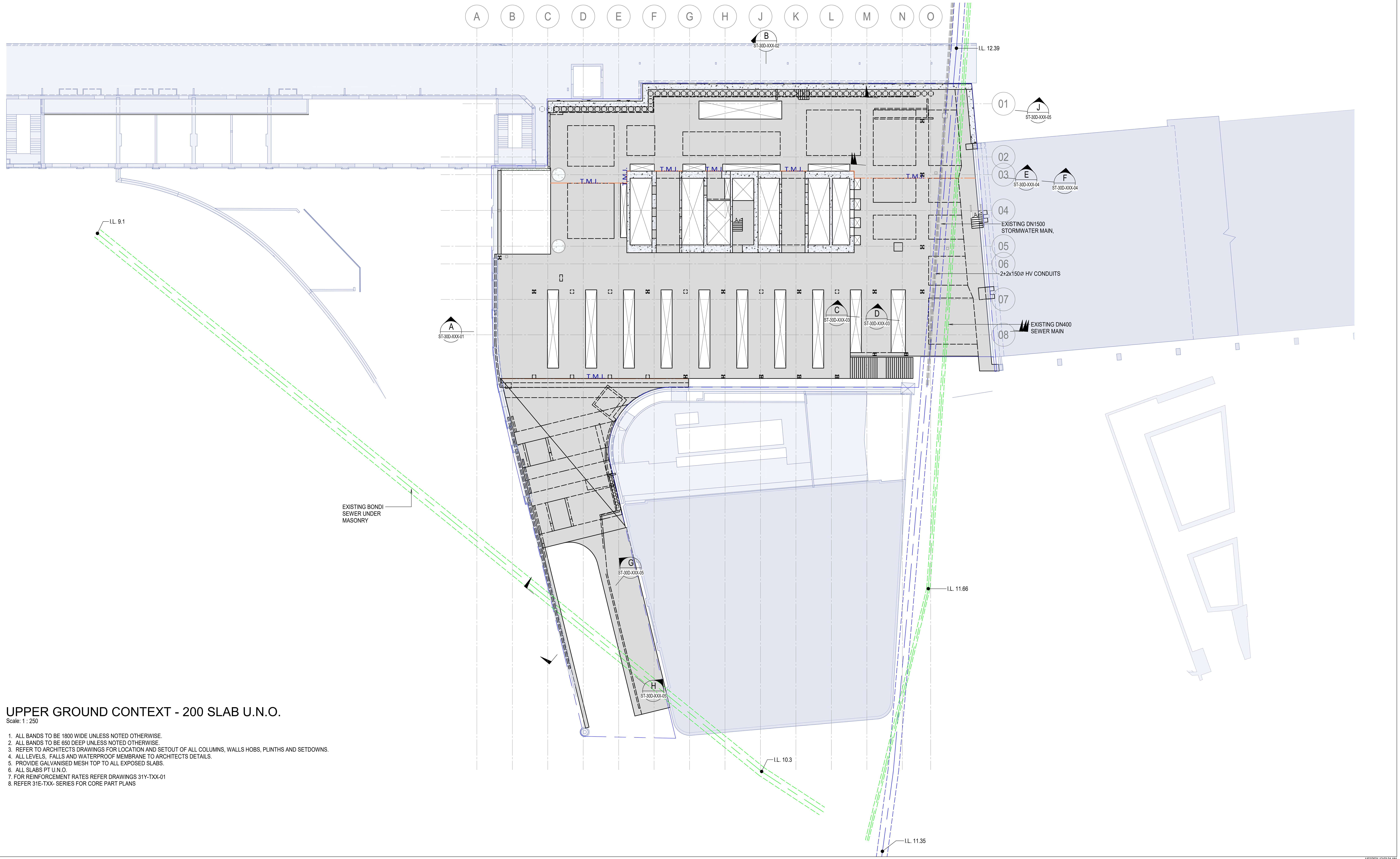
LOWER GROUND CONTEXT PLAN

DRAWING NUMBER

ST-30B-G00-00

ISSUE

07




## UPPER GROUND CONTEXT - 200 SLAB U.N.O.

Scale: 1 : 250

1. ALL BANDS TO BE 1800 WIDE UNLESS NOTED OTHERWISE.
2. ALL BANDS TO BE 650 DEEP UNLESS NOTED OTHERWISE.
3. REFER TO ARCHITECTS DRAWINGS FOR LOCATION AND SETOUT OF ALL COLUMNS, WALLS HOBS, PLINTHS AND SETDOWNS.
4. ALL LEVELS, FALLS AND WATERPROOF MEMBRANE TO ARCHITECTS DETAILS.
5. PROVIDE GALVANISED MESH TOP TO ALL EXPOSED SLABS.
6. ALL SLABS PT U.N.O.
7. FOR REINFORCEMENT RATES REFER DRAWINGS 31Y-TXX-01
8. REFER 31E-TXX- SERIES FOR CORE PART PLANS

ST-30B-G01-00
Printed : 1/07/2021 12:03:34 AM

1/07/2021 12:03:34 AM

Eckersley O'Callaghan
London Office 9th Floor, 236 Gray's Inn Rd, London WC1X 8HB
+44 (0) 20 7354 5402 eocengineers.com

TTW Structural Civil Traffic Façade
Sydney Office 48 Chandos Street St. Leonards NSW 2065
+61 (2) 9439 7288 ttw.com.au

INTELLECTUAL PROPERTY
This drawing is copyright and is the property of TAYLOR THOMSON WHITTING (NSW) Pty Ltd and must not be used without authorisation.

NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS & SPECIFICATIONS.
THE CONTRACTOR IS TO BE RESPONSIBLE FOR ALL DIMENSIONS & FOR THE CORRECT SETTING OUT OF THE WORKS ON SITE.
DO NOT SCALE FROM THIS DRAWING.

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|
| 01 | 20.08.20 | REVISED CONCEPT DESIGN | JRV | RB |
| 02 | 04.09.20 | 50% SD ISSUE | JRV | RB |
| 03 | 30.09.20 | 100% SD ISSUE | JRV | RB |
| 04 | 16.04.21 | FOR INFORMATION - SD | KPB | RB |
| 05 | 23.04.21 | ISSUED FOR SD 2.0 | KPB | RB |
| 06 | 12.05.21 | REFERENCES REVISED | JVR | RB |
| 07 | 30.06.21 | 25%DD D&C TENDER ISSUE | JVR | RB |

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|

KEY PLAN

CONSULTANT

CONSULTANT

CONSULTANT

CONSULTANT

CLIENT
ATLASSIAN
CLIENT NUMBER

PROJECT MANAGER

PROJECT
ATLASSIAN CENTRAL
No.8-10 LEE STREET, HAYMARKET
TTW PROJECT NUMBER
191797

TRUE NORTH PROJECT NORTH
GRAPHIC SCALE
0 2000 5000
Scale : A1 As indicated
DRAWN RB
AUTHORISED KPB
STATUS
**NOT TO BE USED FOR CONSTRUCTION**
PRELIMINARY

DRAWING
UPPER GROUND CONTEXT PLAN
DRAWING NUMBER ST-30B-G01-00
ISSUE 07


ST-30B-XXX-00
Printed : 1/07/2021 12:05:01 AM

1/07/2021 12:05:01 AM

Eckersley O'Callaghan

London Office 9th Floor, 236 Gray's Inn Rd, London WC1X 8HB
+44 (0) 20 7354 5402 eocengineers.com

TTW Structural Civil Traffic Façade

Sydney Office 48 Chandos Street St. Leonards NSW 2065
+61 (2) 9439 7288 ttw.com.au


INTELLECTUAL PROPERTY

This drawing is copyright and is the property of TAYLOR THOMSON WHITTING (NSW) Pty Ltd and must not be used without authorisation.


NOTE

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS & ENGINEERS DRAWINGS & SPECIFICATIONS.
THE CONTRACTOR IS TO BE RESPONSIBLE FOR ALL DIMENSIONS & FOR THE CORRECT SETTING OUT OF THE WORKS ON SITE.
DO NOT SCALE FROM THIS DRAWING.

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|
| 01 | 04.09.20 | 50% SD ISSUE | JRV | RB |
| 02 | 30.09.20 | 100% SD ISSUE | JRV | RB |
| 03 | 16.04.21 | FOR INFORMATION - SD | KPB | RB |
| 04 | 23.04.21 | ISSUED FOR SD 2.0 | KPB | RB |
| 05 | 12.05.21 | REFERENCES REVISED | JVR | RB |
| 06 | 30.06.21 | 25%DD D&C TENDER ISSUE | JVR | RB |

| Rev | Date | Description | Eng | Draft |
|---|---|---|---|---|

KEY PLAN

CONSULTANT

CONSULTANT

CONSULTANT

CONSULTANT

CLIENT

ATLASSIAN

CLIENT NUMBER

PROJECT MANAGER

PROJECT

ATLASSIAN CENTRAL
No.8-10 LEE STREET, HAYMARKET

TTW PROJECT NUMBER

191797

TRUE NORTH

PROJECT NORTH

GRAPHIC SCALE

0 2000 5000

Scale : A1 1 : 500

DRAWN RB

AUTHORISED KPB

STATUS

**NOT TO BE USED FOR CONSTRUCTION**

PRELIMINARY

DRAWING

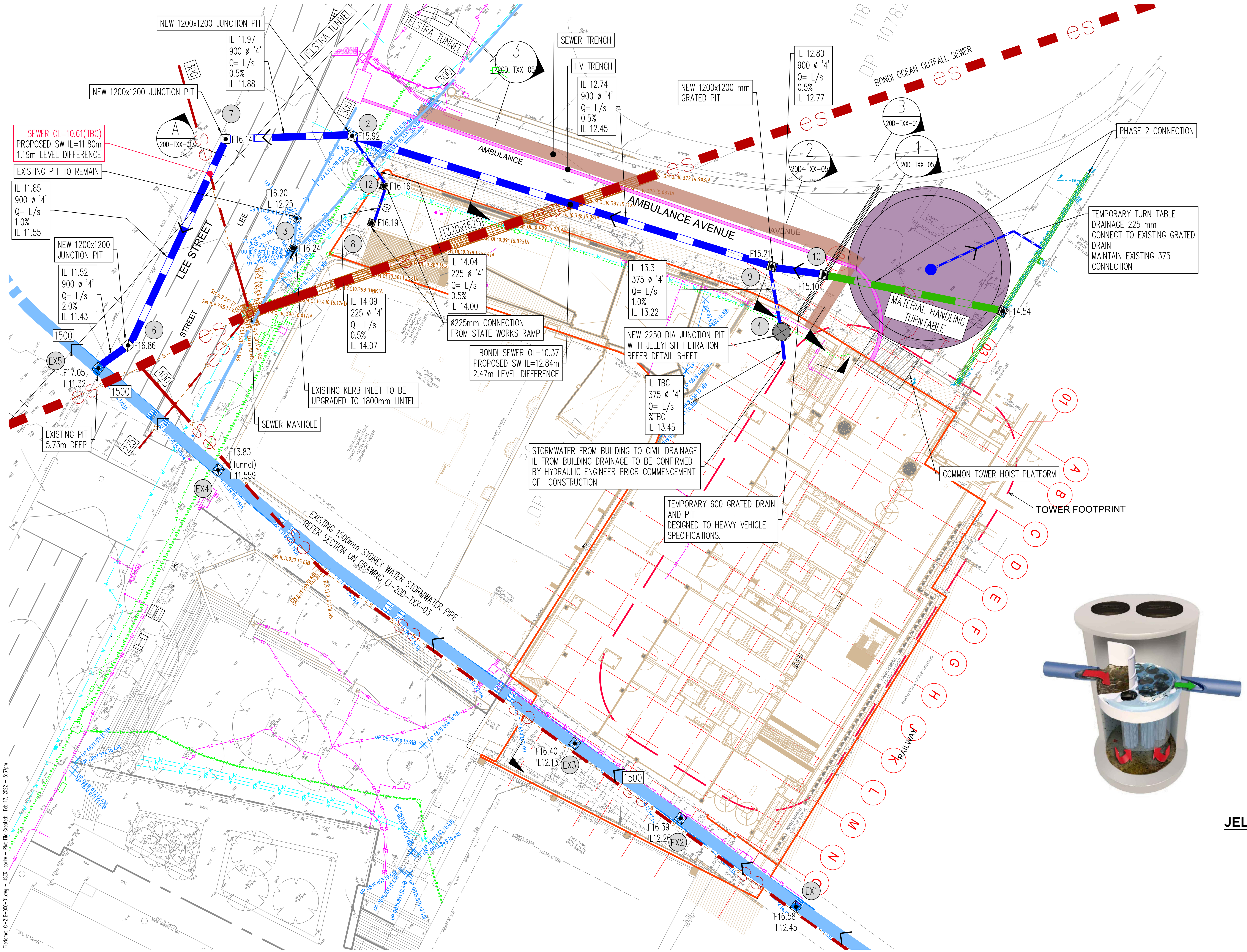
SITE PLAN

DRAWING NUMBER ST-30B-XXX-00

ISSUE 06

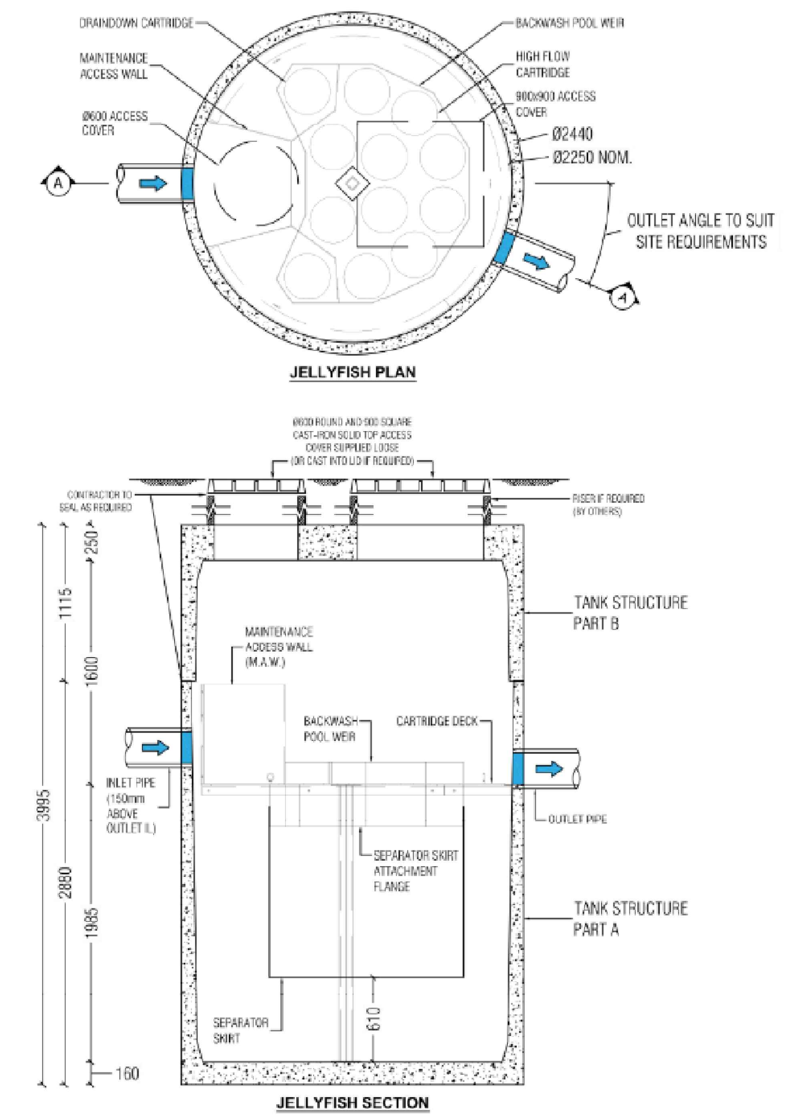
This drawing is copyright and is the property of TAYLOR THOMSON WHITTING (NSW) Pty Ltd and must not be used without authorisation.

THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT NOTES ON DRAWING C01




## SITEWORKS LEGEND

| | |
|---|---|
| ● F22.20 | Finished surface level |
| —F22.00— | Finished contour |
| 300 | Existing Stormwater with pipe size |
| 400 es | Existing Sewer with pipe size |
| | Proposed HV trench |
| | Proposed Sewer |
| 900 | Proposed Stormwater with pipe size |
| | Proposed Phase 2 drainage |
| GD | Proposed Grated drain |




## JELLYFISH SECTION

NTS

0 2.5 5 7.5 10 12.5 15 17.5 20m

1:250 A1 1:500 A3

# FOR CONSTRUCTION

A1

| Rev | Description | Eng | Draft | Date | Rev | Description | Eng | Draft | Date | Rev | Description | Eng | Draft | Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | AFC | EC | AW | 17.02.22 | | | | | | | | | | |

Architect: shp BVN

Engineer: TTW Structural Civil Traffic Façade

612 9439 7288 | 48 Chandos Street St Leonards NSW 2065

Project: ATLASSIAN 8-10 LEE STREET, HAYMARKET

Sheet Subject: PROPOSED STORMWATER PLAN -PHASE 1

| Scale : A1 | Drawn | Authorised |
|---|---|---|
| 1:250 | AW | EC |

| Job No | Drawing No | Revision |
|---|---|---|
| 191797 | CI-21B-000-01 | A |

Plot File Created: Feb 17, 2022 - 5:37pm

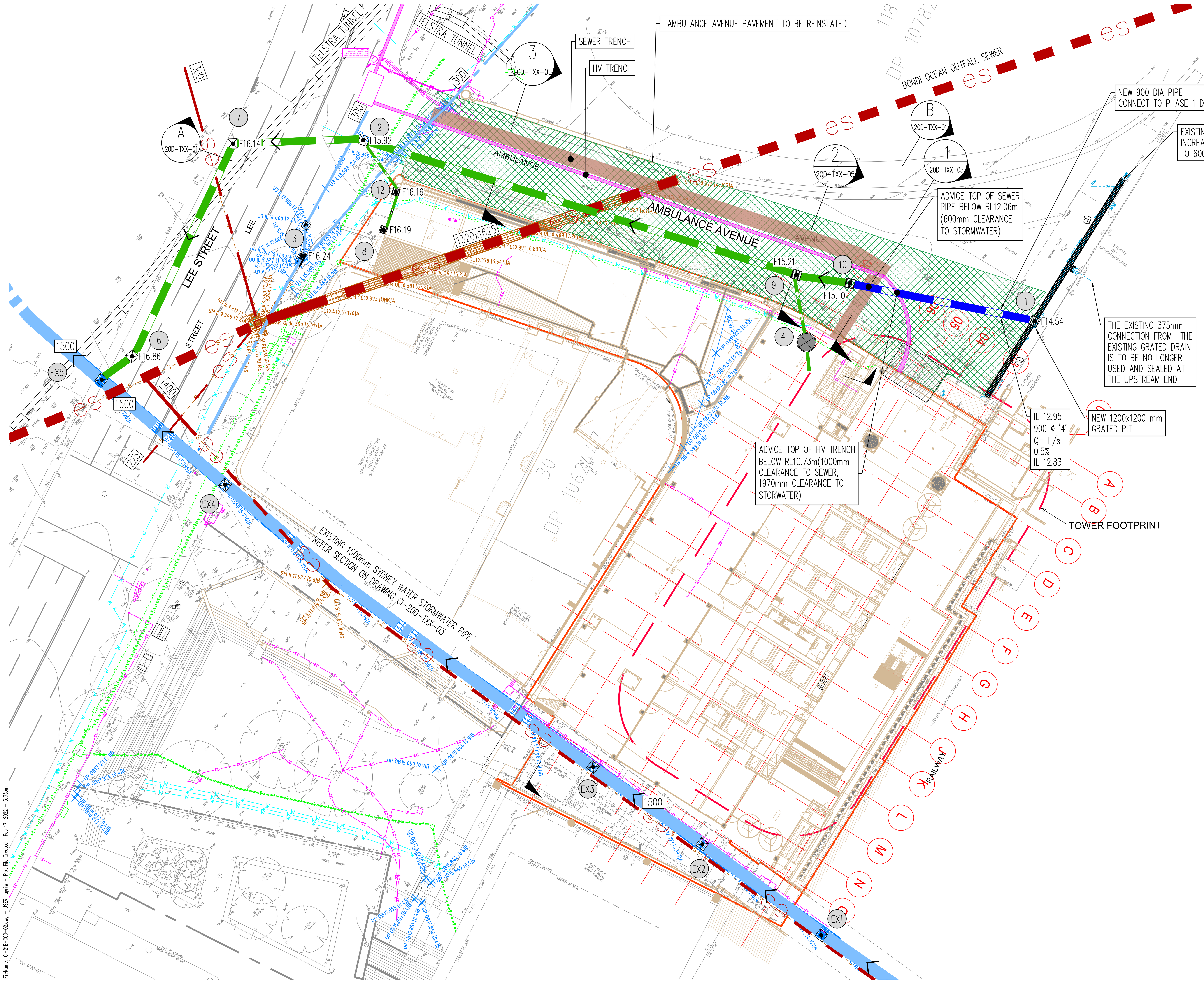
FileName: CI-21B-000-01.dwg - USER: aprlw - Plot File Created: Feb 17, 2022 - 5:37pm

This drawing is copyright and is the property of TAYLOR THOMSON WHITTING (NSW) Pty Ltd and must not be used without authorisation.

THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL RELEVANT NOTES ON DRAWING C01

## SITEWORKS LEGEND

| | |
|---|---|
| F22.20 | Finished surface level |
| F22.00 | Finished contour |
| 300 | Existing Stormwater with pipe size |
| 400 es | Existing Sewer with pipe size |
| | Proposed HV trench |
| | Proposed Sewer |
| 900 | Proposed Stormwater with pipe size |
| | Proposed Phase 1 drainage |
| GD | Proposed Grated drain |




0 2.5 5 7.5 10 12.5 15 17.5 20m

1:250 A1 1:500 A3

# FOR CONSTRUCTION

A1

| Rev | Description | Eng | Draft | Date |
|---|---|---|---|---|
| A | AFC | EC | AW | 17.02.22 |

Architect: shop BVN

Engineer: TTW Structural Civil Traffic Façade

612 9439 7288 | 48 Chandos Street St Leonards NSW 2065

Project: ATLASSIAN 8-10 LEE STREET, HAYMARKET

Sheet Subject: PROPOSED STORMWATER PLAN -PHASE 2

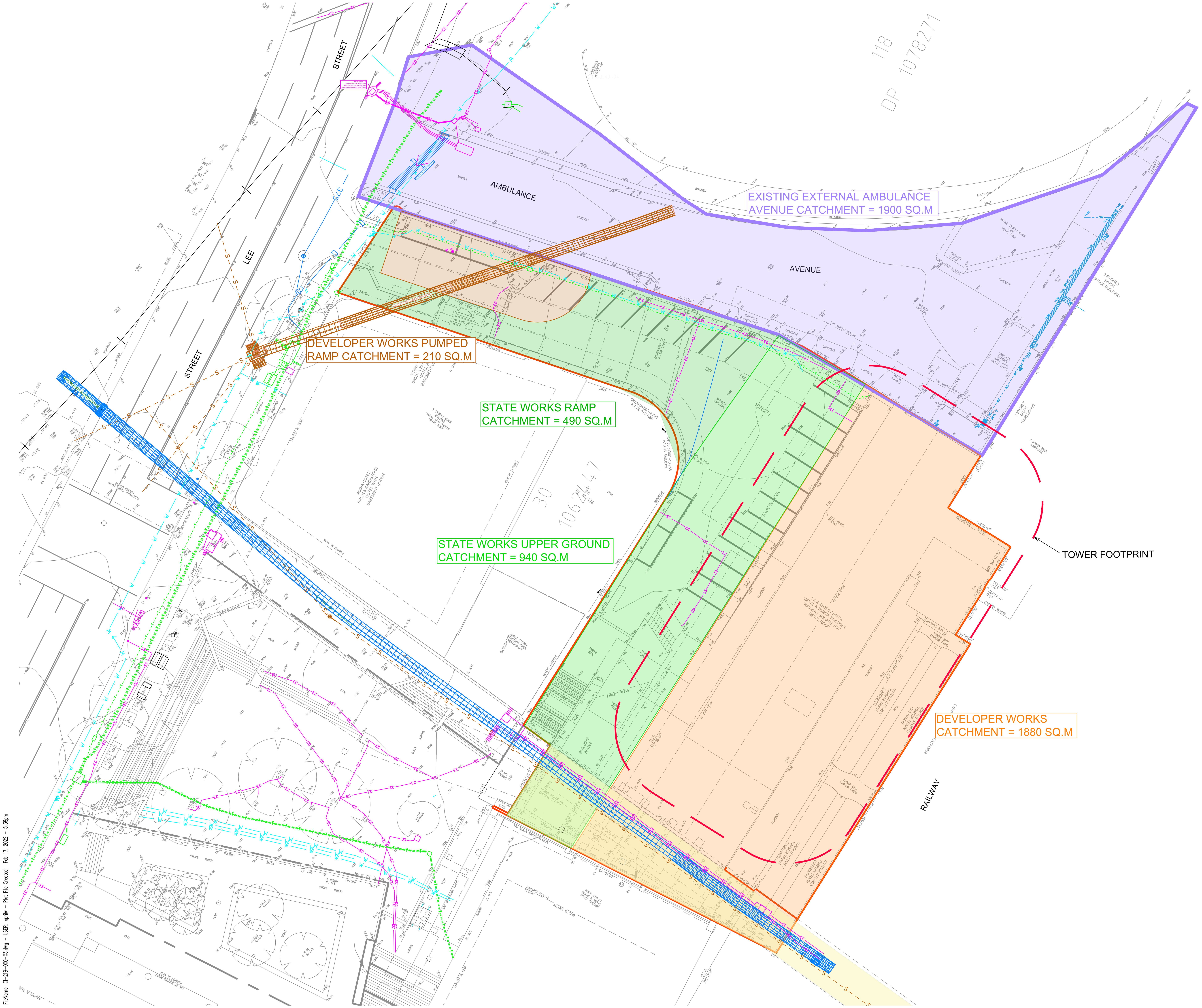
| Scale : A1 | Drawn | Authorised |
|---|---|---|
| 1:250 | AW | SB |

| Job No | Drawing No | Revision |
|---|---|---|
| 191797 | CI-21B-000-02 | A |

Plot File Created: Feb 17, 2022 - 5:33pm

FileName: CI-21B-000-02.dwg - USER: apfie - Plot File Created: Feb 17, 2022 - 5:33pm

This drawing is copyright and is the property of TAYLOR THOMSON WHITTING (NSW) Pty Ltd and must not be used without authorisation.




# FOR CONSTRUCTION

A1

| Rev | Description | Eng | Draft | Date |
|---|---|---|---|---|
| A | AFC | EC | AW | 17.02.22 |

Architect: shp BVN

Engineer: TTW Structural Civil Traffic Façade

612 9439 7288 | 48 Chandos Street St Leonards NSW 2065

Project: ATLASSIAN 8-10 LEE STREET, HAYMARKET

Sheet Subject: STORMWATER CONCEPT CATCHMENT PLAN

| Scale : A1 | Drawn | Authorised |
|---|---|---|
| 1:250 | AW | EC |

| Job No | Drawing No | Revision |
|---|---|---|
| 191797 | CI-21B-000-03 | A |

Plot File Created: Feb 17, 2022 - 5:38pm

APPENDIX 2

**Douglas Partners**
Geotechnics | Environment | Groundwater

Report on
Groundwater Modelling

Proposed Commercial Development
[illegible] Lee Street, Haymarket

Prepared for
Vertical First Pty Ltd

Project [illegible]
October [illegible]

Integrated Practical Solutions

## Document History

Document details

| | | | |
|---|---|---|---|
| Project No. | [illegible] | Document No. | R[illegible]Rev[illegible] |
| Document title | Report on Groundwater Modelling<br>Proposed Commercial Development | | |
| Site address | [illegible] Lee Street, Haymarket | | |
| Report prepared for | Vertical First Pty Ltd | | |
| File name | [illegible]R[illegible]Rev[illegible] | | |

Document status and review

| Status | Prepared by | Reviewed by | Date issued |
|---|---|---|---|
| Revision [illegible] | [illegible] | Fiona MacGregor | [illegible] October [illegible] |
| | | | |
| | | | |
| | | | |

Distribution of copies

| Status | Electronic | Paper | Issued to |
|---|---|---|---|
| Revision [illegible] | [illegible] | | [illegible] Pty Ltd |
| | | | |
| | | | |
| | | | |

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

| | Signature | Date |
|---|---|---|
| Author | | [illegible] October [illegible] |
| Reviewer | pp.Fiona MacGregor | [illegible] October [illegible] |

ISO 9001 Quality Management
FS 604853


Douglas Partners Pty Ltd
ABN [illegible]
www.douglaspartners.com.au
[illegible] Hermitage Road
West Ryde NSW [illegible]
PO Box [illegible]
West Ryde NSW [illegible]
Phone [illegible]

Douglas Partners
Geotechnics | Environment | Groundwater

# Table of Contents

Page

Appendix A: About This Report

Appendix B: Drawings

Appendix C: Results of Groundwater Level Monitoring

Appendix D: Results of In-situ Permeability Testing

Appendix E: Modelling Results – Estimated Groundwater Table and Drawdown Contour

# Report on Groundwater Modelling
# Proposed Commercial Development
# [illegible] Lee Street, [illegible]

## 1. Introduction

This report presents the results of groundwater modelling undertaken for a proposed commercial development at [illegible] Lee Street, Haymarket. The assessment was commissioned in an email by [illegible] Pty Ltd ([illegible]) on behalf of Vertical First Pty Ltd (Vertical) and was undertaken in accordance with a consultancy agreement and our proposal dated [illegible] May [illegible].

This groundwater modelling follows on from a previous preliminary groundwater assessment undertaken by DP (Report [illegible].R.[illegible].Rev[illegible] dated [illegible] July [illegible]) which used a single analytical method and was based on a simplified hydrogeological environment. This groundwater modelling supersedes the previous preliminary assessment and used more sophisticated multi-dimensional (3D) Finite Difference Modelling (FDM) techniques to provide more accurate estimates of groundwater inflow and the extent of groundwater table drawdown due to the proposed basement excavation. The development of the groundwater model also considers the most recent groundwater monitoring results from the period between [illegible] May [illegible] and [illegible] September [illegible].

It is understood that the proposed development at the site is to be divided into a 'Developer Works Zone' and a 'State Works – Link Zone'. The Developer Works are to include excavation for a two-level basement on the western side of Central Station down to an elevation of RL [illegible], followed by construction of a multi-storey commercial tower, whereas the State Works to the west of the tower include a two-level basement to a similar elevation with a [illegible] connection to proposed future adjoining basements.

The basement excavation within the Developer Works Zone is expected to intersect the natural groundwater table. It is understood that the basement is currently designed as a 'drained' basement in both the construction phase and the full operational phase of the building life (or the long-term) to eliminate the need for the provision of waterproof basement walls and a hydrostatic slab.

Under the NSW Aquifer Interference Policy the project has been deemed to be an aquifer interference activity requiring an authorisation from an approval body (for State Significant Developments, under Water Management legislation). This groundwater assessment has been prepared to evaluate the feasibility of adopting a 'drained' basement for this project and includes:

- A summary of the geotechnical and hydrogeological investigations undertaken on site;
- Development of a conceptual hydrogeological model;
- Development of a 3D numerical groundwater model and calibrations to match the groundwater monitoring data;
- Estimation of transient groundwater inflow into a drained basement during and after the construction;
- Estimation of drawdown of the groundwater table caused by the drained basement; and
- Estimation of settlements at adjacent to structures due to the drained basement.

- C□□siderati□□s □□ t□e □S□ □□□i□er I□ter□ere□ce □□lic□ a□d
- C□□□e□ts □□ □r□□□d□ater c□□ta□i□a□ts □□r dis□□sal □□ti□□s□

## 2. Previous Work

T□□ r□□□ds □□c□□□i□ed □e□tec□□ical□e□□ir□□□e□tal a□d □□dr□□e□l□□ical i□□esti□ati□□s □a□e □ee□ c□□□leted □□ D□□□las □art□ers □t□ Ltd □D□□ T□e i□□□r□ati□□ □□tai□ed □r□□ t□e site i□□esti□ati□□s □as □rese□ted i□ t□e □□ll□□i□□ □□□r re□□rts□

- D□ Re□□rt □□□□□□□R□□□□Re□□□dated □□□□st □□□□ □e□tec□□ical I□□esti□ati□□□□
- D□ Re□□rt □□□□□□□R□□□□Re□□□dated Se□te□ □er □□□□ □S□□□le□e□tar□ □e□tec□□ical I□□esti□ati□□□
- D□ Re□□rt □□□□□□□R□□□□D□t□□dated □□ □□□□st □□□□ □reli□i□ar□ C□□ta□i□ati□□ Site I□□esti□ati□□□ a□d
- D□ Re□□rt □□□□□□□R□□□□D□t□□dated □□ □□□e □□□□ □S□□□le□e□tar□ C□□ta□i□ati□□ Site I□□esti□ati□□□

### 2.1 Boreholes

T□e □□re□□les drilled □□ t□e site i□cl□ded□

- □□ easter□ side □□ □□□□ si□ c□red □□re□□les □el□□ t□e l□□est □ase□e□t □l□□r le□el □i□e□ □□re□□les □□□□□□□□□□□□□□□□□□□□ a□d □□□□□ □i□e c□red □□re□□les at □□□er □r□□□d □l□□r le□el □i□e□ □□re□□les □□□□□ t□ □□□□□□ i□cl□di□□ t□□ c□red □□re□□les drilled □r□□ t□e c□□crete □lat□□r□ a□d t□ree □□re□□les drilled □it□i□ t□e s□il t□ de□t□s □□□□□ □ □□□□ □ □el□□ t□e e□isti□□ l□□er □r□□□d □l□□r le□el □i□e □□re□□les □□□□□□□ a□d □□□□□
- □it□i□ t□e □ate □□□r□et cateri□□ □acilit□ at L□□er □r□□□d Fl□□r le□el□ □□□r □□re□□les □□□re□□les □□□□□□□□□□□□□□□□ a□d □□□□□□all □□r e□□ir□□□e□tal testi□□ □□r□□ses□□
- □it□i□ t□e access c□rrid□r a□d st□ra□e areas □est □□ t□e □ate □□□r□et □acilit□ a□d at L□□er □r□□□d Fl□□r le□el□ se□e□ □□re□□les □□□□□□□ □□□□□□ □□□□□ □□□□□□ □□□□□□ □□□□□ □□□□□ i□cl□di□□ t□ree c□red □□re□□les□□
- □it□i□ t□e □di□a □□tel □ase□e□t access dri□e□a□ at L□□er □r□□□d Fl□□r le□el□ □□e □□re□□le □□□re□□le □□□□□□□□r e□□ir□□□e□tal testi□□ □□r□□ses□□
- □□□er Carria□e La□e □□□e□air access ra□□□ t□ree □□re□□les □□□re□□les □□□□□□□□□□□□ a□d □□□□□□□ i□cl□di□□ t□□ c□red □□re□□les□□
- □□ □□la□ce □□e□□e □□□ t□at □□ t□□ □ertical □□re□□les drilled t□r□□□□ t□e retai□i□□ □all □□□ti□□ □□□re□□les □ □ a□d □ □□□ a□d
- □it□i□ t□e □di□a □□tel □ase□e□t□ t□□ i□cli□ed □□re□□les drilled □el□□ a□ e□isti□□ c□□crete □□der□i□ □□□re□□les □ □ a□d □ □□□

□ □re□i□□s □e□tec□□ical i□□esti□ati□□ carried □□t □□ D□ □□r a □ei□□□□□ri□□ site t□ t□e s□□t□ □i□e□ ‘Henry Deane Plaza’: DP Report 27282B, dated 1999) included the drilling of a borehole near to the southern site □□□□dar□□

## 2.2 Standpipes and Permeability Testing

Standpipe piezometers were installed into ten of the boreholes at the site (i.e. [illegible]) and [illegible] to measure groundwater levels. The standpipes comprised screened PVC pipe with gravel backfill, a bentonite pellet seal and a 'gatic' cover at ground level. The installed pipes are screened within either alluvial sand (i.e. [illegible]) or within the underlying very low to high strength rock. The [illegible] in the [illegible] period [illegible] some boreholes indicates the alternatives for the position of the well screen as:

- [illegible] within very low or low strength fine to medium grained sandstone (interpreted to be Mittagong Formation) (boreholes [illegible] and [illegible]) and
- [illegible] within the underlying medium to high strength medium grained sandstone (interpreted to be Hawkesbury Sandstone) (boreholes [illegible] and [illegible]).

Groundwater permeability testing and long-term monitoring of groundwater levels in standpipes has been carried out at the site since [illegible] with the results presented in the following monitoring reports:

- DP Report [illegible] dated [illegible] September [illegible] (Monitoring period [illegible] to August [illegible]);
- DP Report [illegible] dated [illegible] December [illegible] (Monitoring to [illegible] November [illegible]);
- DP Report [illegible] dated [illegible] March [illegible] (Monitoring to [illegible] February [illegible]);
- DP Report [illegible] dated [illegible] May [illegible] (Monitoring to [illegible] May [illegible]) and
- DP Report [illegible] dated [illegible] September [illegible] (Monitoring to [illegible] September [illegible]).

Either rising head or falling head permeability tests were completed within the installed standpipes.

# 3. Field Work Results

## 3.1 Boreholes

The locations of the boreholes and groundwater monitoring wells are shown on Drawing [illegible] (extract from Report [illegible]) in Appendix [illegible].

Six geotechnical cross sections (Sections [illegible] to F-F) showing the interpreted subsurface profile are presented as Drawings [illegible] to [illegible] (extract from Report [illegible]) in Appendix [illegible]. The sections show interpreted geotechnical divisions of underlying soil and rock together with the proposed basement floor levels.

The subsurface conditions encountered at the site can be summarised as:

| | |
|---|---|
| CONCRETE: | Single or multiple concrete slabs with or without a brick pavement/asphalt layer or surface ballast layer over; |
| FILL | Gravel, sand or clay fill to depths ranging between [illegible] and [illegible] on the eastern side of the [illegible] depth within the access corridor and [illegible] (i.e. the Lower Ground Floor level); |
| ALLUVIAL SAND: | Loose to medium dense alluvial sand [illegible] thick, over |
| RESIDUAL SILTY CLAY: | Soft to hard residual silty clay with some ironstone gravel [illegible] thick, over |
| RESIDUAL SANDY CLAY: | Very stiff to hard residual sandy clay [illegible] thick, over |
| SANDSTONE (FINE TO MEDIUM): | Very low to low strength fine to medium grained sandstone with some medium or high strength ironstone cemented bands [illegible] thick. Numerous clay seams were encountered, over |
| SANDSTONE (MEDIUM): | Medium or high strength medium grained sandstone. |

The upper fine to medium grained sandstone is interpreted to be part of the Mittagong Formation and the underlying medium grained sandstone is interpreted to be Hawkesbury Sandstone.

## 3.2 Groundwater Levels

Groundwater level observations are summarised in Tables [illegible] and [illegible] and graphs of the groundwater levels for each data logger (corrected for barometric pressure effects) are included in Appendix C. The graphs include rainfall record data obtained from Observatory Hill, Sydney (Bureau of Meteorology Station [illegible]).

With the exception of Borehole [illegible] water level data affected by disturbance (such as due to rising or falling head testing) has been removed for clarity of presentation. Data is missing from short time periods from Boreholes [illegible] and [illegible] due to errors in placement of the logger within the borehole or due to a very short recording interval being selected leading to the filling of the datalogger memory ahead of schedule.

The water level within the alluvial sand was measured in Borehole [illegible] to rise by approximately [illegible] following [illegible] consecutive days of heavy rain (i.e. [illegible] of rainfall between [illegible] February and [illegible] February [illegible]) to an elevation of RL [illegible]. In contrast, water levels for piezometers screened within the underlying very low to low strength sandstone (interpreted to be Mittagong Formation) were measured to rise by less than about [illegible] in the same period. Water levels in piezometers screened within the underlying medium to high strength sandstone (interpreted to be Hawkesbury Sandstone) varied less than this over the same time period (e.g. refer graphs for [illegible] and [illegible] in Appendix C).

With the exception of borehole [illegible] which had a very slow rate of recharge, the manual water level measurements presented in Tables [illegible] and [illegible] are similar to the logger measurements obtained from data loggers. The typical standing water levels within the sandstone on the eastern and central parts of the site range between RL [illegible] and RL [illegible], whereas standing water levels within the sandstone on the western part of the site range between RL [illegible] and RL [illegible]. It is noted that the measured water levels are generally similar to the elevation of the adjacent Adina Hotel basement floor slab (i.e. RL [illegible]).

**Table 1: Groundwater Observations (Boreholes BH1, BH5, BH8, BH103 and BH104).**

| Measurement Date | Standing Water Level Measurements in Boreholes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BH1 | | BH5 | | BH8 | | BH103 | | BH104 | |
| | Depth (m) | RL[2] | Depth (m) | RL[2] | Depth (m) | RL[2] | Depth (m) | RL[2] | Depth (m) | RL[2] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

Notes: (1) “[illegible]” indicates Not Measured.
[illegible] Elevation (RL) in metres [illegible]D

**Table 2: Groundwater Observations (Boreholes BH107A, BH107B, BH109B, BH112A and BH112B).**

| Measurement Date | Standing Water Level Measurements in Boreholes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BH107A | | BH107B | | BH109B | | BH112A | | BH112B | |
| | Depth (m) | RL² | Depth (m) | RL² | Depth (m) | RL² | Depth (m) | RL² | Depth (m) | RL² |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

Notes: (1) "[illegible]" indicates Not Measured.
(2) Elevation (RL) in metres [illegible]
(3) Transient water level due to slow recharge rate – refer graphs attached

## 3.3 Results of Permeability Testing

Permeability testing was completed within each standpipe with a total [illegible] tests completed between [illegible] and [illegible]. Rising head tests were carried out in each standpipe with the exception of [illegible] with falling head tests completed in three standpipes [illegible] and [illegible]. The permeability of the screened interval was calculated using the Hvorslev analytical method. The results of the permeability testing are presented in Appendix D.

A summary of the calculated permeability results is presented in Table 3.

**Table 3: Calculated Permeability Results**

| Borehole ID | Material Types within Screened Interval | Calculated Permeability (m/sec) |
|---|---|---|
| [illegible] | Sand | [illegible] |
| [illegible] | Sandstone, fine and medium grained with clay seams in upper metre of screened interval | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | Sandstone, fine grained with extremely weathered bands, fractured | [illegible] |
| [illegible] | Sandstone, fine to medium grained, slightly fractured then [illegible] | [illegible] |
| [illegible] | Sandstone, fine to medium grained, high strength with very low strength bands, fractured | [illegible] |
| [illegible] | Sandstone, fine to medium grained, slightly fractured then [illegible] | [illegible] |

| Borehole ID | Material Types within Screened Interval | Calculated Permeability (m/sec) |
|---|---|---|
| [illegible] | Sandstone, fine to medium grained, slightly fractured [illegible] | [illegible] |
| [illegible] | Sandstone, fine grained with very low strength bands (core loss) | [illegible] |
| [illegible] | Sandstone, medium grained, slightly fractured [illegible] | [illegible] to [illegible] |

Notes: [illegible] Two tests carried out; [illegible] Well screen includes an interval of core loss and clay seam [illegible] the top of rock.

Typical permeability values for sandy soils from our previous experience in the area and from published values, are usually in the range [illegible] m/sec to [illegible] m/sec. The calculated permeability values for the sand encountered in borehole [illegible] are not consistent with these values and are considered to be not representative of the permeability of the sand. Borehole [illegible] was positioned near to basement walls for the [illegible] building as well as adjacent to deep concrete footings (founded on rock). It is considered that these factors have influenced the permeability test results for the sand layer in borehole [illegible].

A slow rate of groundwater recharge was observed for standpipes screened within high strength rock with few defects (e.g. [illegible]) with water levels appearing to be similar for standpipes near to each other screened within different materials (e.g. [illegible] and [illegible] screened within either the fine to medium grained sandstone or the underlying medium grained Hawkesbury Sandstone). The rapid increase in water level within the standpipe screened within the alluvial sand and the observation of groundwater near the soil/rock interface in some boreholes (e.g. [illegible]) indicates that a perched water table is probably present within the soils above rock level.

## 4. Proposed Development

It is understood that the proposed development will include the dismantling of the former 'Inward Parcels Shed' building (i.e. the YHA: to be rebuilt following construction of the Level [illegible] [illegible] floor/transfer deck/concrete tie-in of the existing goods lift to Station platform level), removal of the carriage driveways and rails and excavation below the Lower Ground Floor level of the existing building for a two-level basement (to RL [illegible]) followed by construction of a multi-storey commercial tower.

Based on the preliminary drawings provided, it is understood that the proposed [illegible]-level basement will extend close to the property boundaries to the north-east and west and to the Devonshire Street pedestrian Tunnel to the south. For extension of the proposed basement along the eastern boundary of the site, the existing setback of the lower ground floor of the [illegible] building on this side is to be removed. The drawings indicate that a basement entry ramp is to be constructed along the northern side from Lee Street and a connection is proposed from the second basement level to potential future basements to the south of the site (i.e. beneath the pedestrian tunnel).

This will require excavation depths of about [illegible] m on the eastern boundary and about [illegible] m along the other boundaries to below the proposed two-level basement (FFL at RL [illegible] m).

It is understood that the detailed design of the shoring system for the 'drained' basement is yet to be decided. However, it is anticipated that a relatively watertight perimeter 'cut-off' wall socketed a minimum [illegible] into competent slightly fractured to unfractured sandstone will be required to prevent a direct inflow from high permeability fill/alluvial soils and upper fractured rock.

## 5. Geotechnical and Hydrogeological Model

The field work results are summarised on six geotechnical cross-sections in Appendix [illegible], which show the interpreted layers of fill/alluvial and residual soil and sandstone units between selected test locations. The interpreted boundaries shown on the sections are accurate only at the test locations and layers shown diagrammatically on the drawings are inferred. Low bands of lower or higher strength rock may be present within the generalised sandstone layers. Single or multiple concrete slabs were present at the surface over most of the site, with rail ballast encountered over concrete and bricks within the rail carriage [illegible] area.

The interpreted geotechnical model for the site is:

- soft to stiff or very loose to dense fill materials (clay or sand) up to [illegible] thick below the current ground surface [illegible];
- a discontinuous lens of very loose to medium dense sand alluvium, up to [illegible] thick, over;
- soft to hard silty clay or sandy clay residual soil up to about [illegible] thick, overlying;
- fine to medium grained sandstone, very low strength with high strength ironcemented bands, [illegible] thick, and then overlying;
- medium to high strength, medium grained sandstone.

Groundwater measurements from standpipe piezometers on site indicate that there is a relatively consistent permanent 'perennial' groundwater table within the residual soils and [illegible] grained, fractured sandstone (Mittagong Formation) that flows in the north westerly direction towards Lee Street, with an average level of around RL [illegible] in the centre of the site. The measured groundwater levels in piezometers screened in the lower medium grained, less fractured sandstone (Hawkesbury Sandstone) were generally lower by approximately [illegible] in the centre of the site, increasing to [illegible] towards Lee Street. The interpreted groundwater contours and flow directions are illustrated in Drawings [illegible] and [illegible] in Appendix C.

An intermittent perched groundwater table is also indicated to be present near the soil/rock interface and also within the alluvial sand. The upper perched groundwater table is likely to be recharged by surface infiltration into sandy layers following periods of heavy rainfall. The groundwater tables in alluvium and in sandstone appeared to be relatively independent, separated by low permeable residual clay, as there was minimal variability in groundwater levels observed in the sandstone even after some heavy rainfall periods between [illegible] and [illegible].

The seepage within the sandstone bedrock is likely to be controlled by discontinuities in the rock such as the spacing, continuity and aperture of the bedding planes, faults and joints. The seams and other fractures in the weathered rock may also be acting as temporary water storage. Therefore, groundwater inflow is not expected to be uniform around the site and is probably concentrated around localised fracture zones. The regional groundwater flow is also expected to be affected by the nearby basements, pedestrian tunnels and new Sydney Metro underground stations.

# 6. Groundwater Modelling

## 6.1 Methodology

Groundwater modelling was undertaken to assess the potential inflow rates into the proposed basements and the long term drawdown or cone of depression which could be induced by the construction of the basements.

Groundwater model simulations were conducted using MODFLOW [illegible] (McDonald & Harbaugh, [illegible]), developed by the United States Geological Survey. Modflow is a three-dimensional groundwater head and flow model which is widely used and accepted as an industry standard. The model was based on site-specific data where possible as well as estimates [illegible] parameters based on experience in similar environments. The model was developed using the pre-processor or graphical interface program Visual MODFLOW Flex V[illegible] (Schlumberger Water Services).

## 6.2 Numerical Model Geometry

The aquifer surrounding the proposed development was simulated as a multi-layered numerical model to represent the subsurface conditions surrounding the site and to allow the vertical flow components to be simulated more accurately.

The aquifer boundaries of the model were extended approximately [illegible] m from the site boundaries in all directions to simulate the estimated groundwater catchment domain.

For the numerical model the geological units were subdivided into four layers corresponding to the main soil and rock units. The top of the model (i.e. top of Layer 1) was set to approximate the average ground surface across the site at RL [illegible] m. For simplicity, the conceptual model did not incorporate topography or variations in layer thickness. All layers were assigned as MODFLOW [illegible] (Type [illegible] layers (confined/unconfined)). Details of the model layers together with the assigned hydraulic parameters for each layer are provided in Table [illegible].

## 6.3 Boundary Conditions and Aquifer Parameters

The northern and southern boundaries of the model were set as no-flow boundaries. Constant head conditions were applied to the eastern and western model boundaries.

The constant head 'far-end' boundary conditions were calibrated to generate a hydraulic gradient in the north-westerly direction while matching the measured groundwater levels at various monitoring points on site. For simplicity, the groundwater model was calibrated against the groundwater table in the upper fractured sandstone layer (Mittagong [illegible]) as it gives higher results for predictions of groundwater inflow and drawdown compared to the results if the lower groundwater table in Hawkesbury Sandstone is adopted.

□□□ifer □ara□eters re□□ired □□r t□e □□del i□cl□ded □□ri□□□tal (□□) a□d □ertical (□□) □□dra□lic c□□d□cti□it□ □r □er□ea□ilit□ as □ell as s□ecific □ield □r st□ra□e c□efficie□t□ □at□ral □ariati□□s i□ t□e □er□ea□ilit□ □f t□e sedi□e□ts ar□□□d t□e site are li□el□ t□ □cc□r d□e t□ t□e □ariati□□s i□ t□e silt □r cla□ c□□te□t a□d □rai□ si□e □f t□e sa□d□

T□□ical □er□ea□ilit□ □al□es □□r sa□d□ s□ils □r□□ □□r □re□i□□s e□□erie□ce i□ t□e area a□d □r□□ □□□lis□ed □al□es are □s□all□ i□ t□e ra□□e □ □ □□□ □/sec t□ □ □ □□□ □/sec□ T□e calc□lated □al□es □r□□ t□e i□ sit□ □er□ea□ilit□ testi□□ □□r t□e sa□d e□c□□□tered i□ □□re□□le □□□ are □□t c□□siste□t □it□ t□ese □al□es a□d are c□□sidered t□ □e □□t re□rese□tati□e □f t□e □er□ea□ilit□ □f t□e sa□d□ s□ils□ T□ere□□re a t□□ical □er□ea□ilit□ □al□e □□□ □ □□□ □/sec □as ad□□ted □□r La□er □ (□ill a□d all□□i□□) i□ t□e □□del□ I□ □rder t□ e□s□re t□at t□e □□delli□□ is □□t t□□ □□ti□istic□ t□e □ertical c□□d□cti□it□ □as set as e□□al t□ t□e □□ri□□□tal □□dra□lic c□□d□cti□it□ □□r t□is la□er□

T□e □□dra□lic c□□d□cti□it□ □f t□e resid□al cla□ (La□er □) □as ass□□ed t□ □e □ □ □□□ □/sec □it□ a□ ass□□ed □□ri□□□tal t□ □ertical □□dra□lic c□□d□cti□it□ rati□ □□□□

T□e □er□ea□ilit□ □r □□dra□lic c□□d□cti□it□ □f t□e r□c□ □□its (La□ers □ □ □) □ill □ar□ acc□rdi□□ t□ c□a□□es i□ t□e sec□□dar□ str□ct□ral □eat□res (s□c□ as □□i□ts a□d □ract□res) al□□□ □□ic□ □r□□□d□ater □ill □l□□ □ □□et□er t□e □ract□res □a□e □ee□ □illed □□ cla□ as □ell as t□e □rie□tati□□ a□d i□terc□□□ecti□□ □f □ract□res □ill als□ ca□se c□a□□es i□ t□e r□c□ □ass □er□ea□ilit□□

T□e □□delli□□ □as carried □□t ad□□ti□□ □ea□ (□e□□etric) □al□es □□ all t□e i□ sit□ □er□ea□ilit□ test res□lts i□ t□e (□i□e □rai□ed) □ract□red sa□dst□□e (Mitta□□□□ F□r□ati□□) a□d i□ t□e □edi□□ □rai□ed□ sli□□tl□ □ract□red t□ □□□r□□e□ sa□dst□□e (□a□□es□□r□ Sa□dst□□e)□ □ □□ri□□□tal t□ □ertical □□dra□lic c□□d□cti□it□ rati□ □□□ □as □ee□ ass□□ed □□r eac□ □f t□ese la□ers□

T□e ad□□ted □□dra□lic c□□d□cti□it□ □r □er□ea□ilit□ □al□es □□r all □□□r la□ers are s□□□arised i□ Ta□le □□

**Table 4: Model Layer Summary**

| Model Layer | Top of Layer (RL m AHD | Layer Represents | Horizontal Hydraulic Conductivity (m/sec) | Vertical Hydraulic Conductivity (m/sec) |
|---|---|---|---|---|
| □ | □□□ | Fill a□d □ll□□i□□ | □ □ □□□ | □ □ □□□ |
| □ | □□□ | Resid□al Cla□ | □ □ □□□ | □□ □ □□□ |
| □ | □□□ | Fract□red Sa□dst□□e (Mitta□□□□) | □□ □ □□□ | □□ □ □□□ |
| □ | □□□ | Sli□□tl□ Fract□red t□ □□□r□□e□ Sa□dst□□e (□a□□es□□r□) | □□ □ □□□ | □□ □ □□□ |

T□e i□itial □□del i□cl□di□□ t□e e□isti□□ □ase□e□t drai□a□e i□ t□e ad□ace□t □di□a □□tel □ase□e□t □as cali□rated t□ □atc□ t□e e□isti□□ □ater le□els □□ t□e site □it□ t□e □r□□□d□ater le□el □□r □□te□ti□□etric □ead) ra□□i□□ □r□□ a□□□t RL □□□ □ t□ RL □□□ □□ T□is cali□rati□□ c□□□ir□ed t□at t□e □edr□c□ □ara□eters c□□se□ □□r t□e □□del a□□eared t□ □e realistic□ T□e cali□rated i□itial (e□isti□□) □r□□□d□ater le□els are ill□strated i□ Dra□i□□ M□ i□ □□□e□di□ D□

## 6.4 Basement Dewatering – Drain Cells

The MODFLOW drain package can be used to simulate water loss from the groundwater system which occurs due to dewatering operations. Drain cells set with a high conductance ([illegible]/day) simulated the dewatering during and post construction of the basements. The drain cells represent the subfloor drainage and sump system/s located within the basement to dewater the site during construction and then to provide permanent drainage in the long term.

To simulate basement drainage in both the existing drained basement (Medina Hotel) immediately adjacent to the site to the west and the proposed new basement, drain cells were set at the existing basement level (Medina Hotel) and at the proposed new basement bulk excavation levels:

- Proposed new basement — Drain Cells: RL [illegible] m AHD;
- Existing basement (Medina Hotel) — Drain Cells: RL [illegible] m AHD.

The predicted inflows into the drain cells, representing the basement dewatering systems, were monitored throughout the model simulation using the Zone Budget module (MODFLOW).

## 6.5 Cut-off Walls

To reduce direct inflow through the sides of the excavation from the high permeability fill/alluvial soils and upper fractured rock, it is understood that relatively impermeable walls are to be installed around the basement excavation, except for the western boundary where the thickness of highly permeable soils is minimal.

Design of the cut-off walls is yet to be finalised, but they are envisaged to comprise contiguous piles with the gaps between piles sealed during construction by waterproofing linings. The proposed cut-off walls were included in the numerical model by applying a horizontal flow barrier (HFB) to the cells at the excavation faces, which was assigned a nominal [illegible] thickness with a hydraulic conductivity of [illegible]. The wall was simulated to extend down to RL [illegible] (i.e. at least [illegible] cut-off into the slightly fractured and unbroken sandstone layer).

## 6.6 Groundwater Modelling Simulations

The model was initially run under a steady state flow condition with the Medina Hotel basement drain cell activated. Following calibration of the boundary conditions to match the existing groundwater measurement data, the cut-off walls and the drain cells for the proposed new basement were then activated and the model was run under transient flow conditions for a period of [illegible] years and then switched to long-term steady state flow conditions to assess the groundwater inflow rates into the basement during construction and then in the long-term.

# 7. Groundwater Modelling Results

## 7.1 Groundwater Inflow

Groundwater inflow into the drain cells representing the excavation dewatering system was monitored throughout the model simulations using the 'zone budget' module of MODFLOW. The inflow rates represent the estimated total rate of groundwater flowing into the excavation and the volume per unit time requiring extraction via the dewatering system [illegible] in order to dewater the basement excavation during construction and for the long-term case.

Simulated results are summarised in Table [illegible]. During the early stages of construction inflow rates will be higher and will then gradually decrease as the groundwater storage in the aquifer around the excavation decreases and the cone of depression in the potentiometric surface expands out from the basement.

The cumulative inflows during the first year of basement construction are predicted to be about [illegible] ML. In the long-term, inflows are predicted to be less than [illegible] ML per year.

**Table 5: Predictive Model Simulated Inflow Results (i.e. Dewatering pumping rates)**

| Elapsed Time | Dewatering Inflow Rate | | |
|---|---|---|---|
| | $m^3$ / day | L / min | ML / year |
| [illegible] Day | [illegible] | [illegible] | [illegible] (Cumulative during 1st year) |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Year | [illegible] | [illegible] | |
| [illegible] Years | [illegible] | [illegible] | [illegible] |
| [illegible] Years | [illegible] | [illegible] | [illegible] |
| [illegible] Years | [illegible] | [illegible] | [illegible] |
| Long-term | [illegible] | [illegible] | [illegible] |

It should be noted that these volumes are best estimates of the average inflows. It is entirely possible that there could be local zones of higher permeability which could increase the inflows significantly. Accordingly, it is recommended that a factor of safety of at least [illegible] be applied to these numbers for design purposes and that these flow rates be monitored during excavation and construction.

It should be noted that the simulated dewatering rates and drawdown are dependent on the dewatering scheme adopted for the site as included in the numerical models, (i.e. the depth of the basement drainage and sumps or cut-off walls change then the currently predicted dewatering rates may change and further modelling will be required.

## 7.2 Predicted Groundwater Drawdown

Drawing M[illegible] in Appendix D shows the predicted long-term groundwater table following the completion of the proposed 'drained' basement. The long-term drawdown contours were produced by subtracting the predicted water levels from the initial groundwater levels and are illustrated on Drawing M[illegible] in Appendix D.

The model results indicate that the potential drawdown (or impact) on the water table may extend up to [illegible] m from the site boundaries on the upstream side and [illegible] m on the downstream side as shown by the [illegible] m drawdown contour in Drawing M[illegible].

The predicted drawdowns below key structures around the site are:

- Central Station (Regional Line Tracks and Platforms) — Drawdown [illegible]
- Adina Hotel — Drawdown [illegible]
- Existing Devonshire Street Tunnel — Drawdown [illegible]
- Office Complex at [illegible] Lee Street — Drawdown [illegible]
- Railway Square — Drawdown [illegible]

## 7.3 Drawdown Induced Settlement

The upper perched water table within the fill and alluvial soils is expected to be governed by rainfall infiltration. Assuming that perimeter cut-off walls are constructed down into the sandstone, this perched water table is expected to continue fluctuating above and below the soil/rock interface even after the construction of the 'drained' basement. The neighbouring structures and pavement founded on fill or alluvial soils are therefore not expected to experience noticeable dewatering induced settlements.

The lower groundwater table in the sandstone, following the construction of the 'drained' basement, is expected to be close to the bulk excavation level immediately behind the excavation faces of the basement corresponding to a maximum drawdown of approximately [illegible] gradually reducing to less than [illegible] m drawdown at distances of about [illegible] m – [illegible] m away from the basement boundaries.

The maximum drawdowns below the adjacent key structures are predicted to be up to [illegible]. Despite these relatively high levels of local drawdown, the drawdown is expected to occur mostly within sandstone. There should be minimal impact of this drawdown on adjacent structures founded on sandstone (i.e. total additional settlements or differential settlements [illegible]) due to the high deformation modulus of the sandstone bedrock.

## 8. Potential Impact on Neighbouring Properties

An assessment of the potential effects of dewatering on neighbouring properties and groundwater dependent ecosystems has been summarised in Table 6.

**Table 6: Assessment of Potential Effects of Dewatering.**

| Item | Comment |
|---|---|
| Proximity to Groundwater Dependent Ecosystems (GDEs) | No known groundwater dependent ecosystems in close proximity to the site. |
| Water supply losses to neighbouring groundwater users | A review of registered bores within a [illegible] m radius to the surrounding site was undertaken. The search identified no extraction bores or [illegible] monitoring bores within the search area. |
| Potential subsidence of neighbouring structures | It is considered that the local lowering of the water levels within the sandstone will have no significant impact on the surrounding properties or structures. |
| Mounding [illegible] water [illegible] gradient [illegible]structure | Significant mounding of groundwater is not expected. A drained basement would eliminate potential mounding. |

## 9. Aquifer Interference Policy Considerations

The NSW Aquifer Interference Policy (AIP) indicates that the term "aquifer" is commonly understood to mean a groundwater system that is sufficiently permeable to allow water to move within it and which can yield productive volumes of groundwater. A groundwater system is defined as any type of saturated geological formation that can yield low or high volumes of water. However, for the purpose of the AIP the term aquifer has the same meaning as groundwater system and includes low yielding and saline systems.

The basement dewatering of site is expected to occur in the sandstone profile of relatively low permeability with low yield, and is considered to be a "less productive groundwater source" as outlined in the AIP.

It is expected that the measured water levels within the rock on the site are probably associated with seepage flowing through bedding planes, fractures and joints in the rock. Once the groundwater level stabilises following initial excavation, these seepage flows are likely to be relatively minor during periods of dry weather and may increase slightly following periods of wet weather.

Table [illegible] in Section [illegible] of the AIP outlines minimal impact considerations. The AIP indicates that *"if predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable"*. The following minimal impact considerations are outlined for less productive groundwater sources:

- less than or equal to [illegible] cumulative variation in water table [illegible] from any high priority groundwater dependent ecosystem or high priority culturally significant site; or less than a [illegible] decline at any water supply work;
- a cumulative pressure head decline of not more than a [illegible] at any water supply work.

- any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond [illegible] from the activity.

The minimal consideration impacts relate to impacts on groundwater dependent ecosystems and groundwater users. The proposed excavation on the site is considered to comply with the [illegible] minimal consideration requirements for the following reasons:

- the water take for the basement does not involve pumping or extraction of large volumes of groundwater. Water seepage through the rock is to be collected in subfloor drainage and directed to the stormwater or sewer system (subject to approval by Council or by Sydney Water);
- there are no registered groundwater users within [illegible] of the site;
- DP is not aware of any groundwater dependent ecosystems in close proximity to the site;
- DP is not aware of any water sharing agreements in the area; and
- the water take can be easily measured during the construction period and in the long term if required.

## 10. Disposal of Groundwater Contaminants

Selected groundwater samples were tested for common contaminants during the contamination site investigations in order to assess potential disposal options. The results are presented in the following DP Reports and summarised below:

- Report on Detailed Site (Contamination) Investigation, [illegible] R[illegible] dated August [illegible] (DP, [illegible]); and
- Report on Supplementary Site (Contamination) Investigation, [illegible] R[illegible] dated June [illegible] (DP, [illegible]).

DP has installed a total of five groundwater wells screened in Hawkesbury Sandstone including:

- an upgradient groundwater well ([illegible]);
- a downgradient groundwater well ([illegible]); and
- three groundwater wells within the northern central ([illegible]) south-western portion ([illegible]) and close to the northern boundary ([illegible]) of the site.

DP has installed a total of three groundwater wells screened in Mittagong Formation including:

- an upgradient groundwater well ([illegible]);
- a downgradient groundwater well ([illegible]); and
- a groundwater well in the south-western portion of the site ([illegible]).

The location of the above groundwater wells is depicted on Drawings [illegible] of DP [illegible] report. The nested wells including [illegible] and [illegible] were installed to target different rock strata. The sampling design of the well locations/rock stratum was reviewed and approved by an NSW [illegible] accredited auditor (Rod Harwood, Harwood Environmental Consultant) on [illegible] September [illegible]. In additional upgradient well was installed in the sand profile (denoted as [illegible] during the DP [illegible] investigation) located near the south-eastern boundary of the site.

No obvious signs of environmental concern (ie. light non-aqueous phase liquids (LNAPLs) or odours) were noticed during field investigation. There were, however, detectable concentrations of total recoverable hydrocarbons (TRH) in groundwater wells [illegible] and [illegible] and [illegible] which may exhibit minor hydrocarbon odours.

In summary, laboratory test results confirmed the presence of some contaminants of potential concern (COPC) in the groundwater. Copper and zinc were detected at concentrations above the groundwater site assessment criteria (SAC), while polycyclic aromatic hydrocarbons ([illegible]), total recoverable hydrocarbons (TRH) and other metals were detected at levels below the SAC. [illegible] was only detected in the two down-gradient wells ([illegible] and [illegible]) indicating that the source of the [illegible] could be from the fill on site. However, soil leachability (TCLP) testing results do not indicate that [illegible] is likely to leach from the fill into the groundwater.

The elevated levels of copper and zinc in groundwater are common in heavily urbanised areas. Elevated levels of copper and zinc were identified in both the upgradient and down-gradient groundwater wells. The source of the copper and zinc is uncertain but could be linked to the copper and zinc concentrations in the fill layer on site or to the services network at or in proximity to the site. However, considering that elevated levels of copper and zinc were not evident in the fill, the copper and zinc levels identified in the groundwater wells at the site are likely to represent regional background levels rather than site-specific levels.

DP has carried out extensive groundwater contamination assessments across the site including two upgradient groundwater wells to determine the quality of groundwater flowing into the site. On the basis of groundwater quality data from DP ([illegible]) and DP ([illegible]) investigations, the potential risk from surrounding groundwater contamination is considered low.

Further sampling and testing of the groundwater are likely to be required by the City of Sydney Council to assess the quality and suitability of the groundwater prior to discharge to the stormwater system. Alternatively, groundwater could be discharged into sewers (subject to approval from Sydney Water) or to a licensed liquid waste facility. No disposal of groundwater to stormwater or sewer can be carried out until a permit is issued by Council (for stormwater disposal) or Sydney Water (sewer disposal). It is likely that a groundwater management plan will be required as part of the application for a dewatering licence.

On the basis of the current information, all water collected on site should be stored in a holding tank for further assessment of contaminants (including iron[illegible] oil and grease, suspended solids, volatile organic compounds (VOC) and hardness) prior to disposal. It is anticipated that the groundwater will be suitable for disposal following appropriate treatment (subject to monitoring results).

If treatment of contaminants is required for Council (stormwater discharge) or Sydney Water (sewer discharge), a remediation contractor can be engaged to devise a concept and/or detailed design of the treatment system. This would generally involve the following (or similar):

- Settlement tanks to remove the suspended solids from the dewatered excavation;
- Oil/water separator vessels to recover floating product and separate sinking product (if any);
- Sand filtration to remove fine sediment from the water stream;

- Aeration to remove the BOD; and
- Granular activated carbon (GAC) filtration and resultant filtration to adsorb contaminants.

## 11. Conclusions

The site investigations have identified fill and alluvial soils over residual clay and weak sandstone rock grading to medium to high strength sandstone. A perennial groundwater level has been measured at about RL [illegible] in standpipes on the site within the medium to high strength rock. A perched, intermittent groundwater table is present within the near surface fill and alluvial soils, but is not expected to be impacted by the proposed excavation provided that perimeter watertight cut-off walls are constructed and extended [illegible] into the slightly fractured or [illegible] sandstone.

The proposed excavation is expected to extend to approximately [illegible] below the measured groundwater level in medium to high strength sandstone.

An estimate of groundwater inflow into the new basement has been undertaken using [illegible]D Finite Difference modelling techniques. The annual inflow rates have been estimated to be in the order of [illegible] ML for the first year of basement construction gradually decreasing to [illegible] ML per year for the long term. However, based on our experience in other deep excavations into sandstone bedrock in the area, DP expects that the actual seepage into the excavation will be much lower than these predicted values due to the low volumes of water contained within the joints and defects in the rock.

If the predicted annual inflow is more than [illegible] ML/year, the proposed basement, if constructed as a 'drained' basement, will generally require a Water Access Licence and a Water Supply Work approval for construction and long-term dewatering from the relevant approval bodies such as [illegible]. [illegible] groundwater contamination testing and long-term on-site treatment may be required prior to discharge.

Due to the high deformation modulus (compressibility) of the sandstone, any long-term drawdown of the groundwater level is not expected to cause any significant settlement on the neighbouring structures.

In conclusion, it is considered, from a hydrogeological point of view, that a 'drained' basement is feasible without any significant impact to surrounding groundwater systems or property. This will be subject to review and approval from Council and relevant authorities

## 12. Limitations

Douglas Partners (DP) has prepared this report for this project at [illegible] Lee Street, Haymarket in accordance with DP's proposal SYD190190.P.003.Rev5, and acceptance received from [illegible] Pty Ltd on behalf of Vertical First Pty Ltd on [illegible] May [illegible]. The work was carried out under a consultancy agreement. This report is provided for the exclusive use of Vertical First Pty Ltd or their agents, for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the groundwater components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

**Douglas Partners Pty Ltd**

# Appendix A

## About This Report

# About this Report

Douglas Partners

## Introduction

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

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

## Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

## Borehole and Test Pit Logs

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

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

## Groundwater

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

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

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

## Reports

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

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

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

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

# *About this Report*

### Site Anomalies

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

### Information for Contractual Purposes

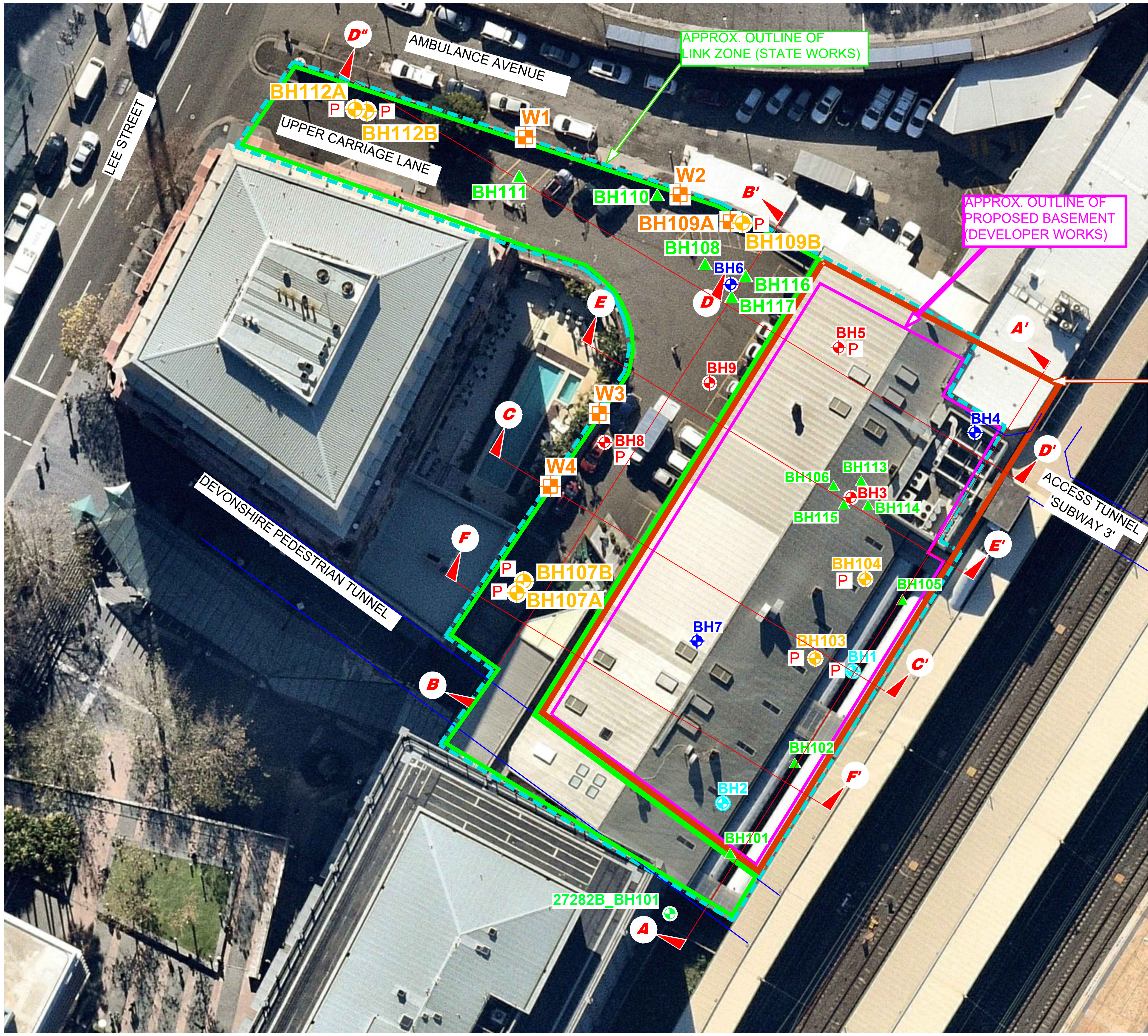
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

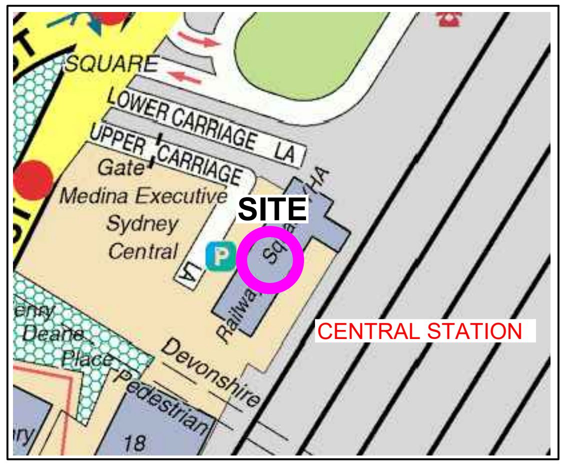
### Site Inspection

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

# Appendix B

Drawings




**Locality Plan**

**LEGEND**

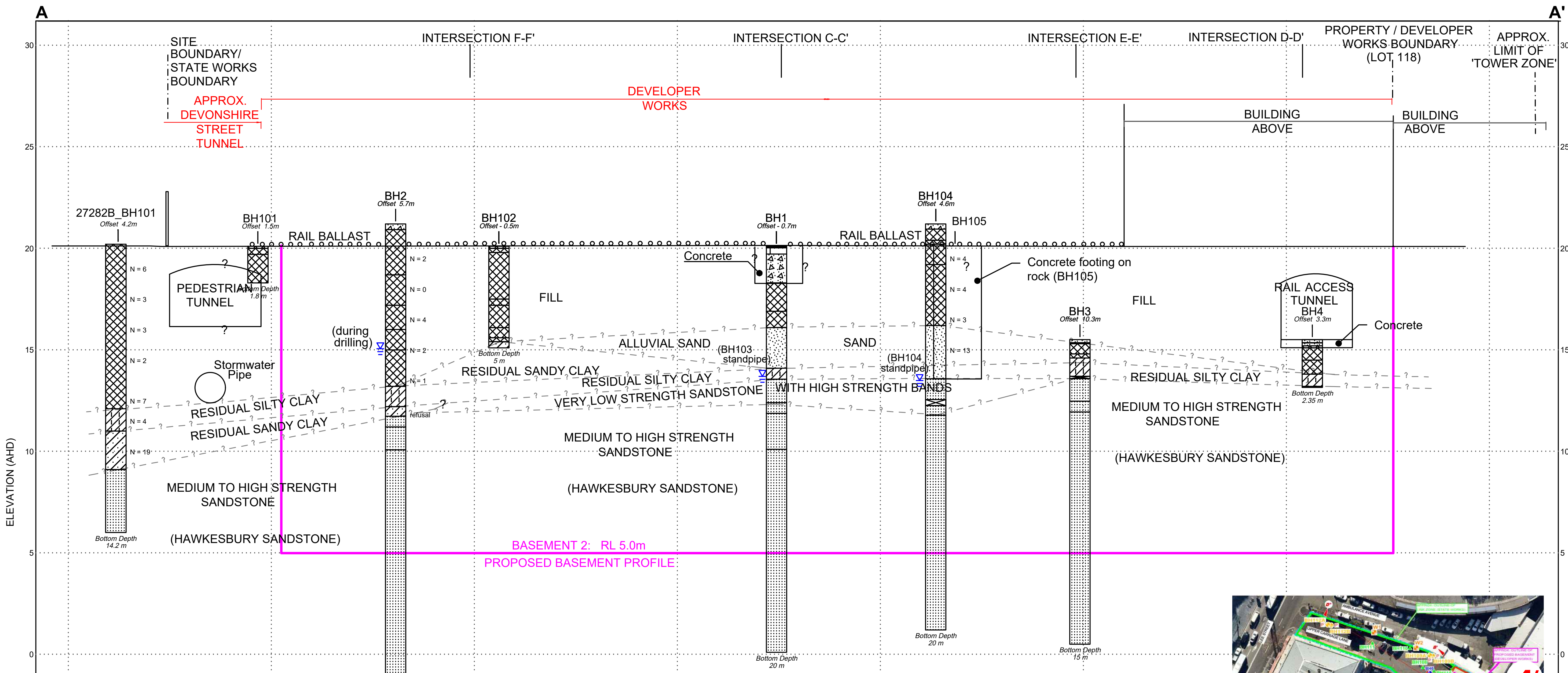
- Previous geotechnical borehole (DP Project 27282B, dated 1999)
- Environmental borehole - Lower Ground Floor (DP Report 86767.01.R.001.DftB, dated 29 August 2019)
- Geotechnical & environmental borehole - Lower Ground Floor (DP Report 86767.00.R.001.Rev0, dated 26 August 2019)
- Geotechnical & environmental borehole - Upper Ground Floor (DP Report 86767.00.R.001.Rev0, dated 26 August 2019)
- Environmental borehole
- Geotechnical & environmental borehole
- Geotechnical borehole
- P Standpipe piezometer
- A A' Geotechnical Cross Section A-A'
- Approximate site boundary

NOTE:
1: Base image from Nearmap.com (Dated 1 July 2019)
2: Test locations are approximate only and are shown with reference to existing features.
3. Approximate Development Outlines are as provided by Avenor Pty Ltd on 12 August 2019.

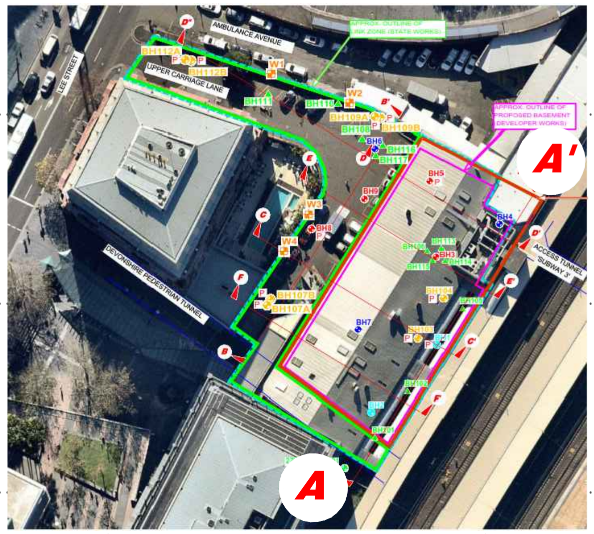
0 5 10 15 20 30 40 50m
1:500 @ A3

**Douglas Partners**
*Geotechnics | Environment | Groundwater*

| | | | |
|---|---|---|---|
| CLIENT: Atlassian Pty Ltd | | TITLE: **Test Location Plan** | PROJECT No: 86767.00 |
| OFFICE: Sydney | DRAWN BY: HDS | **Proposed Commercial Development** | DRAWING No: 1 |
| SCALE: 1:500 @ A3 | DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 8 |




NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.



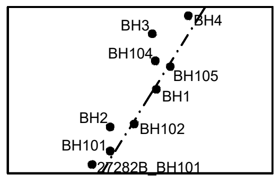

DISTANCE ALONG PROFILE (m)

LEGEND

| | |
|---|---|
| Concrete | Sand |
| Bricks | Silty Clay |
| Fill | Sandstone |
| Sandy Clay | Core Loss |

TESTS / OTHER
N - Standard penetration test value
Water level

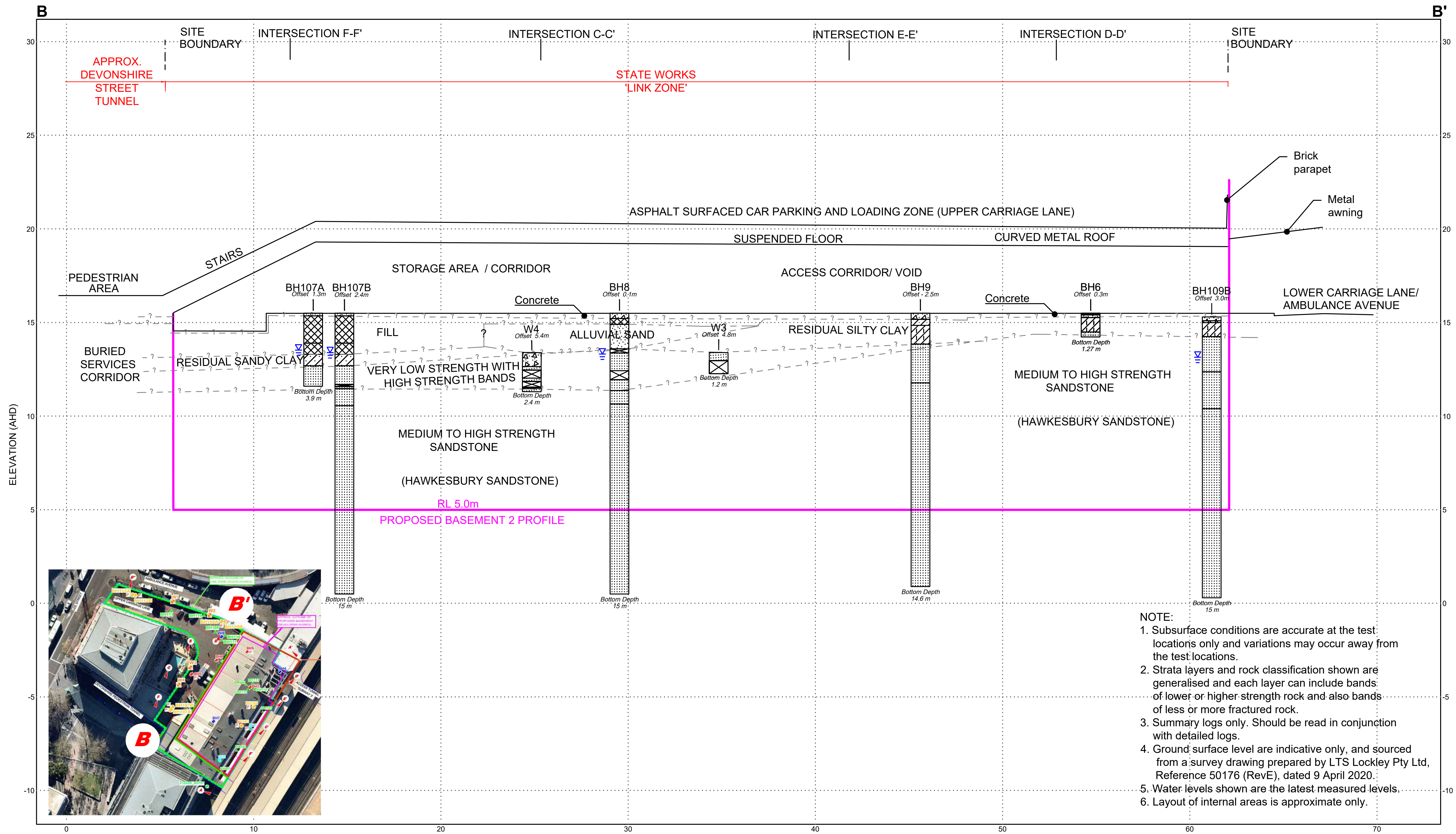
SITE MAP




0 4
Horizontal Scale (metres)
Natural Scale

**Douglas Partners**
Geotechnics / Environment / Groundwater

| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Interpreted Geotechnical Cross-Section A-A'** | PROJECT No: 86767.00 |
| OFFICE: Sydney | DRAWN BY: HDS | **Proposed Commercial Development** | DRAWING No: 2 |
| SCALE: 1:200 (H) 1:200 (V) @ A3 | DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 3 |



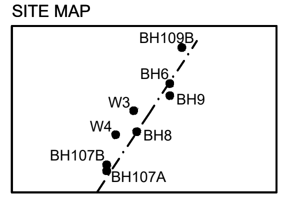

NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.

LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Concrete
- Filling
- Sand
- Sandstone
- Silty Clay
- Silty Clay

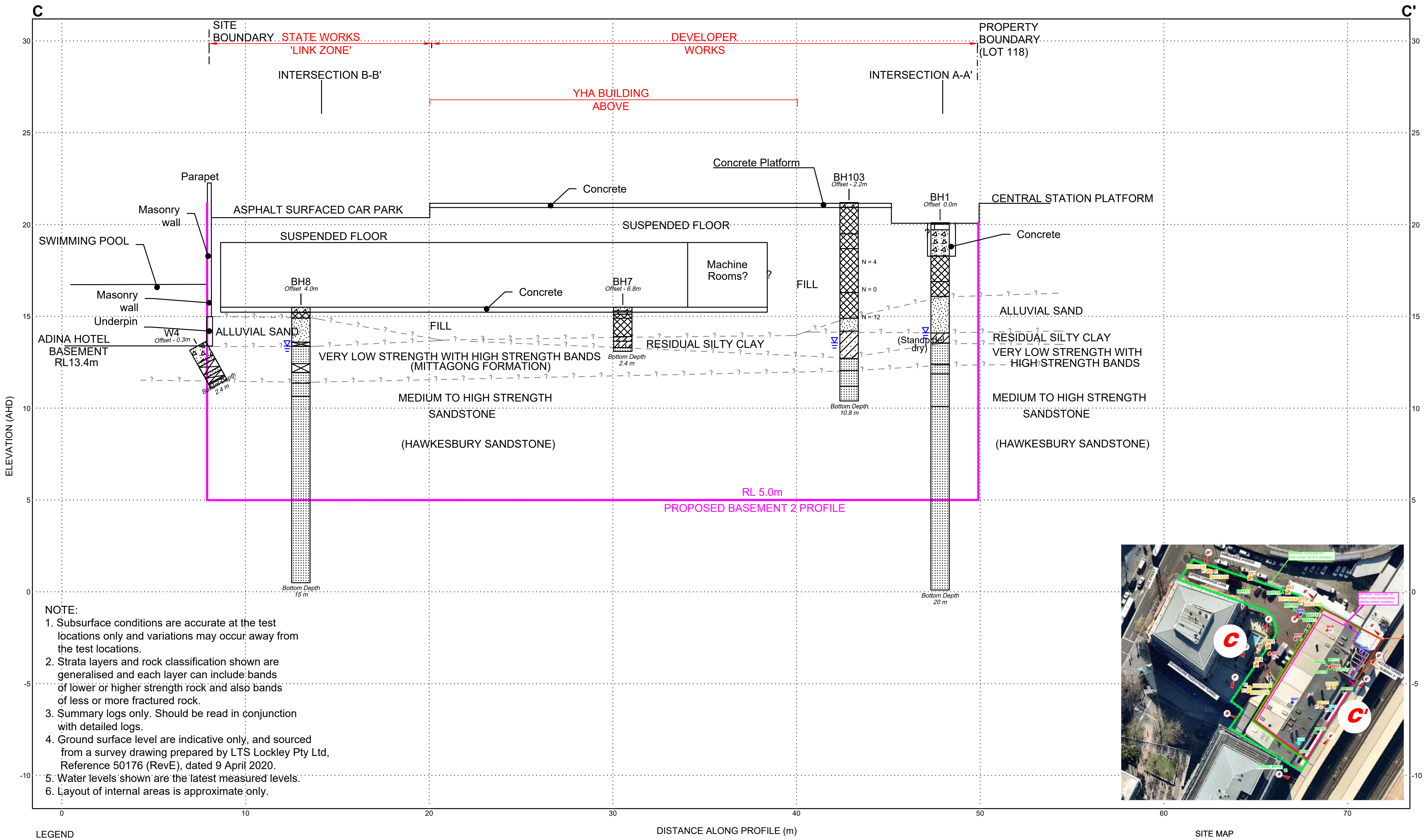
TESTS / OTHER
N - Standard penetration test value
Water level

SITE MAP




0 4
Horizontal Scale (metres)
Natural Scale

| | | | |
|---|---|---|---|
| **Douglas Partners** Geotechnics / Environment / Groundwater | CLIENT: Vertical First Pty Ltd | TITLE: **Interpreted Geotechnical Cross-Section B-B'** | PROJECT No: 86767.00 |
| | OFFICE: Sydney / DRAWN BY: HDS | **Proposed Commercial Development** | DRAWING No: 3 |
| | SCALE: 1:200 (H) 1:200 (V) @ A3 / DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 3 |




NOTE:

1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.

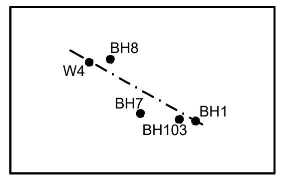
LEGEND

- Core Loss
- Bricks
- Concrete
- Filling
- Sand
- Sandstone
- Silty Clay
- Sandy Clay

TESTS / OTHER

- N - Standard penetration test value
- Water level

SITE MAP



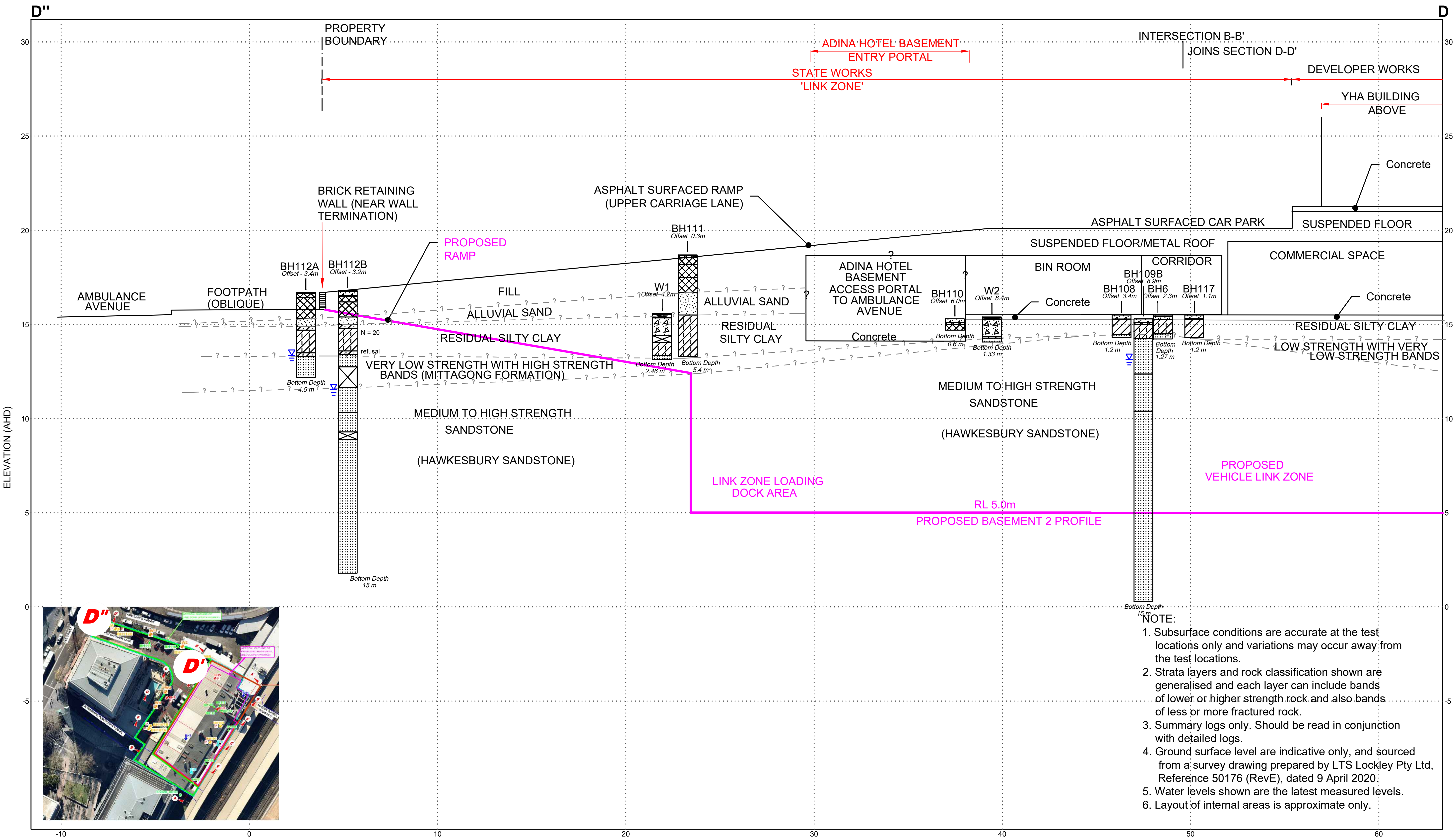

0 4

Horizontal Scale (metres)

Natural Scale

**Douglas Partners**
Geotechnics | Environment | Groundwater

| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Interpreted Geotechnical Cross-Section C-C'** | PROJECT No: 86767.00 |
| OFFICE: Sydney | DRAWN BY: HDS | **Proposed Commercial Development** | DRAWING No: 4 |
| SCALE: 1:200 (H) 1:200 (V) @ A3 | DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 3 |

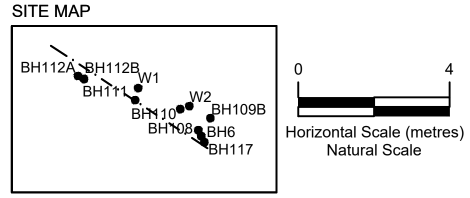



NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.

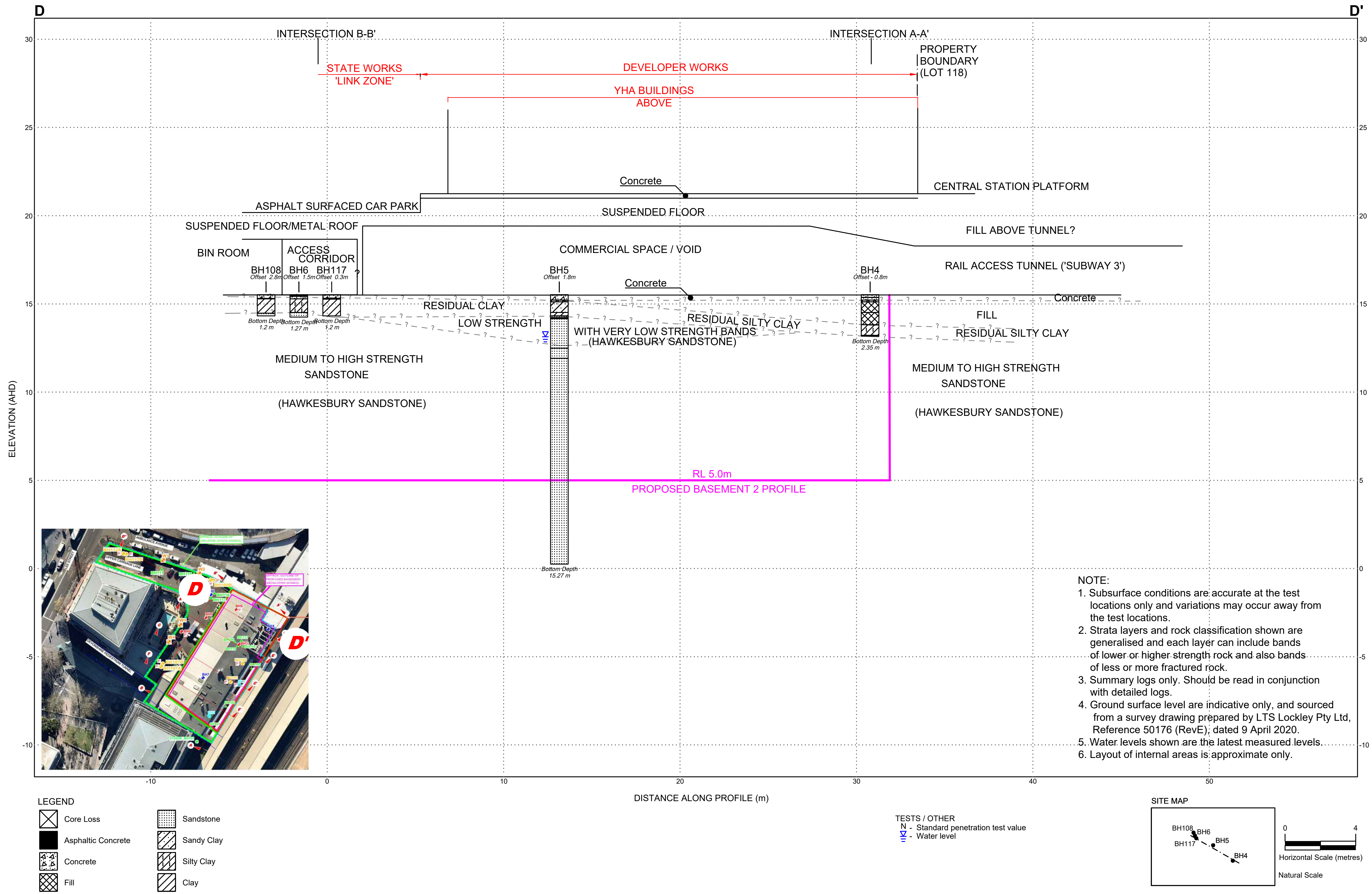
LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Concrete
- Fill
- Sand
- Sandstone
- Sandy Clay
- Silty Clay

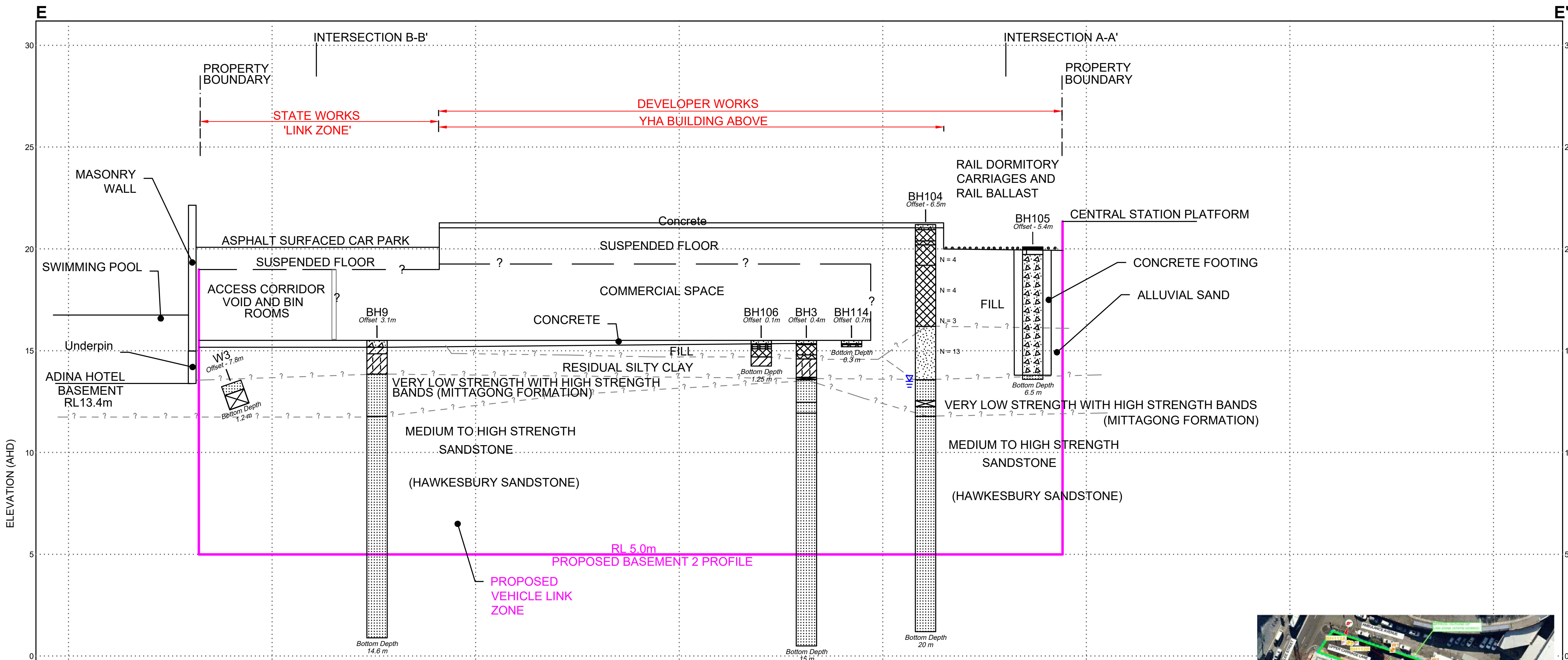
SITE MAP



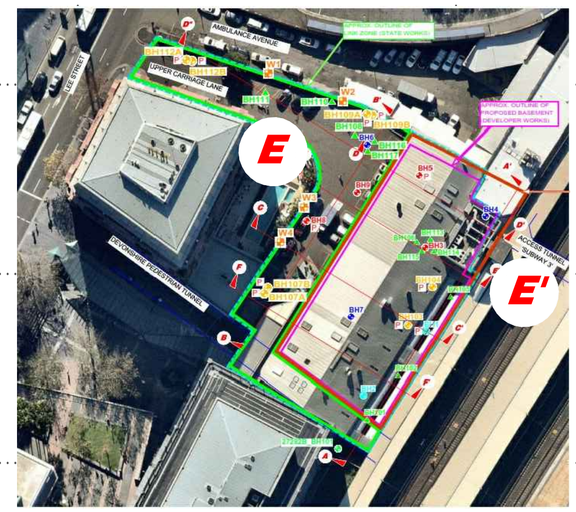

| | | | |
|---|---|---|---|
| **Douglas Partners** Geotechnics / Environment / Groundwater | CLIENT: Vertical First Pty Ltd | TITLE: **Interpreted Geotechnical Cross-Section D''-D (extended)** | PROJECT No: 86767.00 |
| | OFFICE: Sydney — DRAWN BY: HDS/ PSCH | **Proposed Commercial Development** | DRAWING No: 5 |
| | SCALE: 1:200 (H) 1:200 (V) @ A3 — DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 2 |




| | | | |
|---|---|---|---|
| **Douglas Partners** Geotechnics / Environment / Groundwater | CLIENT: Vertical First Pty Ltd | TITLE: **Interpreted Geotechnical Cross-Section D-D'** | PROJECT No: 86767.00 |
| | OFFICE: Sydney — DRAWN BY: HDS | **Proposed Commercial Development** | DRAWING No: 5A |
| | SCALE: 1:200 (H) 1:200 (V) @ A3 — DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 3 |




NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.

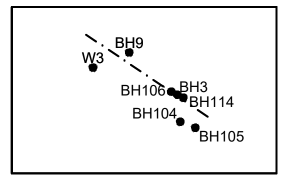



LEGEND

| | |
|---|---|
| Core Loss | Fill |
| Bricks | Sand |
| Clay | Sandstone |
| Concrete | Silty Clay |

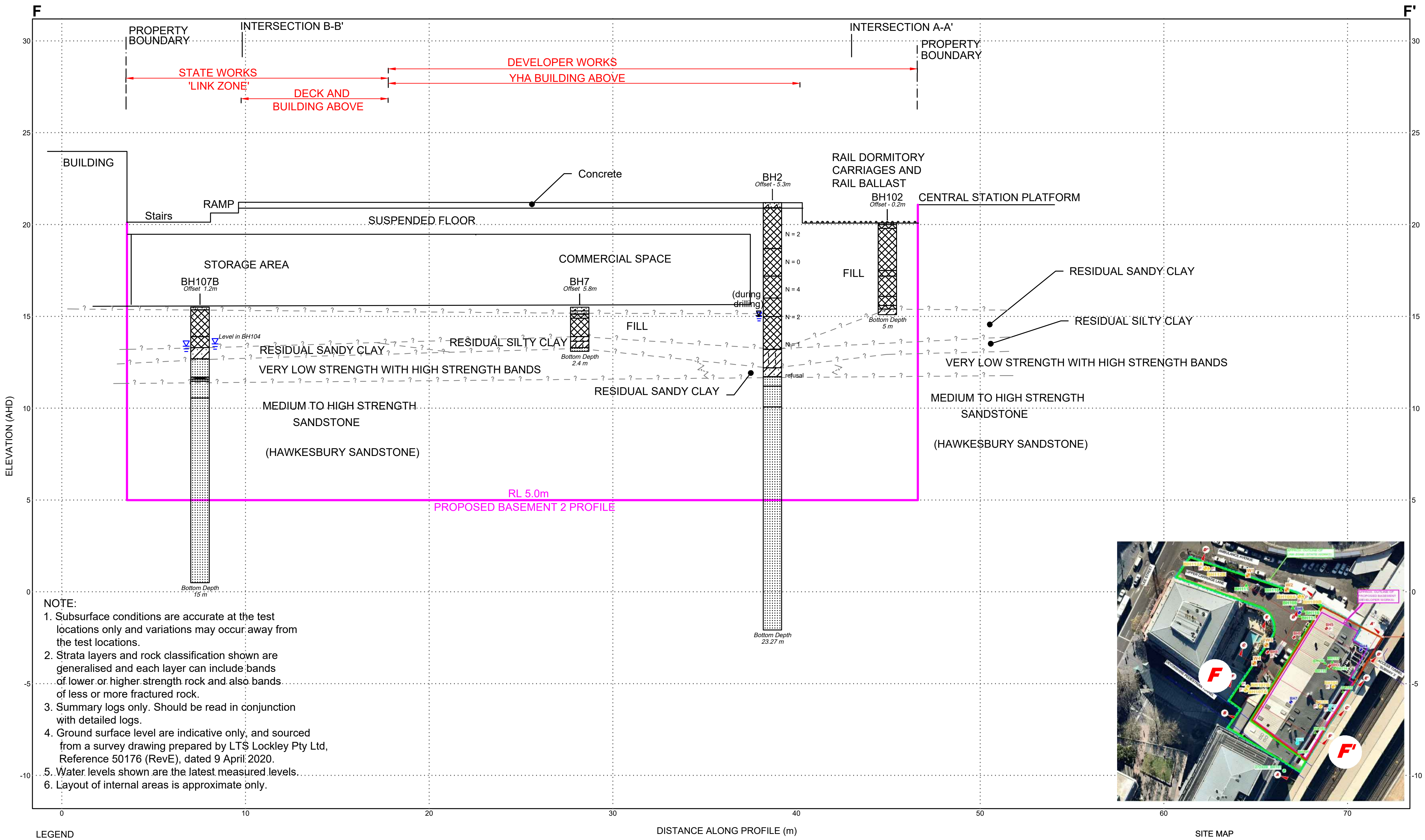
TESTS / OTHER
N - Standard penetration test value
Water level

SITE MAP




0 4
Horizontal Scale (metres)
Natural Scale

| | | | |
|---|---|---|---|
| **Douglas Partners** Geotechnics / Environment / Groundwater | CLIENT: Vertical First Pty Ltd | TITLE: **Interpreted Geotechnical Cross-Section E-E'** | PROJECT No: 86767.00 |
| | OFFICE: Sydney — DRAWN BY: HDS/ PSCH | **Proposed Commercial Development** | DRAWING No: 6 |
| | SCALE: 1:200 (H) 1:200 (V) @ A3 — DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 2 |




NOTE:

1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.

LEGEND

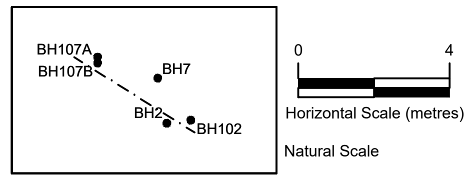
- Core Loss
- Concrete
- Filling
- Sandstone
- Sandy Clay
- Silty Clay

TESTS / OTHER

N - Standard penetration test value

- Water level

SITE MAP



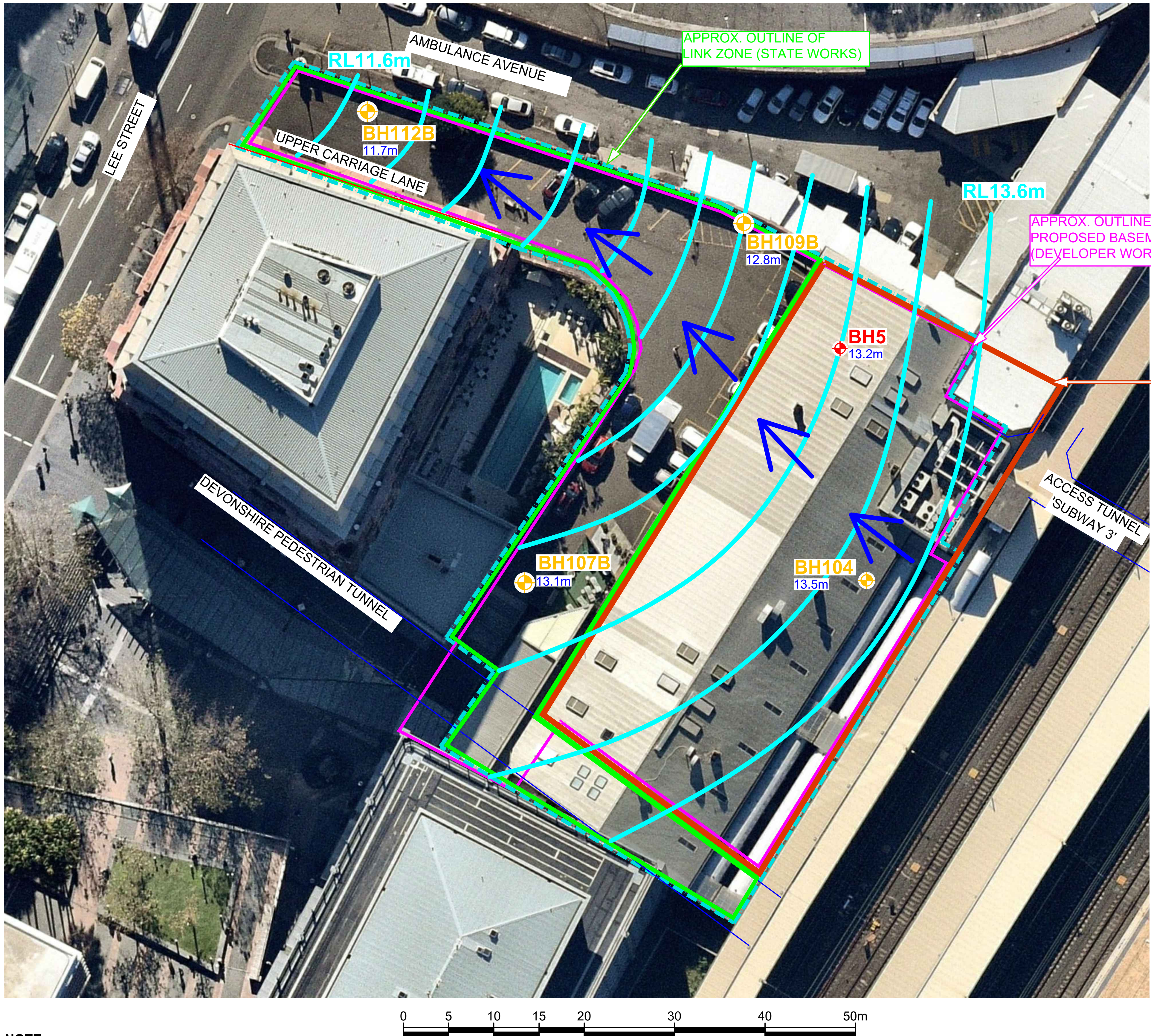

**Douglas Partners**
Geotechnics | Environment | Groundwater

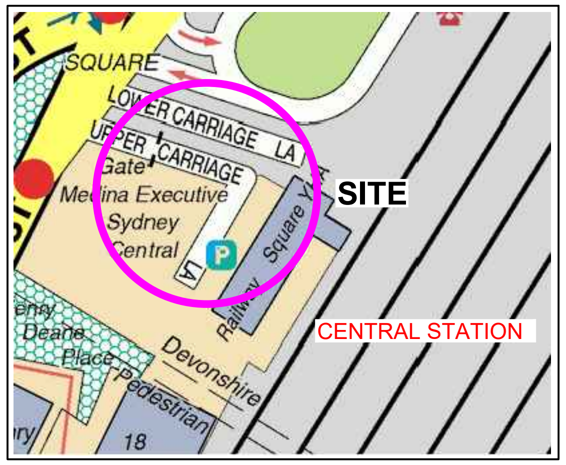
| | | |
|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Interpreted Geotechnical Cross-Section F-F'** |
| OFFICE: Sydney | DRAWN BY: HDS | **Proposed Commercial Development** |
| SCALE: 1:200 (H) 1:200 (V) @ A3 | DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** |

| | |
|---|---|
| PROJECT No: | 86767.00 |
| DRAWING No: | 7 |
| REVISION: | 2 |

# Appendix C

Res□lts □□□ r□□□d□ater Le□el M□□it□ri□□




Locality Plan

**NOTE:**

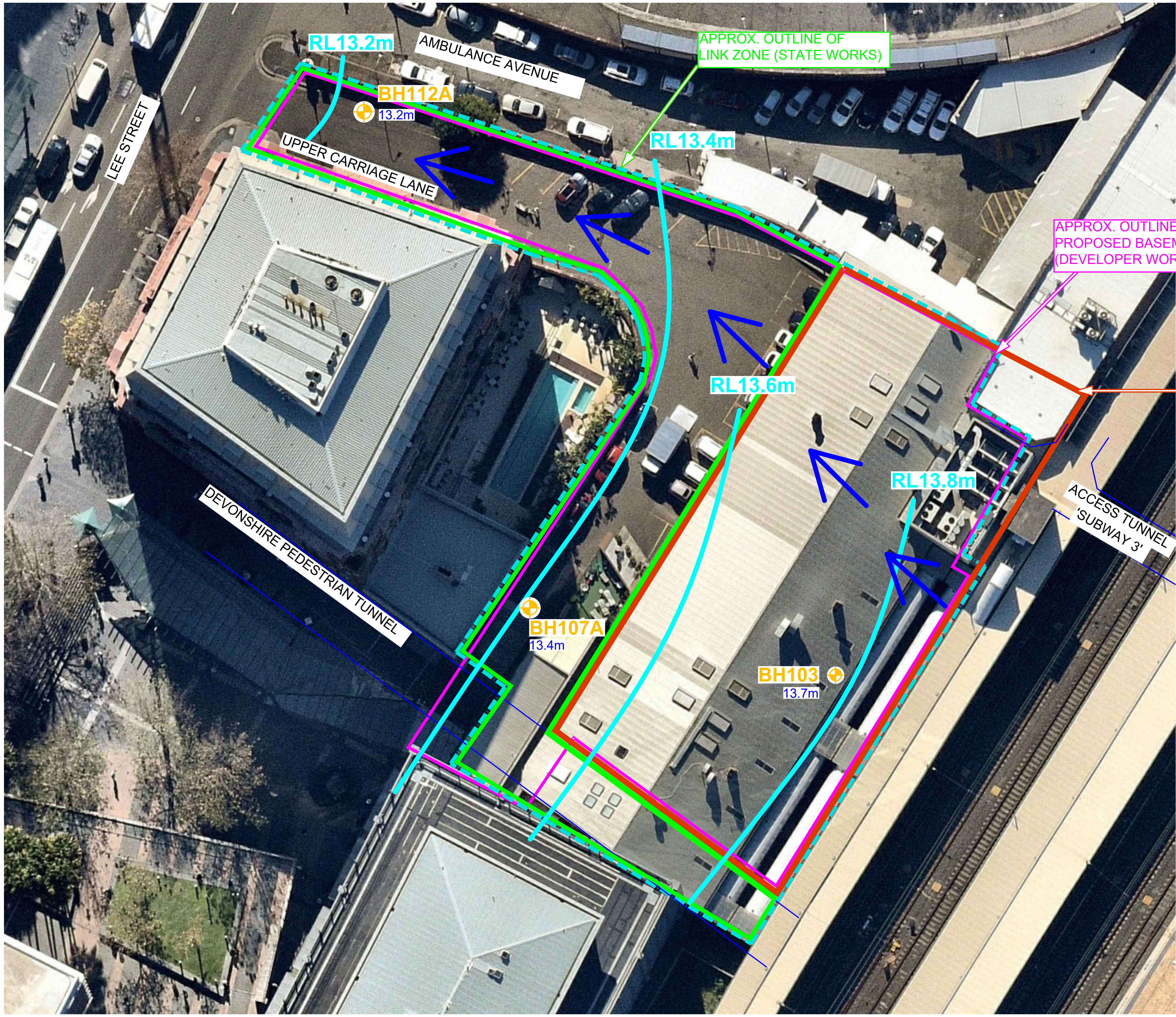
1. Base image from Nearmap.com (Dated 1 July 2019)
2. Test locations are approximate only and are shown with reference to existing features.
3. Approximate Development Outlines are as provided by Avenor Pty Ltd on 12 August 2019.
4. Groundwater level measurements taken on 05.05.2020 (BH5 and BH104) and 07.09.2020 (BH109B, 107B and 112B)
5. Bores not relevant to this drawing have been removed; refer to Drawing 1 or Report for location of all boreholes.
6. Groundwater contours shown for the site extents only.

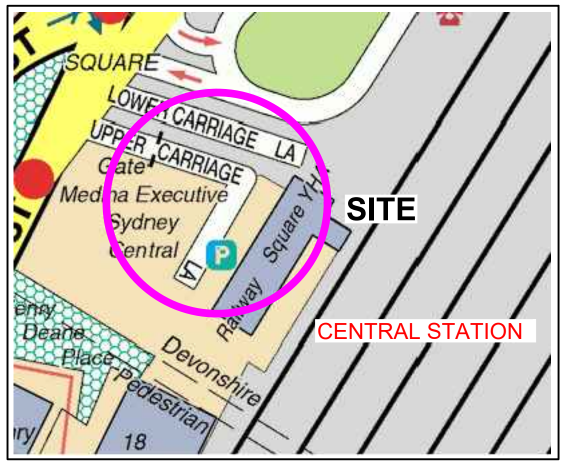
**LEGEND**

- Geotechnical & environmental borehole - Lower Ground Floor (DP Report 86767.00.R.001.Rev0, dated 26 August 2019)
- Geotechnical & environmental borehole (DP Report 86767.00.R001.Rev0, dated 26 August 2019)
- Inferred groundwater contour (RL(m))
- Direction of flow
- 13.2m Water elevation
- RL13.6m Contour elevation
- Approximate site boundary

**Douglas Partners**
Geotechnics / Environment / Groundwater

| | | | | |
|---|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Groundwater Levels and Flow Direction from Piezometers Screened in Hawkesbury Sandstone** | N | PROJECT No: 86767.06 |
| OFFICE: Sydney | DRAWN BY: BZ | **Proposed Commercial Development, 8-10 Lee Street, HAYMARKET** | | DRAWING No: 3 |
| SCALE: 1:500 @ A3 | DATE: 21.09.2020 | | | REVISION: 0 |




**Locality Plan**

**NOTE:**
1. Base image from Nearmap.com (Dated 1 July 2019)
2. Test locations are approximate only and are shown with reference to existing features.
3. Approximate Development Outlines are as provided by Avenor Pty Ltd on 12 August 2019.
4. Groundwater level measurements taken on 05.05.2020 (BH5 and BH104) and 07.09.2020 (BH109B, 107B and 112B)
5. Bores not relevant to this drawing have been removed; refer to Drawing 1 or Report for location of all boreholes.
6. Groundwater contours shown for the site extents only.

0 5 10 15 20 30 40 50m
1:500 @ A3

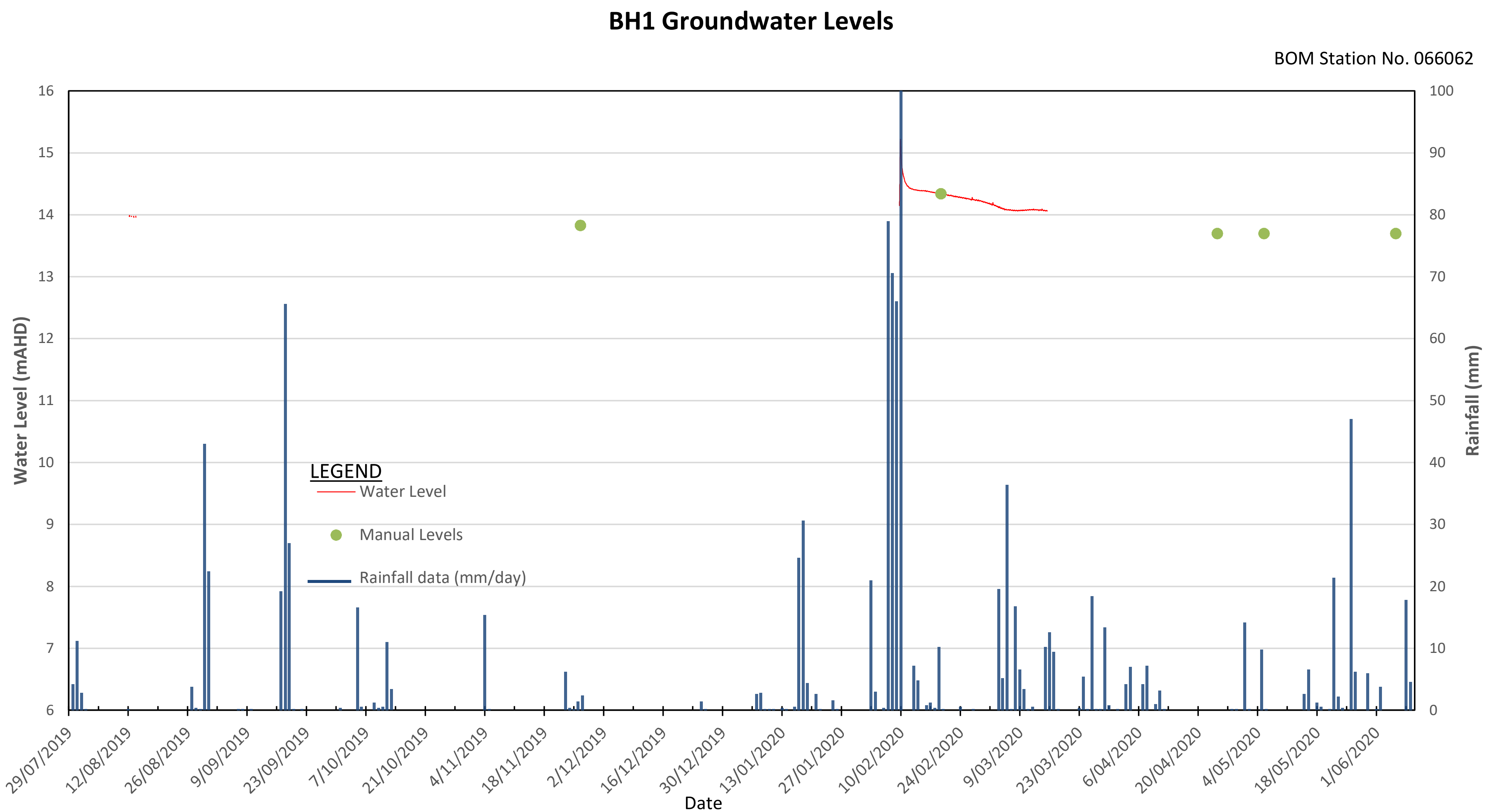
## LEGEND

- Geotechnical & environmental borehole - Lower Ground Floor (DP Report 86767.00.R.001.Rev0, dated 26 August 2019)
- Geotechnical & environmental borehole (DP Report 86767.00.R001.Rev0, dated 26 August 2019)
- Inferred groundwater contour (RL(m))
- Direction of flow
- 13.2m Water elevation
- RL13.6m Contour elevation
- Approximate site boundary

**Douglas Partners**
*Geotechnics / Environment / Groundwater*

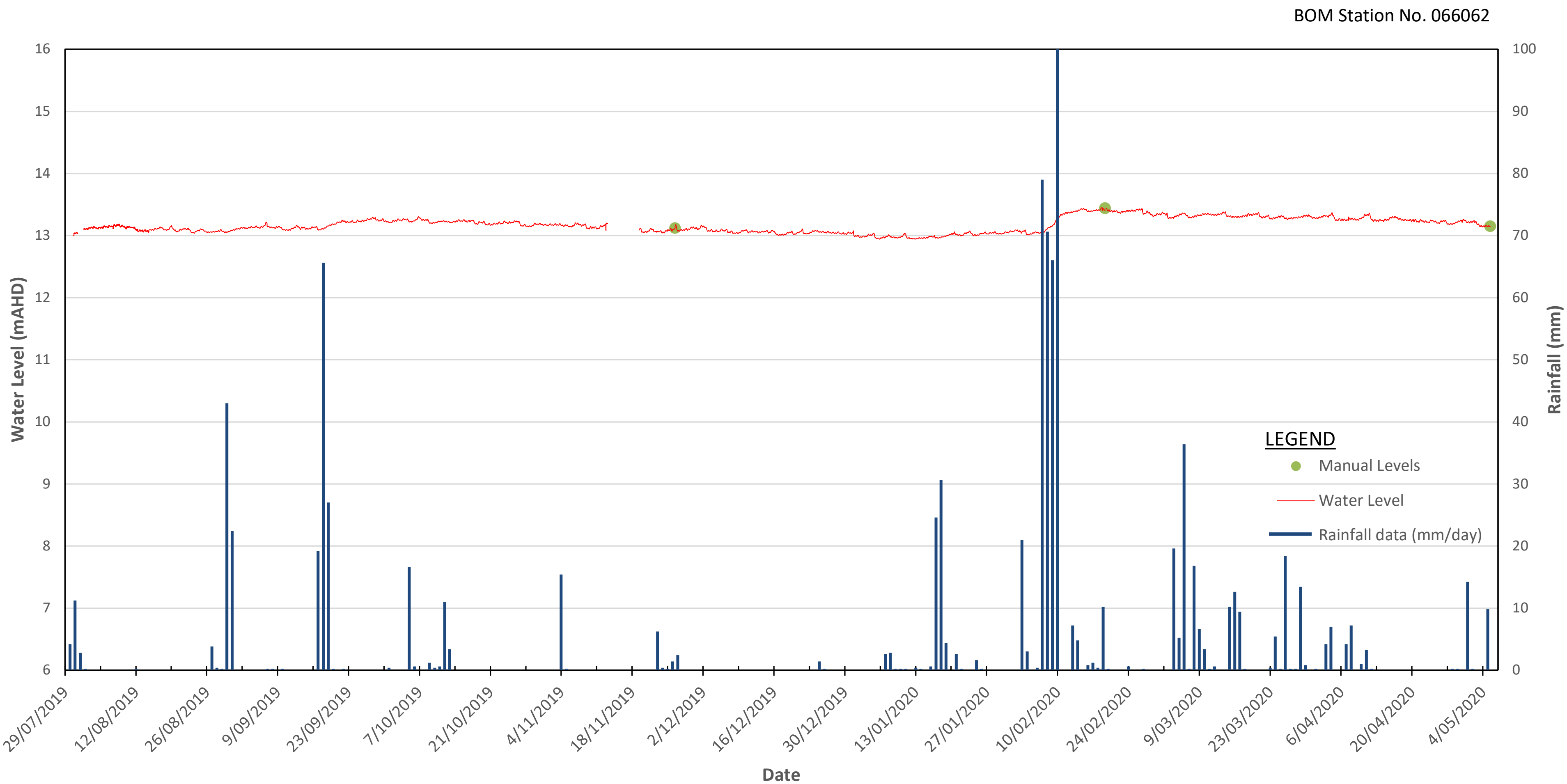
| | | |
|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Groundwater Levels and Flow Direction from Piezometers Screened in Mittagong Formation** **Proposed Commercial Development, 8-10 Lee Street, HAYMARKET** |
| OFFICE: Sydney | DRAWN BY: BZ | |
| SCALE: 1:500 @ A3 | DATE: 21.09.2020 | |

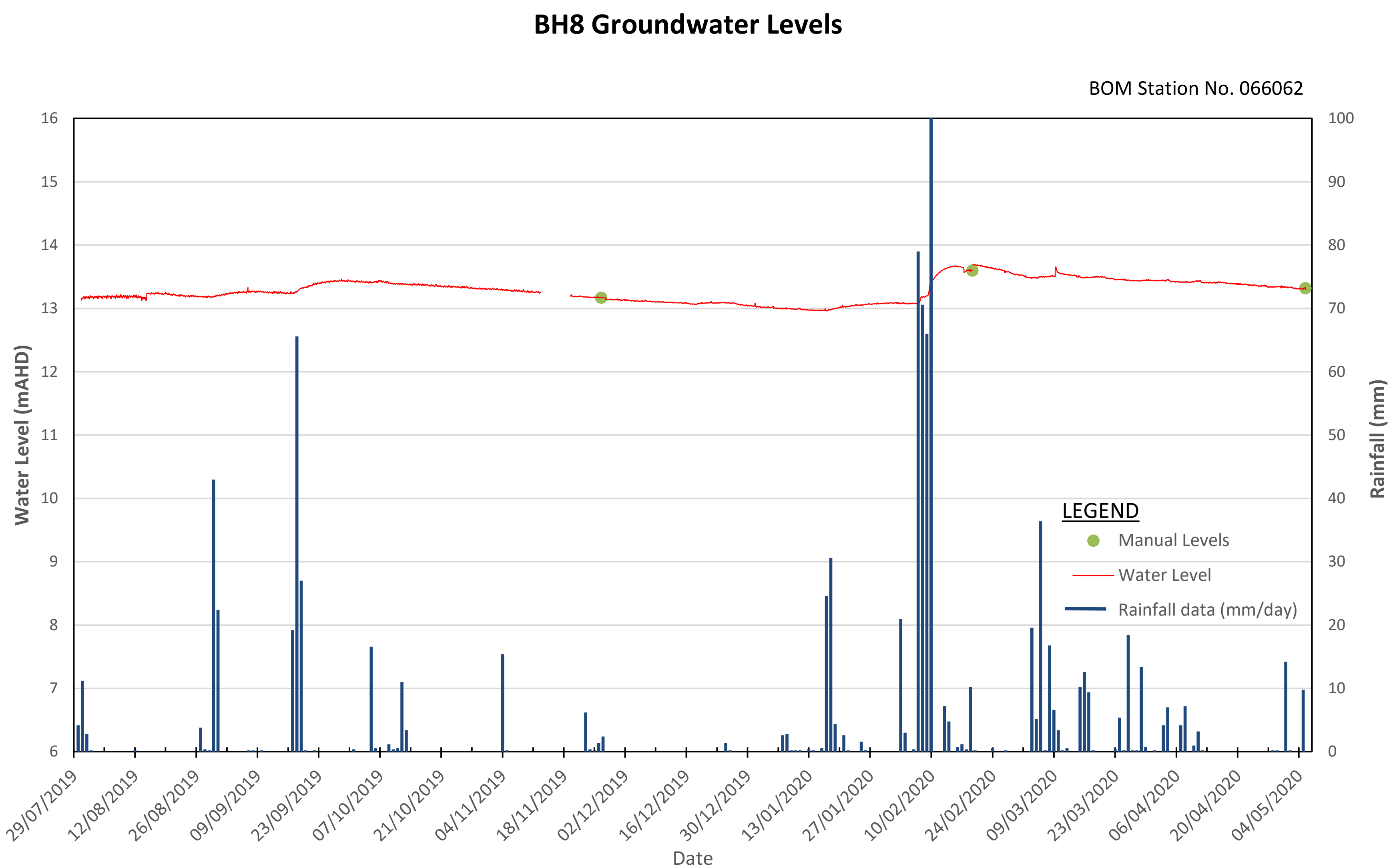
| | |
|---|---|
| PROJECT No: | 86767.06 |
| DRAWING No: | 4 |
| REVISION: | 0 |



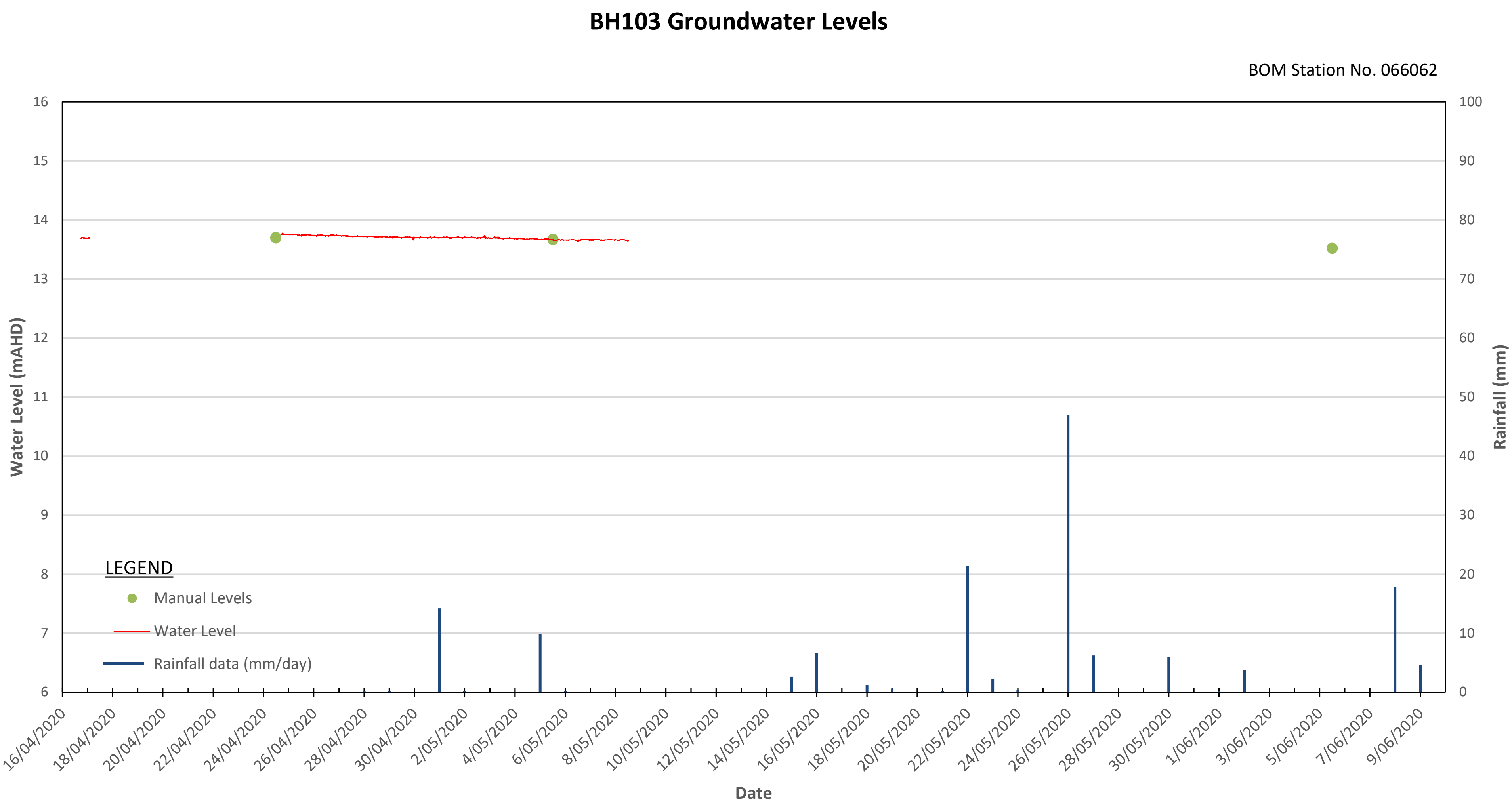
BH1 Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
Date
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
29/07/2019
12/08/2019
26/08/2019
9/09/2019
23/09/2019
7/10/2019
21/10/2019
4/11/2019
18/11/2019
2/12/2019
16/12/2019
30/12/2019
13/01/2020
27/01/2020
10/02/2020
24/02/2020
9/03/2020
23/03/2020
6/04/2020
20/04/2020
4/05/2020
18/05/2020
1/06/2020

# BH5 Groundwater Levels

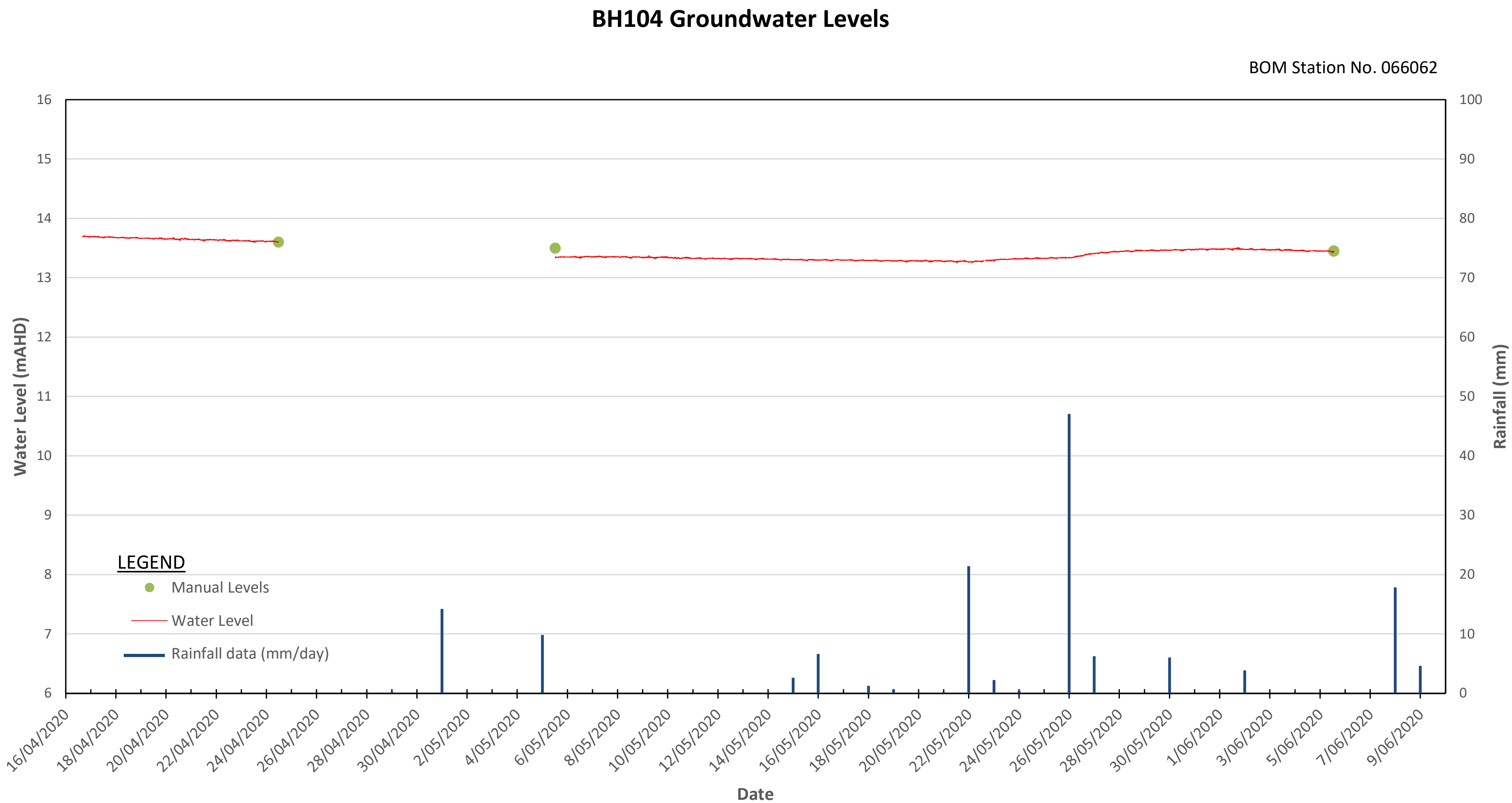


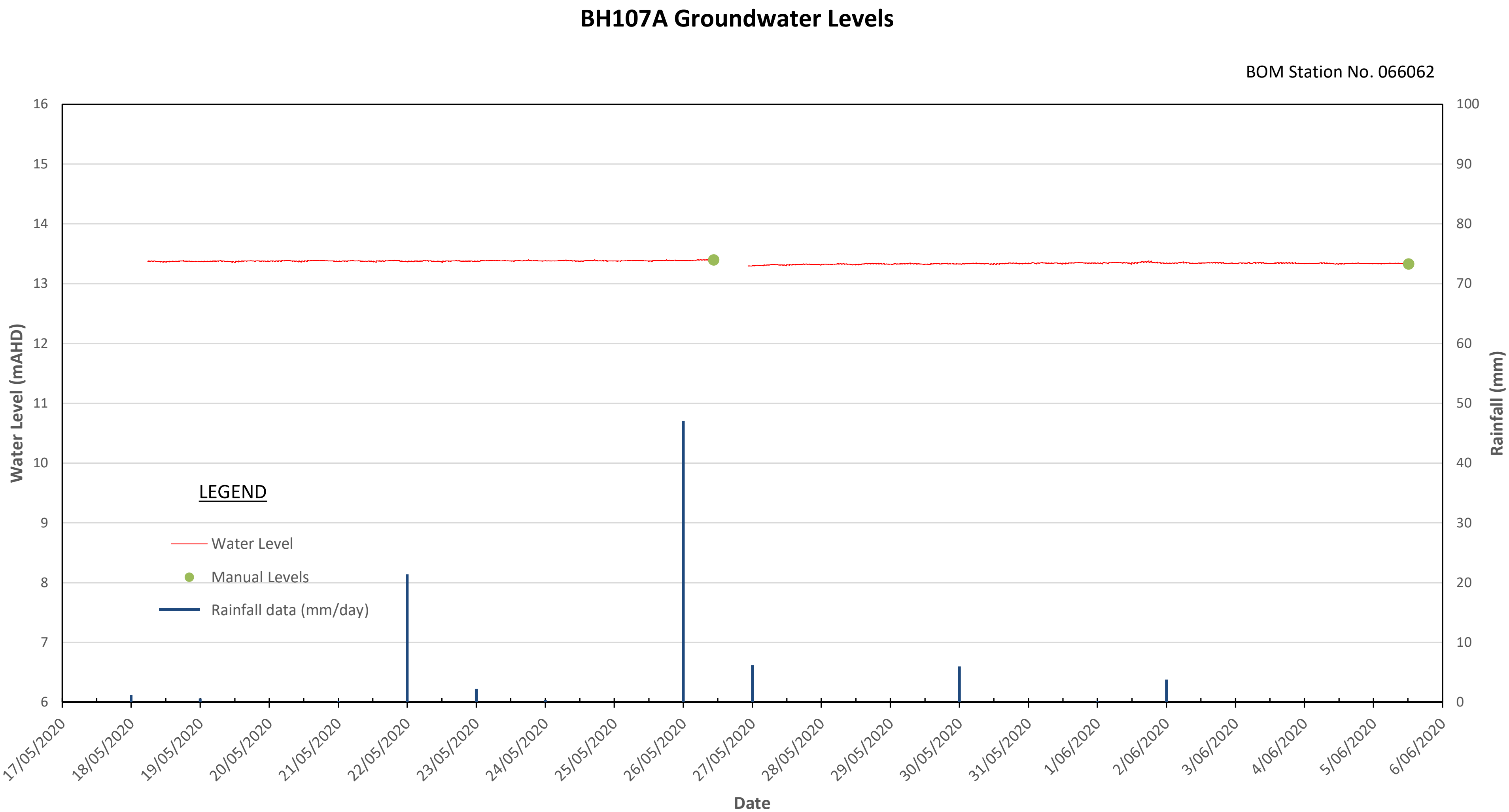


BH8 Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
LEGEND
Manual Levels
Water Level
Rainfall data (mm/day)
29/07/2019
12/08/2019
26/08/2019
09/09/2019
23/09/2019
07/10/2019
21/10/2019
04/11/2019
18/11/2019
02/12/2019
16/12/2019
30/12/2019
13/01/2020
27/01/2020
10/02/2020
24/02/2020
09/03/2020
23/03/2020
06/04/2020
20/04/2020
04/05/2020
Date

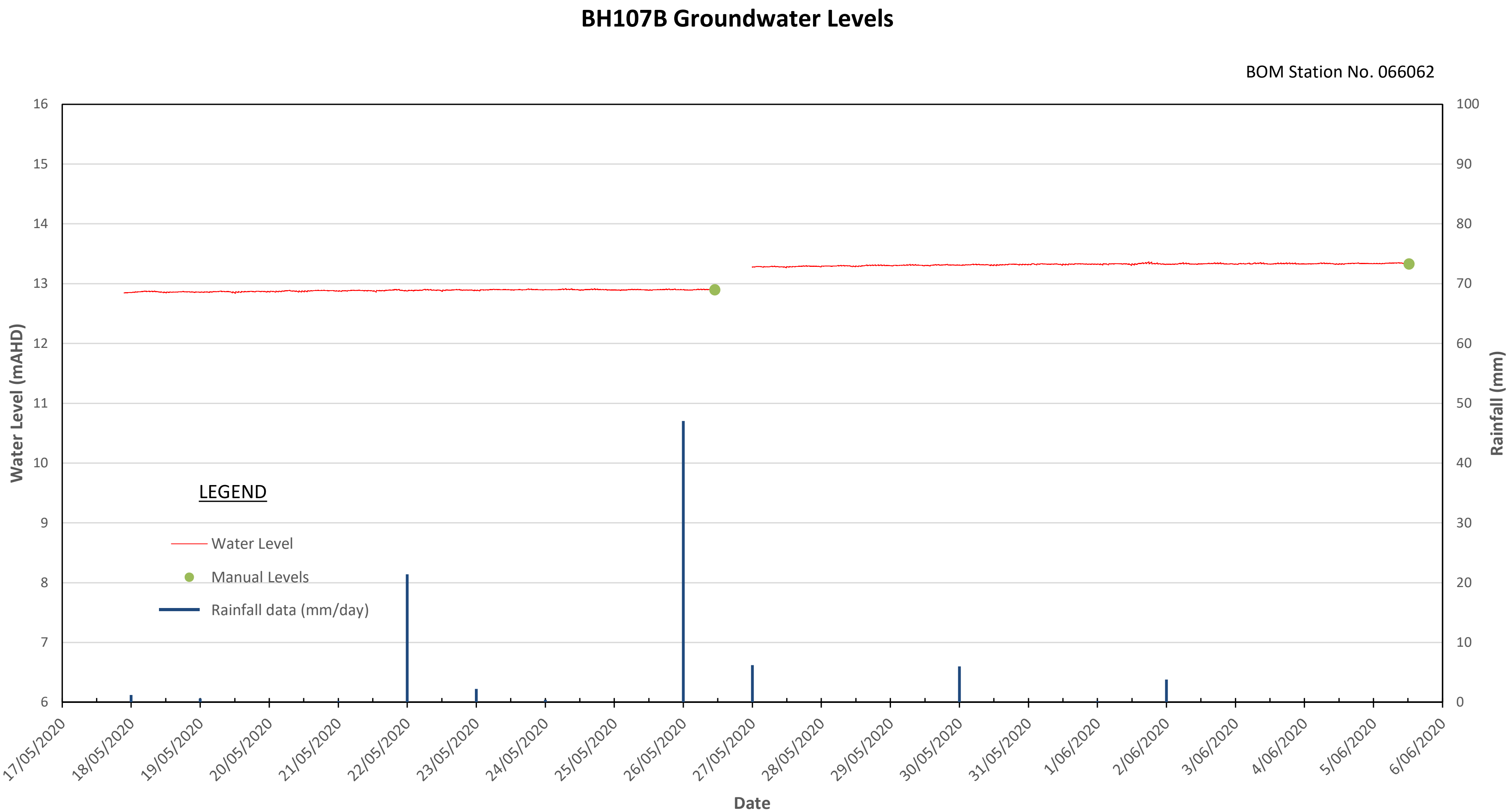


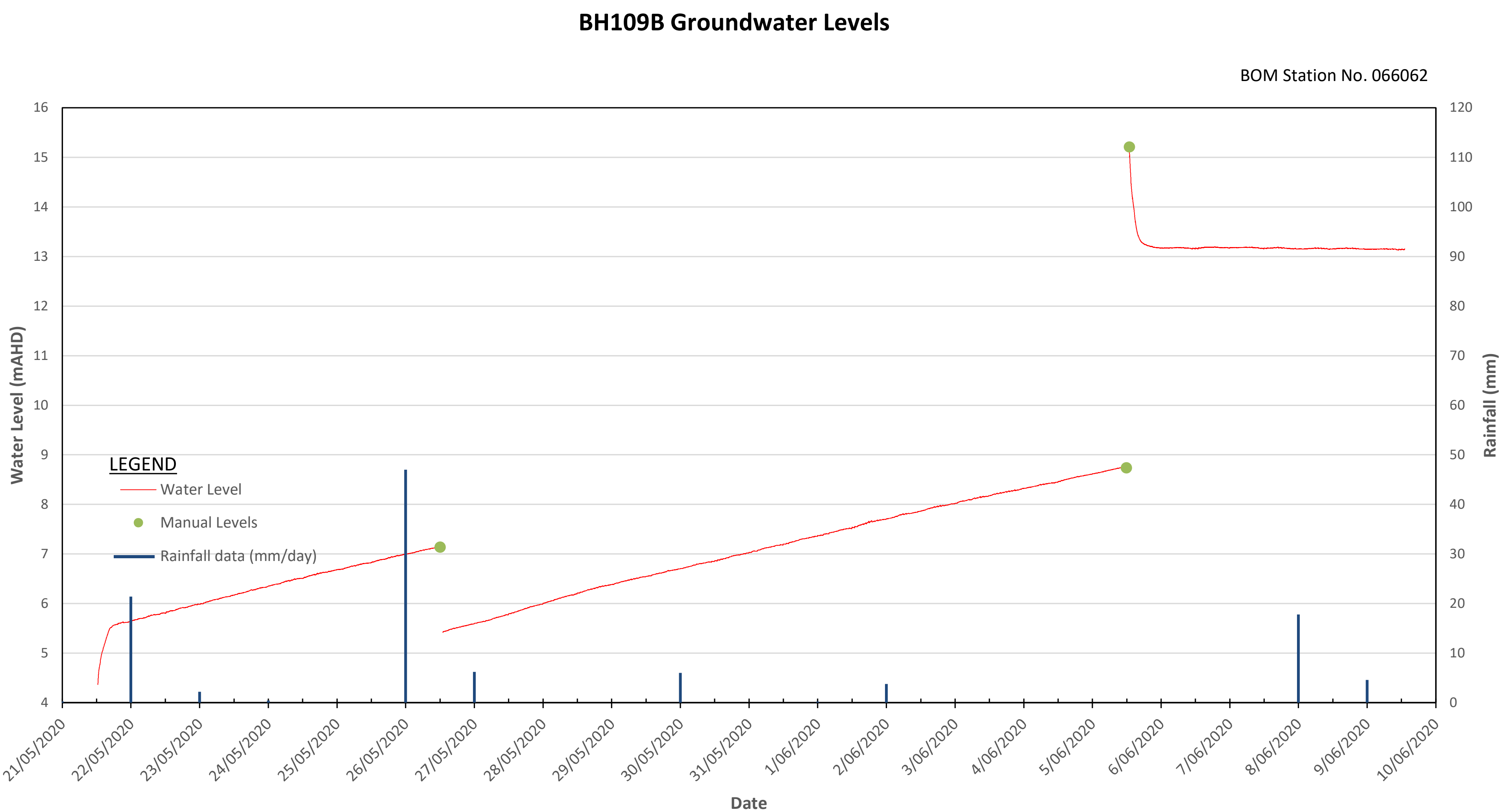
BH103 Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
Date
LEGEND
Manual Levels
Water Level
Rainfall data (mm/day)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
16/04/2020
18/04/2020
20/04/2020
22/04/2020
24/04/2020
26/04/2020
28/04/2020
30/04/2020
2/05/2020
4/05/2020
6/05/2020
8/05/2020
10/05/2020
12/05/2020
14/05/2020
16/05/2020
18/05/2020
20/05/2020
22/05/2020
24/05/2020
26/05/2020
28/05/2020
30/05/2020
1/06/2020
3/06/2020
5/06/2020
7/06/2020
9/06/2020


BH104 Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
LEGEND
Manual Levels
Water Level
Rainfall data (mm/day)
16/04/2020
18/04/2020
20/04/2020
22/04/2020
24/04/2020
26/04/2020
28/04/2020
30/04/2020
2/05/2020
4/05/2020
6/05/2020
8/05/2020
10/05/2020
12/05/2020
14/05/2020
16/05/2020
18/05/2020
20/05/2020
22/05/2020
24/05/2020
26/05/2020
28/05/2020
30/05/2020
1/06/2020
3/06/2020
5/06/2020
7/06/2020
9/06/2020
Date

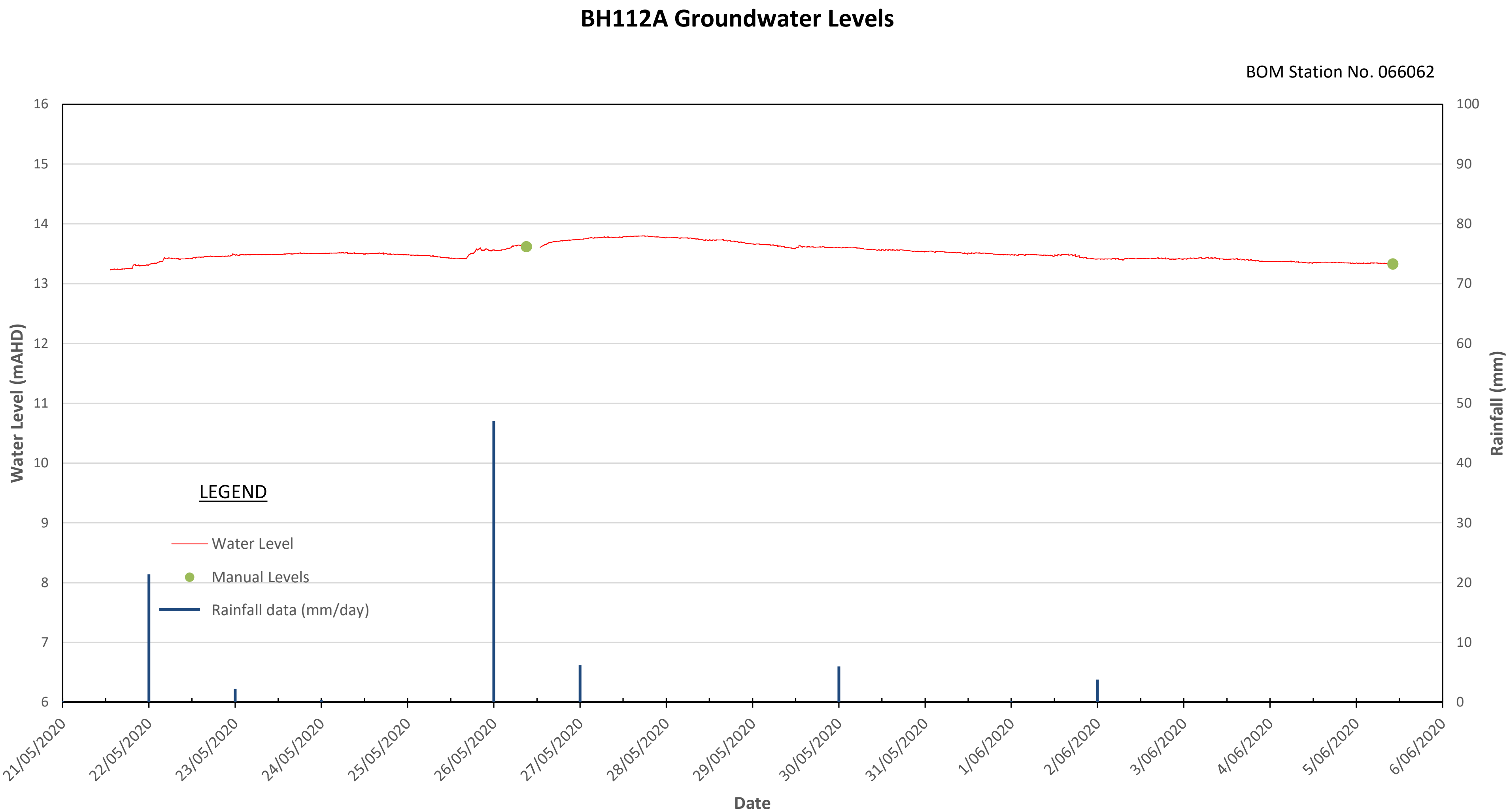


BH107A Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
Date
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
17/05/2020
18/05/2020
19/05/2020
20/05/2020
21/05/2020
22/05/2020
23/05/2020
24/05/2020
25/05/2020
26/05/2020
27/05/2020
28/05/2020
29/05/2020
30/05/2020
31/05/2020
1/06/2020
2/06/2020
3/06/2020
4/06/2020
5/06/2020
6/06/2020

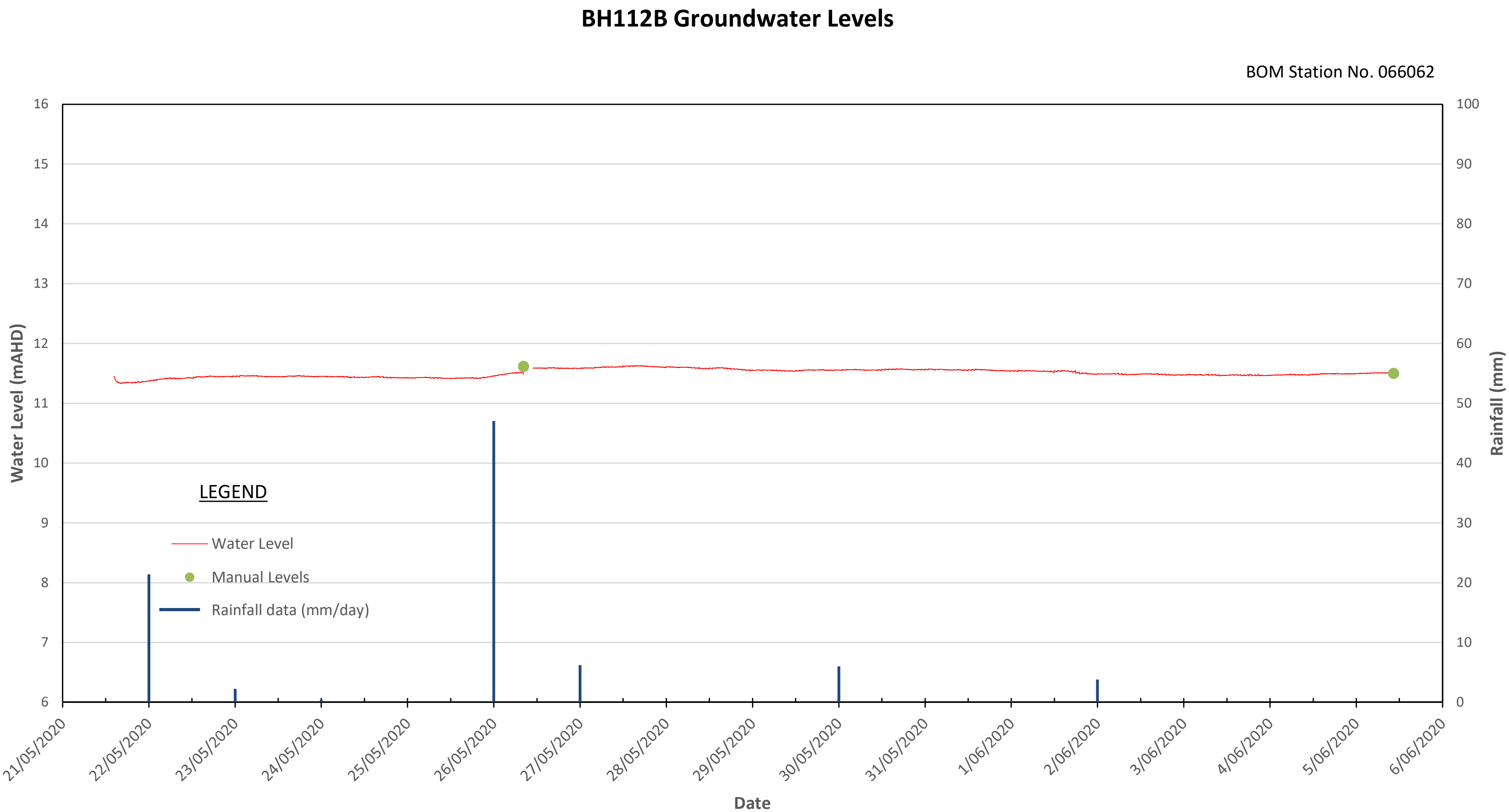

BH107B Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
17/05/2020
18/05/2020
19/05/2020
20/05/2020
21/05/2020
22/05/2020
23/05/2020
24/05/2020
25/05/2020
26/05/2020
27/05/2020
28/05/2020
29/05/2020
30/05/2020
31/05/2020
1/06/2020
2/06/2020
3/06/2020
4/06/2020
5/06/2020
6/06/2020
Date



BH109B Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
Date
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
16
15
14
13
12
11
10
9
8
7
6
5
4
120
110
100
90
80
70
60
50
40
30
20
10
0
21/05/2020
22/05/2020
23/05/2020
24/05/2020
25/05/2020
26/05/2020
27/05/2020
28/05/2020
29/05/2020
30/05/2020
31/05/2020
1/06/2020
2/06/2020
3/06/2020
4/06/2020
5/06/2020
6/06/2020
7/06/2020
8/06/2020
9/06/2020
10/06/2020



BH112A Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
21/05/2020
22/05/2020
23/05/2020
24/05/2020
25/05/2020
26/05/2020
27/05/2020
28/05/2020
29/05/2020
30/05/2020
31/05/2020
1/06/2020
2/06/2020
3/06/2020
4/06/2020
5/06/2020
6/06/2020
Date


BH112B Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
21/05/2020
22/05/2020
23/05/2020
24/05/2020
25/05/2020
26/05/2020
27/05/2020
28/05/2020
29/05/2020
30/05/2020
31/05/2020
1/06/2020
2/06/2020
3/06/2020
4/06/2020
5/06/2020
6/06/2020
Date

# Appendix D

Results of In situ Permeability Testing

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Atlassian Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commerical Development | Test date: | 31-Jul-19 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | JJH |

**Test Location**

Description: Standpipe in borehole
Material type: FILL/sandy CLAY, then SAND

**Test No.** BH1
Easting: 333983.4 m
Northing 6249262.5 m
Surface Level: 20.1 m AHD

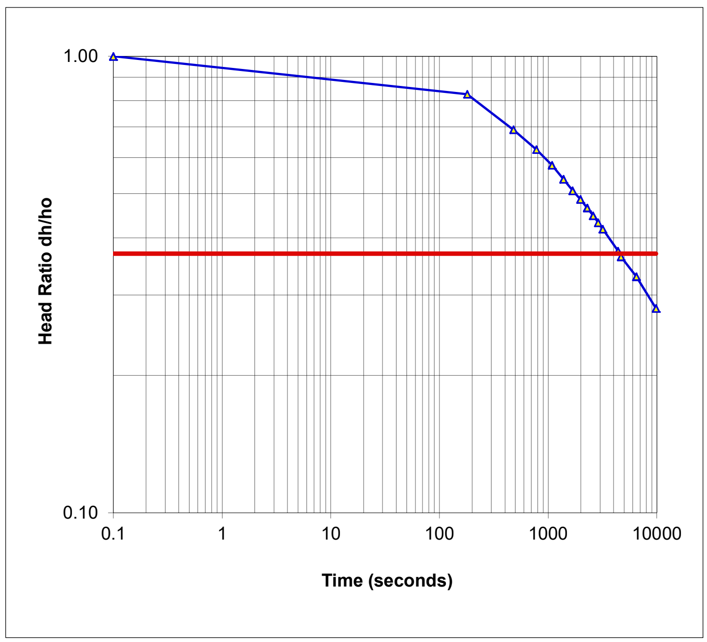
**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 114.3 | mm | Depth to water before test | 5.95 | m |
| Well screen diameter (2R) | 114.3 | mm | Depth to water at start of test | 0.00 | m |
| Length of well screen (Le) | 2 | m | | | |

PVC screen 6.3m-4.3m, sand 6.3-4.2m; blank from 4.3m onwards, bentonite from 4.2m onwards

**Test Results**

| Time (sec) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0.1 | 0 | 5.95 | 1.000 |
| 180.0 | 1.03 | 4.92 | 0.827 |
| 480.0 | 1.84 | 4.11 | 0.691 |
| 780.0 | 2.23 | 3.72 | 0.625 |
| 1080.0 | 2.51 | 3.44 | 0.578 |
| 1380.0 | 2.74 | 3.21 | 0.539 |
| 1680.0 | 2.93 | 3.02 | 0.508 |
| 1980.0 | 3.05 | 2.90 | 0.487 |
| 2280.0 | 3.18 | 2.77 | 0.466 |
| 2580.0 | 3.28 | 2.67 | 0.448 |
| 2880.0 | 3.38 | 2.57 | 0.432 |
| 3180.0 | 3.46 | 2.49 | 0.418 |
| 4380.0 | 3.72 | 2.23 | 0.374 |
| 4680.0 | 3.78 | 2.17 | 0.364 |
| 6480.0 | 3.99 | 1.96 | 0.329 |
| 9780.0 | 4.28 | 1.67 | 0.281 |




To = 4500 seconds

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **6.5E-07** | m/sec |
| | **=** | **0.232** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Atlassian Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commerical Development | Test date: | 14-Aug-19 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | KR |

**Test Location**
Description: Standpipe in borehole
Material type: FILL/sandy CLAY, then SAND

**Test No.** BH1
Easting: 333983.4 m
Northing 6249262.5 m
Surface Level: 20.1 m AHD

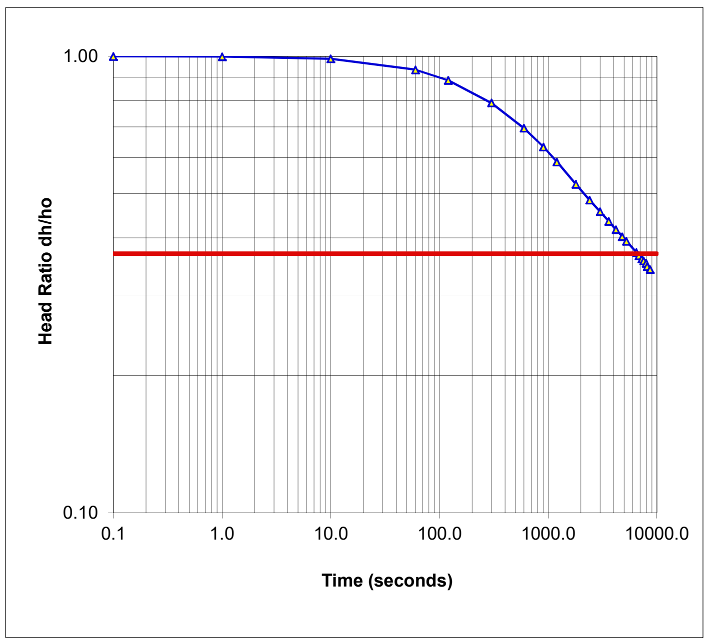
**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 114.3 | mm | Depth to water before test | 6.27 | m |
| Well screen diameter (2R) | 114.3 | mm | Depth to water at start of test | 0.36 | m |
| Length of well screen (Le) | 2 | m | | | |

PVC screen 6.3m-4.3m, sand 6.3-4.2m; blank from 4.3m onwards, bentonite from 4.2m onwards

**Test Results**

| Time (sec) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0.1 | 0.36 | 5.91 | 1.000 |
| 1.0 | 0.36 | 5.91 | 0.999 |
| 10.0 | 0.43 | 5.84 | 0.988 |
| 60.0 | 0.74 | 5.53 | 0.935 |
| 120.0 | 1.03 | 5.24 | 0.886 |
| 300.0 | 1.59 | 4.68 | 0.791 |
| 600.0 | 2.15 | 4.12 | 0.697 |
| 900.0 | 2.52 | 3.75 | 0.633 |
| 1200.0 | 2.80 | 3.47 | 0.587 |
| 1800.0 | 3.17 | 3.10 | 0.525 |
| 2400.0 | 3.41 | 2.86 | 0.484 |
| 3000.0 | 3.57 | 2.70 | 0.457 |
| 3600.0 | 3.70 | 2.57 | 0.435 |
| 4200.0 | 3.80 | 2.47 | 0.417 |
| 4793.0 | 3.89 | 2.38 | 0.403 |
| 5250.0 | 3.94 | 2.33 | 0.394 |
| 6450.0 | 4.07 | 2.20 | 0.372 |
| 6810.0 | 4.11 | 2.17 | 0.366 |
| 7230.0 | 4.14 | 2.13 | 0.360 |
| 7530.0 | 4.16 | 2.11 | 0.357 |
| 7950.0 | 4.19 | 2.09 | 0.353 |
| 8130.0 | 4.22 | 2.05 | 0.347 |
| 8670.0 | 4.25 | 2.02 | 0.342 |




To = 6500 seconds

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **4.5E-07** | m/sec |
| | **=** | **0.161** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

D□□□las □art□ers □t□Ltd
□□□ □□ □□□ □□□ □□□
□□□□d□□□las□art□ers□c□□ □a□

# □er□ e□□□□□ □e□□n□ □R□□n□ or □□□□n□ □e□d □e□□Re□or□

| | | | |
|---|---|---|---|
| Clie□t□ | □tlassia□ □t□Ltd | □r□ect □□□ | □□□□□□□□ |
| □r□ect□ | □r□□□sed C□□ □ercial De□el□□□ e□t | Test date□ | □□□□□l□□□ |
| L□cati□□□ | □□□□ Lee Street□□a□□ ar□et | Tested □□□ | □□□ |

**□e□□□oc□□on**

| | | | | |
|---|---|---|---|---|
| Descri□ti□□□ | Sta□d□i□e i□ □□re□□le | □asti□□□ | □□□□□□ | □ |
| Material t□□e□ | Sa□dst□□e | □□rt□i□□ | □□□□□□□ | □ |
| | | S□r□ace Le□el□ | □□□□ | □ □□D |

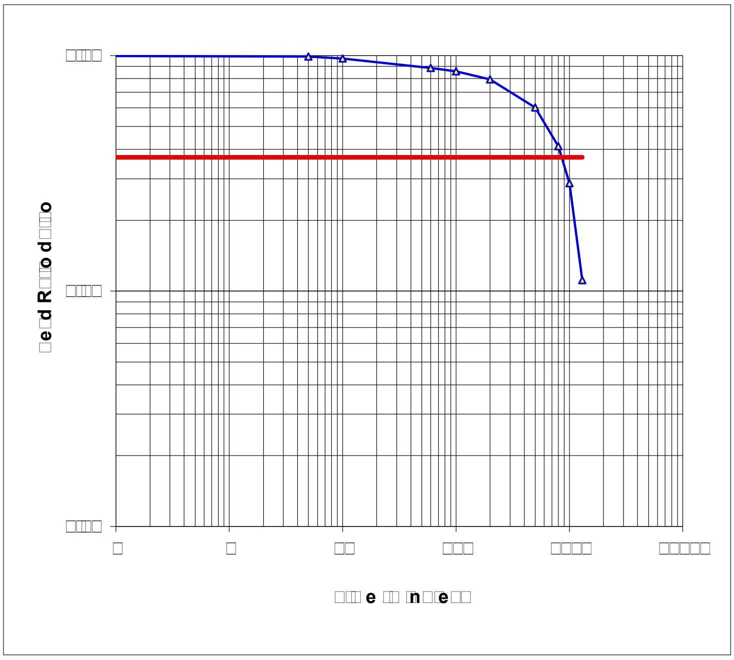
**□e□No.** □□□

**De□□□□ o□□ e□□n□□□□□□□on**

| | | | | | |
|---|---|---|---|---|---|
| □ ell casi□□ dia□eter □□r□ | □□ | □ □ | De□t□t□ □ater □e□□re test | □□□□ | □ |
| □ ell scree□ dia□eter □□R□ | □□ | □ □ | De□t□t□ □ater at start □□test | □□□□□ | □ |
| Le□□t□ □□□ell scree□ □Le□ | □□□□□ | □ | | | |

**□e□□Re□□□□□**

| Ti□e □□i□□ | De□t□ □□ □ | C□a□□e i□ □ead□d□ □□ □ | d□ □□ □ |
|---|---|---|---|
| | | | |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □□ | □□□□□ | □□□□□ | □□□□□ |
| □□ | □□□□□ | □□□□□ | □□□□□ |
| □□□ | □□□□□ | □□□□□ | □□□□□ |
| □□□ | □□□□□ | □□□□ | □□□□□ |
| □□□ | □□□□ | □□□□ | □□□□□ |
| □□□ | □□□□ | □□□□ | □□□□□ |
| □□□□ | □□□ | □□□□ | □□□□□ |
| □□□□ | □□□□ | □□□□ | □□□□□ |



T□ □ □□□ □i□s
□□□□□ secs

□□eor□: Falli□□ □ead □er□ea□ilit□calc□lated □si□□ e□□ati□□ □□ □ □□rsle□

□ □ □r□ I□□Le□R□□□Le T□

□□ere r □ radi□s □□casi□□
R □ radi□s □□□ell scree□
Le □ le□□t□ □□□ell scree□
T□ □ ti□e ta□e□ t□ rise □r □all t□ □□□ □□i□itial c□a□□e

| | | | |
|---|---|---|---|
| □ □dr□□□c Cond□c□□□□□ | □ □ | □.□□ □□□ | □ □sec |
| | □ | □.□□□ | c□ □□□□r |

D□□□las □art□ers □t□Ltd
□□□ □□ □□□ □□□ □□□
□□□□d□□□las□art□ers□c□□ □a□

# □er□ e□□□□□ □e□□n□ □R□□n□ □e□d □e□□Re□or□

| | | | |
|---|---|---|---|
| Clie□t□ | □tlassia□ □t□Ltd | □r□ect □□□ | □□□□□□□□ |
| □r□ect□ | □r□□□sed C□□ □ercial De□el□□□ e□t | Test date□ | □□□□□I□□□ |
| L□cati□□□ | □□□□ Lee Street□□a□□ ar□et | Tested □□□ | □□□ |

**□e□□□oc□□on**

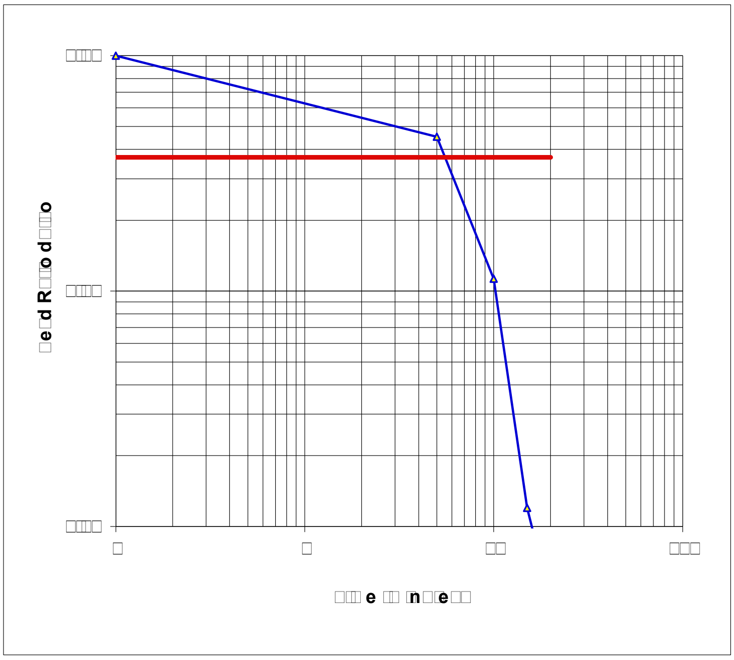
| | | | | |
|---|---|---|---|---|
| Descri□ti□□□ | Sta□d□i□e i□ □□re□□le | □asti□□□ | □□□□□□□ | □ |
| Material t□□e□ | Sa□dst□□e | □□rt□i□□ | □□□□□□□□ | □ |
| | | S□r□ace Le□el□ | □□□□ | □ □□D |

**De□□□□ o□□ e□□n□□□□□□on**

| | | | | | |
|---|---|---|---|---|---|
| □ ell casi□□ dia□eter □□r□ | □□ | □ □ | De□t□t□ □ater □e□□re test | □□□ | □ |
| □ ell scree□ dia□eter □□R□ | □□ | □ □ | De□t□t□ □ater at start □□test | □□□□ | □ |
| Le□□t□ □□□ell scree□ □Le□ | □□□□ | □ | | | |

**□e□□Re□□□□**

| Ti□e □□i□□ | De□t□ □□ □ | C□a□□e i□ □ead□d□ □□ □ | d□ □□ □ |
|---|---|---|---|
| | | | |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |




T□ □ □□□ □i□s
□□□ secs

**□□eor□:** Falli□□ □ead □er□ea□ilit□calc□lated □si□□ e□□ati□□ □□ □ □□rsle□

□ □ □r[□] l□Le□R□□□Le T□

□□ere r □ radi□s □□casi□□
R □ radi□s □□□ell scree□
Le □ le□□t□ □□□ell scree□
T□ □ ti□e ta□e□ t□ rise □r □all t□ □□□ □□i□itial c□a□□e

| | | | |
|---|---|---|---|
| □ □dr□□□c Cond□c□□□□ | □ □ | □.□□ □□□ | □ □sec |
| | □ | □.□□□ | c□ □□□□r |

Douglas Partners
Geotechnics / Environment / Groundwater

D□□□las □art□ers □t□Ltd
□□□ □□ □□□ □□□ □□□
□□□□d□□□las□art□ers□c□□ □a□

# □er□ e□□□□□ □e□□□n□ □R□□n□ or □□□□n□ □e□d □e□□Re□or□

| | | | |
|---|---|---|---|
| Clie□t□ | □tlassia□ □t□Ltd | □r□ect □□□ | □□□□□□□□ |
| □r□ect□ | □r□□□sed C□□ □ercial De□el□□□e□t | Test date□ | □□□□□r□□□ |
| L□cati□□□ | □□□□ Lee Street□□a□□ar□et | Tested □□□ | □□ |

**□e□□oc□□on**

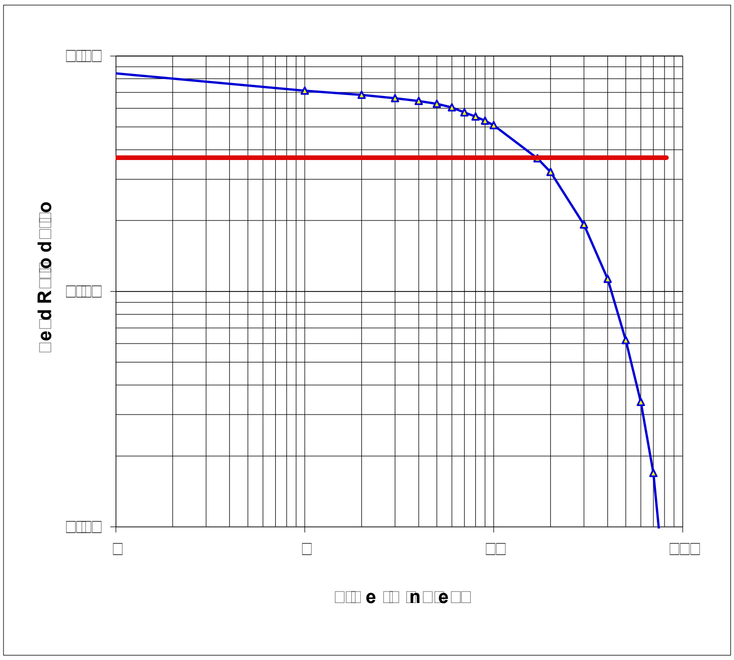
| | | | | |
|---|---|---|---|---|
| Descri□ti□□□ | Sta□d□i□e i□ □□re□□le | **□e□□No.** | □□□□□ | |
| Material t□□e□ | Sa□dst□□e | □asti□□□ | □□□□□□ | □ |
| | | □□rt□i□□ | □□□□□□□ | □ |
| | | S□r□ace Le□el□ | □□□□ | □ □□D |

**De□□□ o□□ e□□n□□□□□on**

| | | | | | |
|---|---|---|---|---|---|
| □ ell casi□□dia□eter □□r□ | □□ | □□ | De□t□t□ □ater □e□□re test | □□□ | □ |
| □ ell scree□ dia□eter □□R□ | □□ | □□ | De□t□t□ □ater at start □□test | □□□□ | □ |
| Le□□t□ □□□ell scree□ □Le□ | □□□ | □ | | | |

**□e□□Re□□□□**

| Ti□e □□i□□ | De□t□ □□ □ | C□a□□e i□ □ead□d□ □□ □ | d□ □□ □ |
|---|---|---|---|
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□ | □□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□ | □ | □□□□□ |



T□ □ □□ □i□s
□□□□ secs

**□□eor□:** Falli□□ □ead □er□ea□ilit□calc□lated □si□□ e□□ati□□ □□ □ □□rsle□

□ □ □r□ l□□Le□R□□□Le T□

□□ere r □ radi□s □□casi□□
R □ radi□s □□□ell scree□
Le □ le□□t□ □□□ell scree□
T□ □ ti□e ta□e□t□ rise □r □all t□ □□□ □□i□itial c□a□□e

| | | | |
|---|---|---|---|
| □ □dr□□□c Cond□c□□□□ | □ □ | □.□□□□ | □ □sec |
| | □ | □.□□□ | c□ □□□□r |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Rising or Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 24-Apr-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | AS |

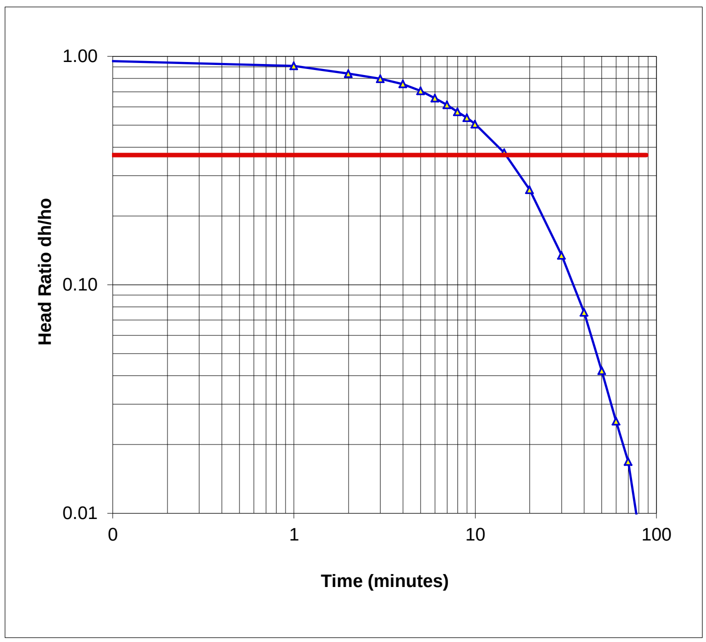
| | | | | |
|---|---|---|---|---|
| **Test Location** | | **Test No.** | BH103 | |
| Description: | Standpipe in borehole | Easting: | 333978 | m |
| Material type: | Sandstone | Northing | 6249263 | m |
| | | Surface Level: | 21.2 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 7.44 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 8.63 | m |
| Length of well screen (Le) | 0.8 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: dH (m) | dH/Ho |
|---|---|---|---|
| 0 | 8.63 | 1.19 | 1.000 |
| 1 | 8.52 | 1.08 | 0.908 |
| 2 | 8.44 | 1.00 | 0.840 |
| 3 | 8.39 | 0.95 | 0.798 |
| 4 | 8.34 | 0.90 | 0.756 |
| 5 | 8.28 | 0.84 | 0.706 |
| 6 | 8.22 | 0.78 | 0.655 |
| 7 | 8.17 | 0.73 | 0.613 |
| 8 | 8.12 | 0.68 | 0.571 |
| 9 | 8.08 | 0.64 | 0.538 |
| 10 | 8.04 | 0.60 | 0.504 |
| 14.5 | 7.89 | 0.45 | 0.378 |
| 20 | 7.75 | 0.31 | 0.261 |
| 30 | 7.6 | 0.16 | 0.134 |
| 40 | 7.53 | 0.09 | 0.076 |
| 50 | 7.49 | 0.05 | 0.042 |
| 60 | 7.47 | 0.03 | 0.025 |
| 70 | 7.46 | 0.02 | 0.017 |
| 80 | 7.45 | 0.01 | 0.008 |
| 88 | 7.44 | 0 | 0.000 |




To = 14.5 mins
870 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **1.4E-06** | m/sec |
| | **=** | **0.493** | cm/hour |

**Douglas Partners**
Geotechnics / Environment / Groundwater

D□□□las □art□ers □t□Ltd
□□□ □□ □□□ □□□ □□□
□□□□d□□□las□art□ers□c□□ □a□

## □er□ e□□□□□ □e□□□n□ □R□□n□ or □□□□n□ □e□d □e□□Re□or□

| | | | |
|---|---|---|---|
| Clie□t□ | □tlassia□ □t□Ltd | □r□ect □□□ | □□□□□□□□ |
| □r□ect□ | □r□□□sed C□□ □ercial De□el□□□ e□t | Test date□ | □□□□□r□□□ |
| L□cati□□□ | □□□□ Lee Street□□a□□ ar□et | Tested □□□ | □□ |

**□e□□□oc□□□on**

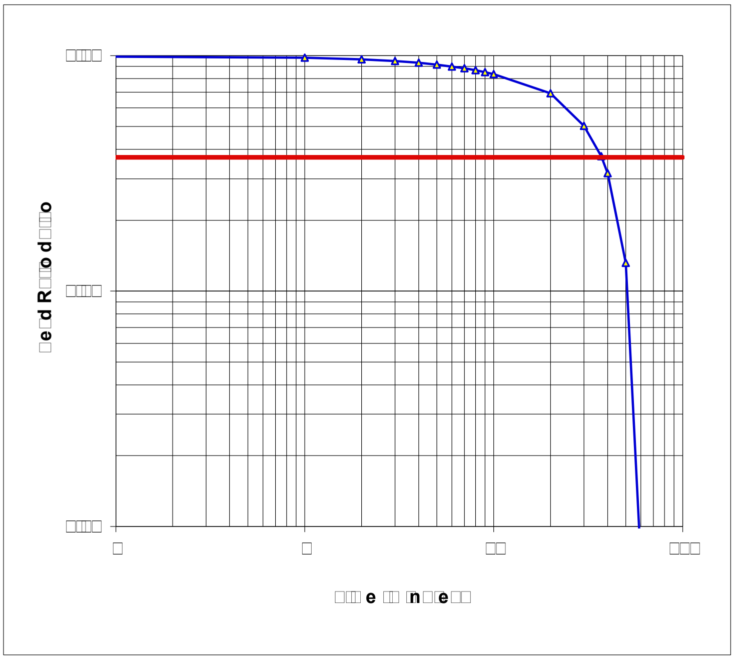
| | | | | |
|---|---|---|---|---|
| Descri□ti□□□ | Sta□d□i□e i□ □□re□□le | **□e□□No.** | □□□□□ | |
| Material t□□e□ | Sa□dst□□e | □asti□□□ | □□□□□□ | □ |
| | | □□rt□i□□ | □□□□□□□ | □ |
| | | S□r□ace Le□el□ | □□□ | □ □□D |

**De□□□□ o□□ e□□n□□□□□□□on**

| | | | | | |
|---|---|---|---|---|---|
| □ ell casi□□ dia□eter □r□ | □□ | □ □ | De□t□ t□ □ater □e□re test | □□□ | □ |
| □ ell scree□ dia□eter □R□ | □□ | □ □ | De□t□ t□ □ater at start □□test | □□□□ | □ |
| Le□□t□ □□□ell scree□ □Le□ | □ | □ | | | |

**□e□□Re□□□□**

| Ti□e □□i□□ | De□t□ □□ □ | C□a□□e i□ □ead□d□ □□ □ | d□ □□ □ |
|---|---|---|---|
| | | | |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□□ | □□□□ | □□□□ | □□□□□ |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |




T□ □ □□ □i□s
□□□□ secs

**□□eor□:** Falli□□ □ead □er□ea□ilit□calc□lated □si□□ e□□ati□□ □□ □ □□rsle□

□ □ □r[□] l□□Le□R□□□Le T□

□□ere r □ radi□s □□casi□□
R □ radi□s □□□ell scree□
Le □ le□□t□ □□□ell scree□
T□ □ ti□e ta□e□ t□ rise □r □all t□ □□□ □□i□itial c□a□□e

| | | | |
|---|---|---|---|
| □ □dr□□□c Cond□c□□□□ | □ □ | □.□□□□□ | □ □sec |
| | □ | □.□□□□ | c□ □□□□r |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Rising Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 22-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

**Test Location**

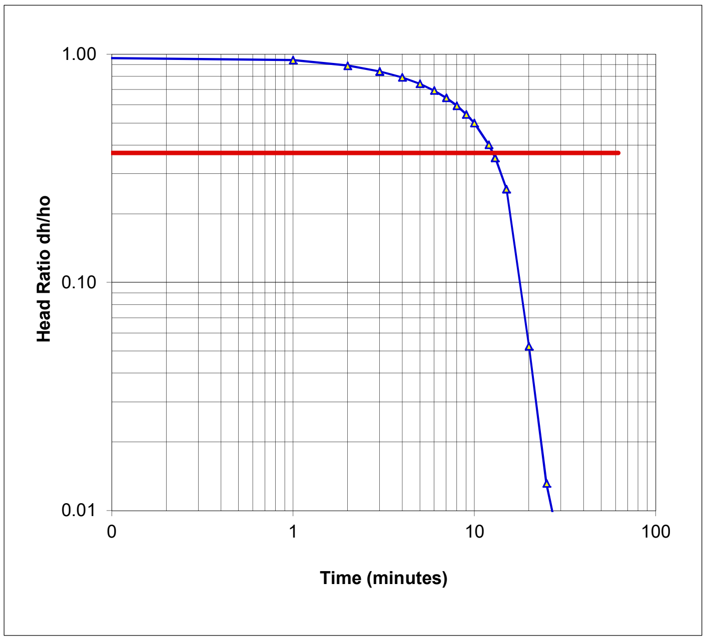
| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | **Test No.** | BH104 | |
| Material type: | Sandstone | Easting: | 333983 | m |
| | | Northing | 6249272 | m |
| | | Surface Level: | 21.2 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 7.91 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 10.95 | m |
| Length of well screen (Le) | 6 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 10.95 | 3.04 | 1.000 |
| 1 | 10.78 | 2.87 | 0.944 |
| 2 | 10.62 | 2.71 | 0.891 |
| 3 | 10.47 | 2.56 | 0.842 |
| 4 | 10.32 | 2.41 | 0.793 |
| 5 | 10.17 | 2.26 | 0.743 |
| 6 | 10.02 | 2.11 | 0.694 |
| 7 | 9.87 | 1.96 | 0.645 |
| 8 | 9.72 | 1.81 | 0.595 |
| 9 | 9.57 | 1.66 | 0.546 |
| 10 | 9.43 | 1.52 | 0.500 |
| 12 | 9.13 | 1.22 | 0.401 |
| 13 | 8.98 | 1.07 | 0.352 |
| 15 | 8.69 | 0.78 | 0.257 |
| 20 | 8.07 | 0.16 | 0.053 |
| 25 | 7.95 | 0.04 | 0.013 |
| 30 | 7.93 | 0.02 | 0.007 |
| 35 | 7.92 | 0.01 | 0.003 |
| 62 | 7.91 | 0 | 0.000 |




To = 12.5 mins
750 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **3.5E-07** | m/sec |
| | **=** | **0.127** | cm/hour |

# Permeability Testing - Rising or Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 17-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

**Test Location**

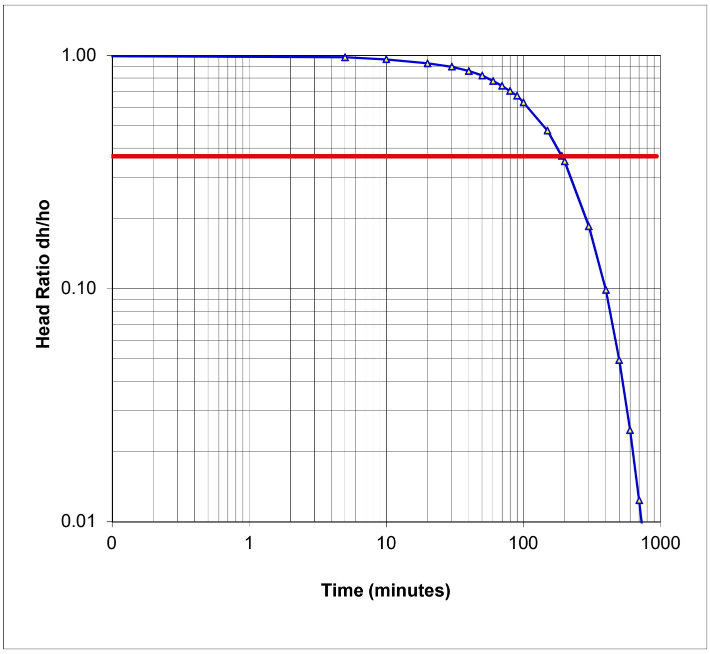
| | | | | |
|---|---|---|---|---|
| | | **Test No.** | BH107A | |
| Description: | Standpipe in borehole | Easting: | 333945 | m |
| Material type: | Sandstone | Northing | 6249270 | m |
| | | Surface Level: | 15.5 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 2.13 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 3.75 | m |
| Length of well screen (Le) | 0.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 3.75 | 1.62 | 1.000 |
| 5 | 3.72 | 1.59 | 0.981 |
| 10 | 3.69 | 1.56 | 0.963 |
| 20 | 3.63 | 1.50 | 0.926 |
| 30 | 3.58 | 1.45 | 0.895 |
| 40 | 3.52 | 1.39 | 0.858 |
| 50 | 3.46 | 1.33 | 0.821 |
| 60 | 3.39 | 1.26 | 0.778 |
| 70 | 3.33 | 1.20 | 0.741 |
| 80 | 3.27 | 1.14 | 0.704 |
| 90 | 3.22 | 1.09 | 0.673 |
| 100 | 3.15 | 1.02 | 0.630 |
| 150 | 2.9 | 0.77 | 0.475 |
| 190.5 | 2.73 | 0.6 | 0.370 |
| 200 | 2.7 | 0.57 | 0.352 |
| 300 | 2.43 | 0.3 | 0.185 |
| 400 | 2.29 | 0.16 | 0.099 |
| 500 | 2.21 | 0.08 | 0.049 |
| 600 | 2.17 | 0.04 | 0.025 |
| 700 | 2.15 | 0.02 | 0.012 |
| 800 | 2.14 | 0.01 | 0.006 |
| 936 | 2.13 | 0 | 0.000 |




To = 190.5 mins
11430 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **1.4E-07** | m/sec |
| | **=** | **0.051** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

## Permeability Testing - Rising Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 26-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | AS |

**Test Location**

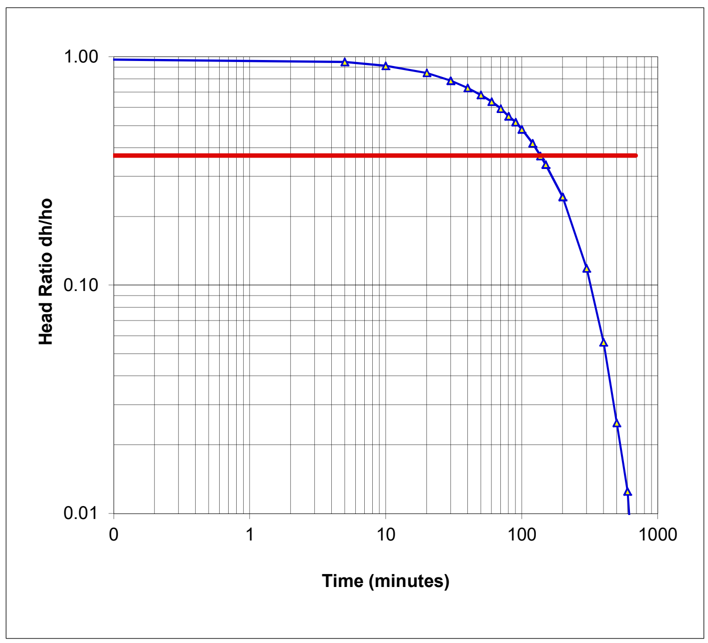
| | | | | |
|---|---|---|---|---|
| | | **Test No.** | BH107A | |
| Description: | Standpipe in borehole | Easting: | 333945 | m |
| Material type: | Sandstone | Northing | 6249270 | m |
| | | Surface Level: | 15.5 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 2.2 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 3.8 | m |
| Length of well screen (Le) | 0.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 3.8 | 1.60 | 1.000 |
| 5 | 3.72 | 1.52 | 0.950 |
| 10 | 3.66 | 1.46 | 0.913 |
| 20 | 3.56 | 1.36 | 0.850 |
| 30 | 3.46 | 1.26 | 0.788 |
| 40 | 3.37 | 1.17 | 0.731 |
| 50 | 3.29 | 1.09 | 0.681 |
| 60 | 3.22 | 1.02 | 0.638 |
| 70 | 3.15 | 0.95 | 0.594 |
| 80 | 3.08 | 0.88 | 0.550 |
| 90 | 3.03 | 0.83 | 0.519 |
| 100 | 2.97 | 0.77 | 0.481 |
| 120 | 2.87 | 0.67 | 0.419 |
| 137 | 2.79 | 0.59 | 0.369 |
| 150 | 2.74 | 0.54 | 0.338 |
| 200 | 2.59 | 0.39 | 0.244 |
| 300 | 2.39 | 0.19 | 0.119 |
| 400 | 2.29 | 0.09 | 0.056 |
| 500 | 2.24 | 0.04 | 0.025 |
| 600 | 2.22 | 0.02 | 0.013 |
| 650 | 2.21 | 0.01 | 0.006 |
| 687 | 2.2 | 0 | 0.000 |




To = 137 mins
8220 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **2.0E-07** | m/sec |
| | **=** | **0.071** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

## Permeability Testing - Rising or Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 17-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

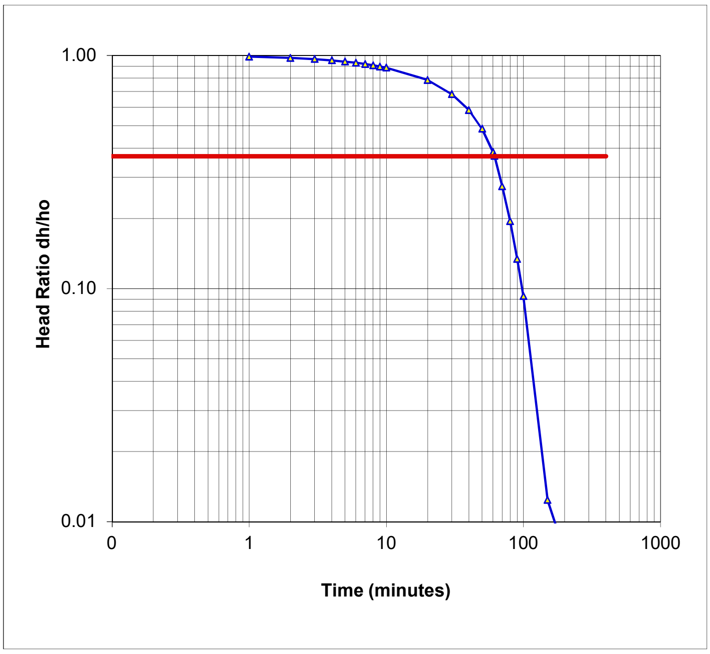
| | | | | |
|---|---|---|---|---|
| **Test Location** | | **Test No.** | BH107B | |
| Description: | Standpipe in borehole | Easting: | 333945 | m |
| Material type: | Sandstone | Northing | 6249272 | m |
| | | Surface Level: | 15.5 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 2.65 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 10.72 | m |
| Length of well screen (Le) | 5.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 10.72 | 8.07 | 1.000 |
| 1 | 10.63 | 7.98 | 0.989 |
| 2 | 10.53 | 7.88 | 0.976 |
| 3 | 10.44 | 7.79 | 0.965 |
| 4 | 10.34 | 7.69 | 0.953 |
| 5 | 10.25 | 7.60 | 0.942 |
| 6 | 10.16 | 7.51 | 0.931 |
| 7 | 10.07 | 7.42 | 0.919 |
| 8 | 9.98 | 7.33 | 0.908 |
| 9 | 9.89 | 7.24 | 0.897 |
| 10 | 9.8 | 7.15 | 0.886 |
| 20 | 8.98 | 6.33 | 0.784 |
| 30 | 8.16 | 5.51 | 0.683 |
| 40 | 7.36 | 4.71 | 0.584 |
| 50 | 6.56 | 3.91 | 0.485 |
| 60 | 5.76 | 3.11 | 0.385 |
| 61.5 | 5.64 | 2.99 | 0.371 |
| 70 | 4.87 | 2.22 | 0.275 |
| 80 | 4.22 | 1.57 | 0.195 |
| 90 | 3.73 | 1.08 | 0.134 |
| 100 | 3.4 | 0.75 | 0.093 |
| 150 | 2.75 | 0.1 | 0.012 |
| 200 | 2.71 | 0.06 | 0.007 |
| 300 | 2.69 | 0.04 | 0.005 |
| 400 | 2.68 | 0.03 | 0.004 |
| 500 | 2.66 | 0.01 | 0.001 |
| 636 | 2.65 | 0 | 0.000 |




To = 61.5 mins
3690 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **7.7E-08** | m/sec |
| | **=** | **0.028** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Rising Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 26-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | AS |

**Test Location**

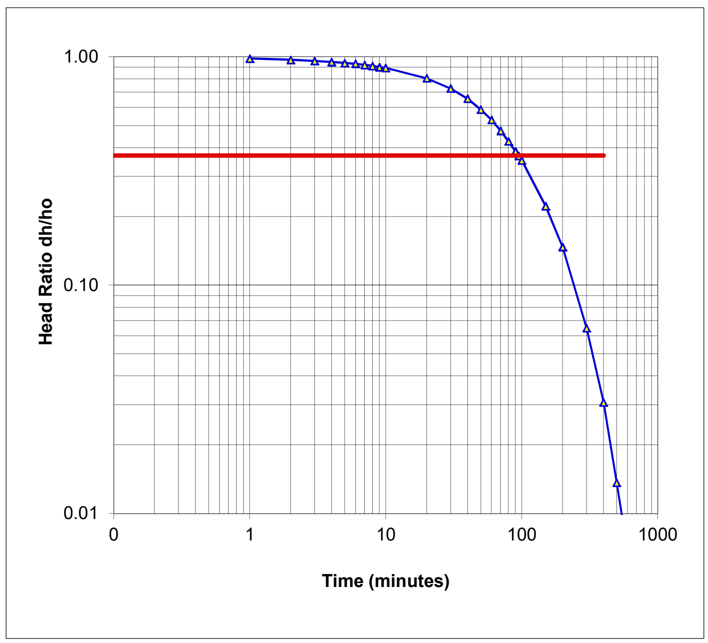
| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | **Test No.** | BH107B | |
| Material type: | Sandstone | Easting: | 333945 | m |
| | | Northing | 6249272 | m |
| | | Surface Level: | 15.5 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 2.22 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 5.15 | m |
| Length of well screen (Le) | 5.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 5.15 | 2.93 | 1.000 |
| 1 | 5.10 | 2.88 | 0.983 |
| 2 | 5.06 | 2.84 | 0.969 |
| 3 | 5.03 | 2.81 | 0.959 |
| 4 | 5.00 | 2.78 | 0.949 |
| 5 | 4.97 | 2.75 | 0.939 |
| 6 | 4.95 | 2.73 | 0.932 |
| 7 | 4.92 | 2.70 | 0.922 |
| 8 | 4.89 | 2.67 | 0.911 |
| 9 | 4.86 | 2.64 | 0.901 |
| 10 | 4.84 | 2.62 | 0.894 |
| 20 | 4.58 | 2.36 | 0.805 |
| 30 | 4.35 | 2.13 | 0.727 |
| 40 | 4.14 | 1.92 | 0.655 |
| 50 | 3.94 | 1.72 | 0.587 |
| 60 | 3.77 | 1.55 | 0.529 |
| 70 | 3.61 | 1.39 | 0.474 |
| 80 | 3.47 | 1.25 | 0.427 |
| 90 | 3.35 | 1.13 | 0.386 |
| 95 | 3.30 | 1.08 | 0.369 |
| 100 | 3.25 | 1.03 | 0.352 |
| 150 | 2.87 | 0.65 | 0.222 |
| 200 | 2.65 | 0.43 | 0.147 |
| 300 | 2.41 | 0.19 | 0.065 |
| 400 | 2.31 | 0.09 | 0.031 |
| 500 | 2.26 | 0.04 | 0.014 |
| 600 | 2.24 | 0.02 | 0.007 |




To = 95 mins
5700 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **5.0E-08** | m/sec |
| | **=** | **0.018** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

## Permeability Testing - Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 5-Jun-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

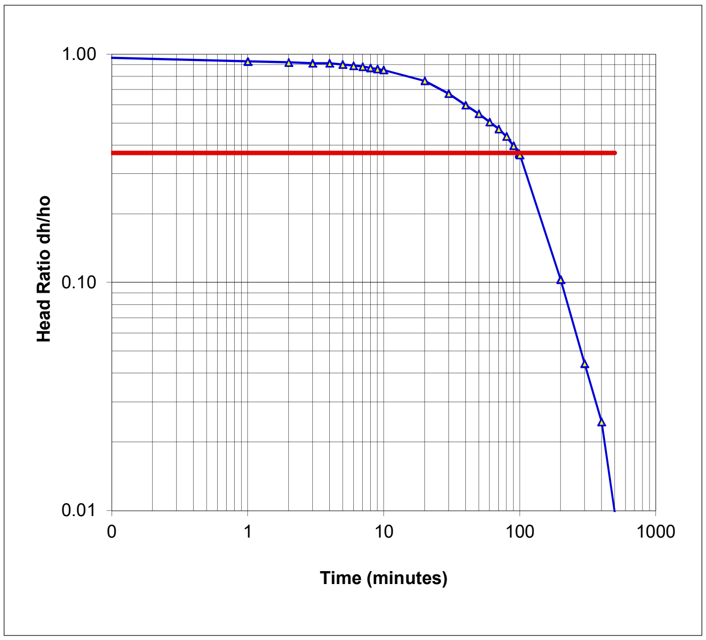
| | | | | |
|---|---|---|---|---|
| **Test Location** | | **Test No.** | BH109B | |
| Description: | Standpipe in borehole | Easting: | 333970 | m |
| Material type: | Sandstone | Northing | 6249311 | m |
| | | Surface Level: | 15.3 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water at end of test | 2.17 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 0.13 | m |
| Length of well screen (Le) | 5.6 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 0.13 | 2.04 | 1.000 |
| 1 | 0.27 | 1.90 | 0.931 |
| 2 | 0.29 | 1.88 | 0.922 |
| 3 | 0.31 | 1.86 | 0.912 |
| 4 | 0.31 | 1.86 | 0.912 |
| 5 | 0.33 | 1.84 | 0.902 |
| 6 | 0.35 | 1.82 | 0.892 |
| 7 | 0.37 | 1.80 | 0.882 |
| 8 | 0.39 | 1.78 | 0.873 |
| 9 | 0.41 | 1.76 | 0.863 |
| 10 | 0.43 | 1.74 | 0.853 |
| 20 | 0.61 | 1.56 | 0.765 |
| 30 | 0.8 | 1.37 | 0.672 |
| 40 | 0.95 | 1.22 | 0.598 |
| 50 | 1.05 | 1.12 | 0.549 |
| 60 | 1.14 | 1.03 | 0.505 |
| 70 | 1.21 | 0.96 | 0.471 |
| 80 | 1.28 | 0.89 | 0.436 |
| 90 | 1.36 | 0.81 | 0.397 |
| 98.5 | 1.42 | 0.75 | 0.368 |
| 100 | 1.43 | 0.74 | 0.363 |
| 200 | 1.96 | 0.21 | 0.103 |
| 300 | 2.08 | 0.09 | 0.044 |
| 400 | 2.12 | 0.05 | 0.025 |
| 500 | 2.15 | 0.02 | 0.010 |
| 600 | 2.17 | 0 | 0.000 |




To = 98.5 mins
5910 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **4.7E-08** | m/sec |
| | **=** | **0.017** | cm/hour |

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 5-Jun-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

**Test Location**

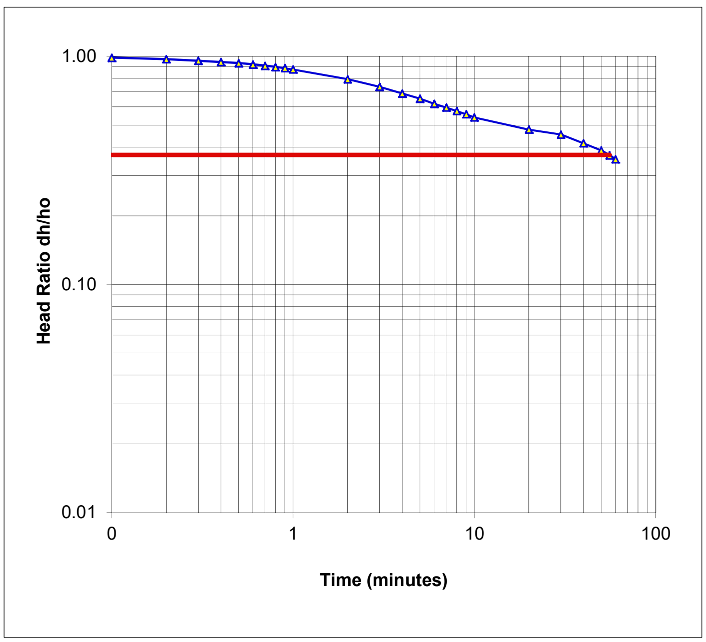
| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | **Test No.** | BH112A | |
| Material type: | Sandstone | Easting: | 333926 | m |
| | | Northing | 6249325 | m |
| | | Surface Level: | 16.7 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 3.39 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 0.00 | m |
| Length of well screen (Le) | 0.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 0.00 | 3.39 | 1.000 |
| 0.10 | 0.05 | 3.34 | 0.985 |
| 0.20 | 0.1 | 3.29 | 0.971 |
| 0.30 | 0.15 | 3.24 | 0.956 |
| 0.40 | 0.19 | 3.20 | 0.944 |
| 0.50 | 0.23 | 3.16 | 0.932 |
| 0.60 | 0.27 | 3.12 | 0.920 |
| 0.70 | 0.31 | 3.08 | 0.909 |
| 0.80 | 0.35 | 3.04 | 0.897 |
| 0.90 | 0.38 | 3.01 | 0.888 |
| 1.00 | 0.42 | 2.97 | 0.876 |
| 2 | 0.7 | 2.69 | 0.794 |
| 3 | 0.9 | 2.49 | 0.735 |
| 4 | 1.06 | 2.33 | 0.687 |
| 5 | 1.18 | 2.21 | 0.652 |
| 6 | 1.29 | 2.1 | 0.619 |
| 7 | 1.37 | 2.02 | 0.596 |
| 8 | 1.44 | 1.95 | 0.575 |
| 9 | 1.5 | 1.89 | 0.558 |
| 10 | 1.56 | 1.83 | 0.540 |
| 20 | 1.77 | 1.62 | 0.478 |
| 30 | 1.85 | 1.54 | 0.454 |
| 40 | 1.98 | 1.41 | 0.416 |
| 50 | 2.08 | 1.31 | 0.386 |
| 55.6 | 2.14 | 1.25 | 0.369 |
| 60 | 2.19 | 1.2 | 0.354 |




To = 55.6 mins
3336 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **4.8E-07** | m/sec |
| | **=** | **0.174** | cm/hour |

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Rising or Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 21-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

**Test Location**

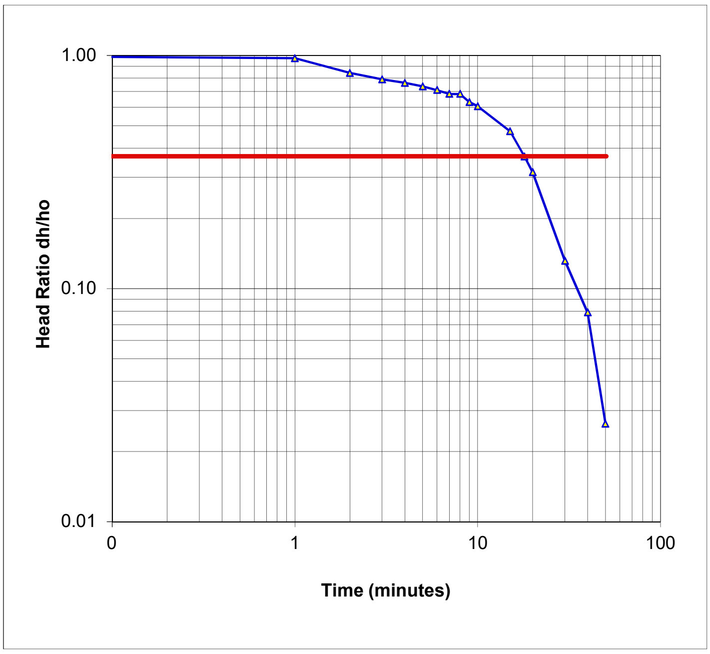
| | | | | |
|---|---|---|---|---|
| | | **Test No.** | BH112B | |
| Description: | Standpipe in borehole | Easting: | 333928 | m |
| Material type: | Sandstone | Northing | 6249324 | m |
| | | Surface Level: | 16.8 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 5.37 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 5.75 | m |
| Length of well screen (Le) | 6 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 5.75 | 0.38 | 1.000 |
| 1 | 5.74 | 0.37 | 0.974 |
| 2 | 5.69 | 0.32 | 0.842 |
| 3 | 5.67 | 0.30 | 0.789 |
| 4 | 5.66 | 0.29 | 0.763 |
| 5 | 5.65 | 0.28 | 0.737 |
| 6 | 5.64 | 0.27 | 0.711 |
| 7 | 5.63 | 0.26 | 0.684 |
| 8 | 5.63 | 0.26 | 0.684 |
| 9 | 5.61 | 0.24 | 0.632 |
| 10 | 5.6 | 0.23 | 0.605 |
| 15 | 5.55 | 0.18 | 0.474 |
| 18 | 5.51 | 0.14 | 0.368 |
| 20 | 5.49 | 0.12 | 0.316 |
| 30 | 5.42 | 0.05 | 0.132 |
| 40 | 5.4 | 0.03 | 0.079 |
| 50 | 5.38 | 0.01 | 0.026 |
| 50.5 | 5.37 | 0 | 0.000 |




To = 18 mins
1080 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **2.4E-07** | m/sec |
| | **=** | **0.088** | cm/hour |

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 5-Jun-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

**Test Location**

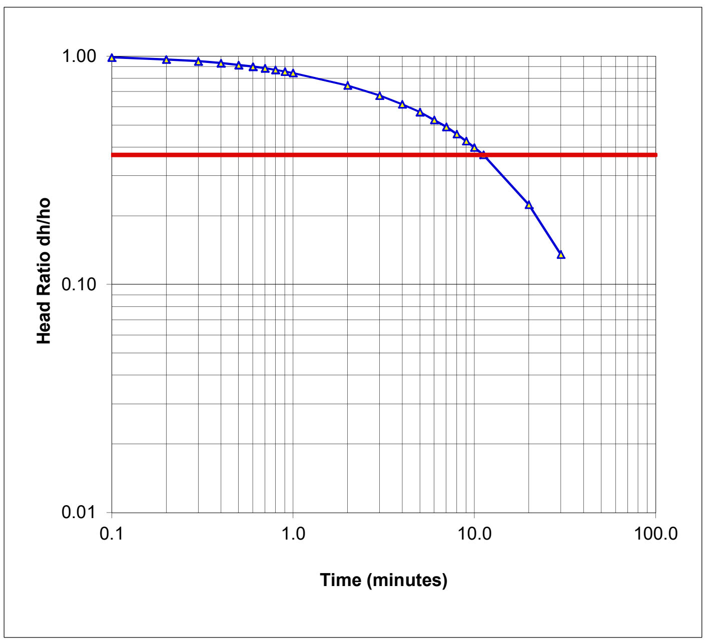
| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | **Test No.** | BH112B | |
| Material type: | Sandstone | Easting: | 333928 | m |
| | | Northing | 6249324 | m |
| | | Surface Level: | 16.8 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 5.32 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 0.00 | m |
| Length of well screen (Le) | 6 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0.0 | 0.00 | 5.32 | 1.000 |
| 0.1 | 0.06 | 5.26 | 0.989 |
| 0.2 | 0.17 | 5.15 | 0.968 |
| 0.3 | 0.26 | 5.06 | 0.951 |
| 0.4 | 0.36 | 4.96 | 0.932 |
| 0.5 | 0.45 | 4.87 | 0.915 |
| 0.6 | 0.53 | 4.79 | 0.900 |
| 0.7 | 0.61 | 4.71 | 0.885 |
| 0.8 | 0.68 | 4.64 | 0.872 |
| 0.9 | 0.76 | 4.56 | 0.857 |
| 1 | 0.82 | 4.50 | 0.846 |
| 2 | 1.36 | 3.96 | 0.744 |
| 3 | 1.74 | 3.58 | 0.673 |
| 4 | 2.04 | 3.28 | 0.617 |
| 5 | 2.29 | 3.03 | 0.570 |
| 6 | 2.52 | 2.8 | 0.526 |
| 7 | 2.71 | 2.61 | 0.491 |
| 8 | 2.89 | 2.43 | 0.457 |
| 9 | 3.06 | 2.26 | 0.425 |
| 10 | 3.20 | 2.12 | 0.398 |
| 11.2 | 3.35 | 1.97 | 0.370 |
| 20 | 4.13 | 1.19 | 0.224 |
| 30 | 4.6 | 0.72 | 0.135 |




To = 11.2 mins
672 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

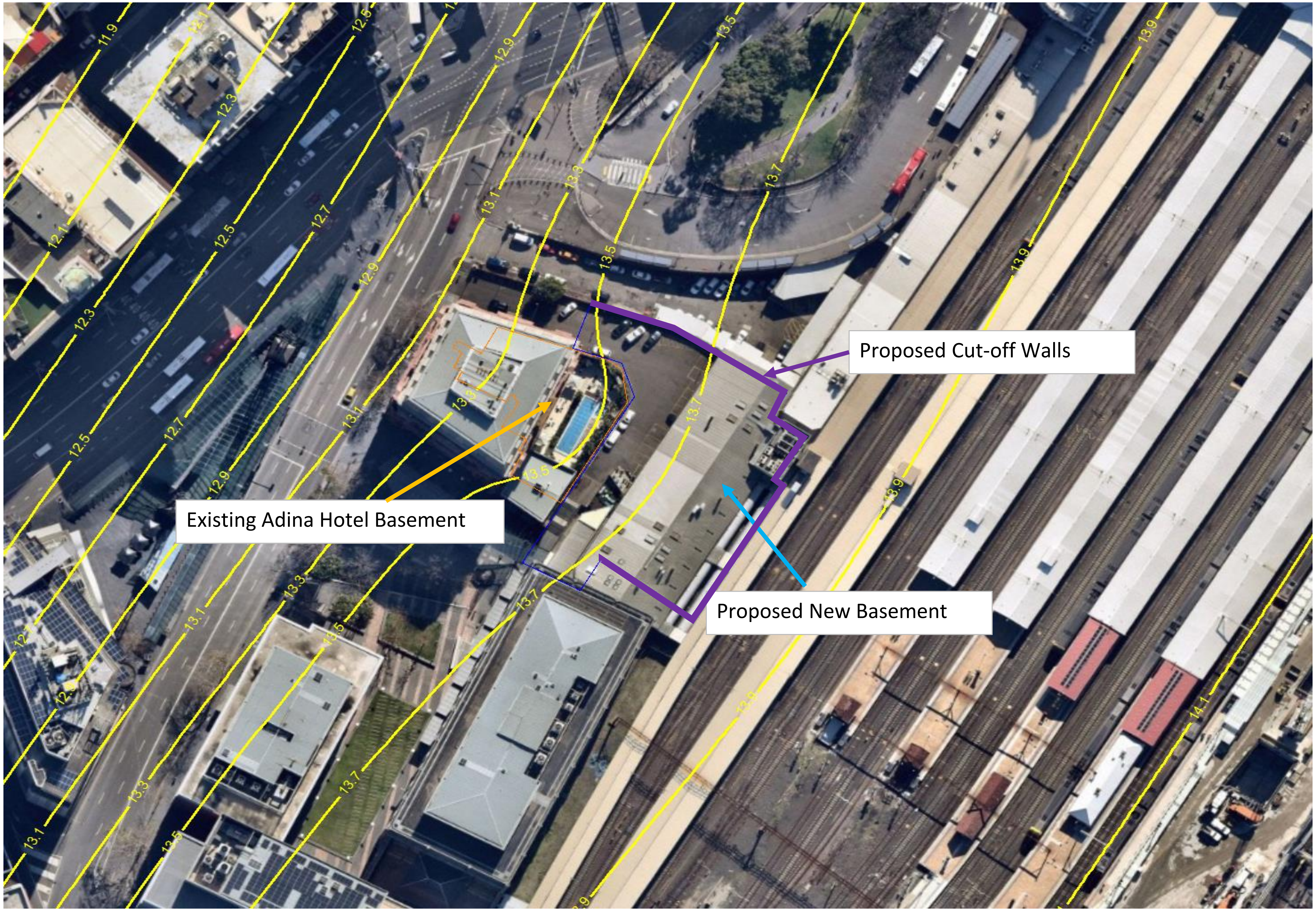
$k = [r^2 \ln(Le/R)]/2Le\ To$

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **3.9E-07** | m/sec |
| | **=** | **0.141** | cm/hour |

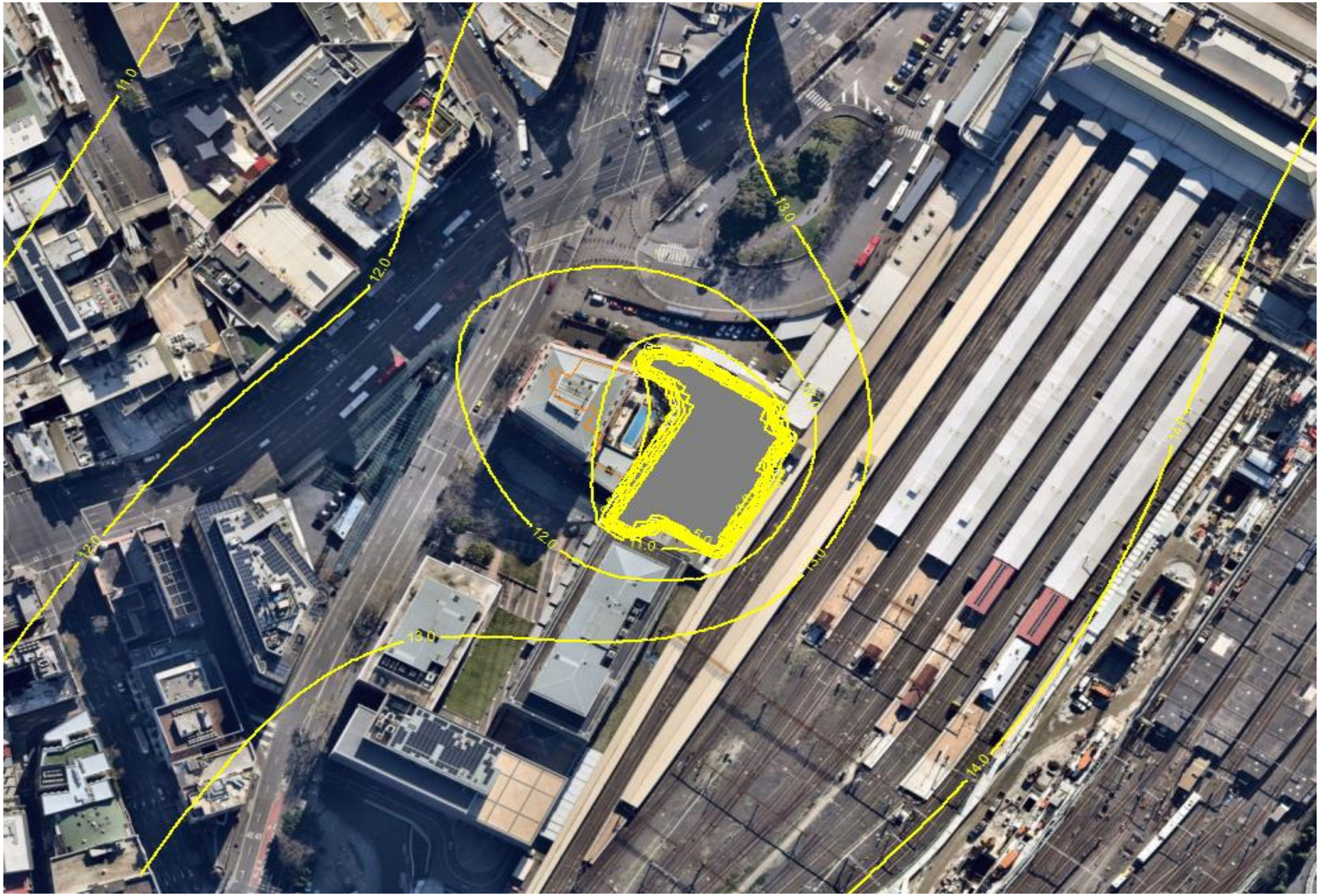
# Appendix E

Modelling Results
Estimated Groundwater Table and Drawdown Contours



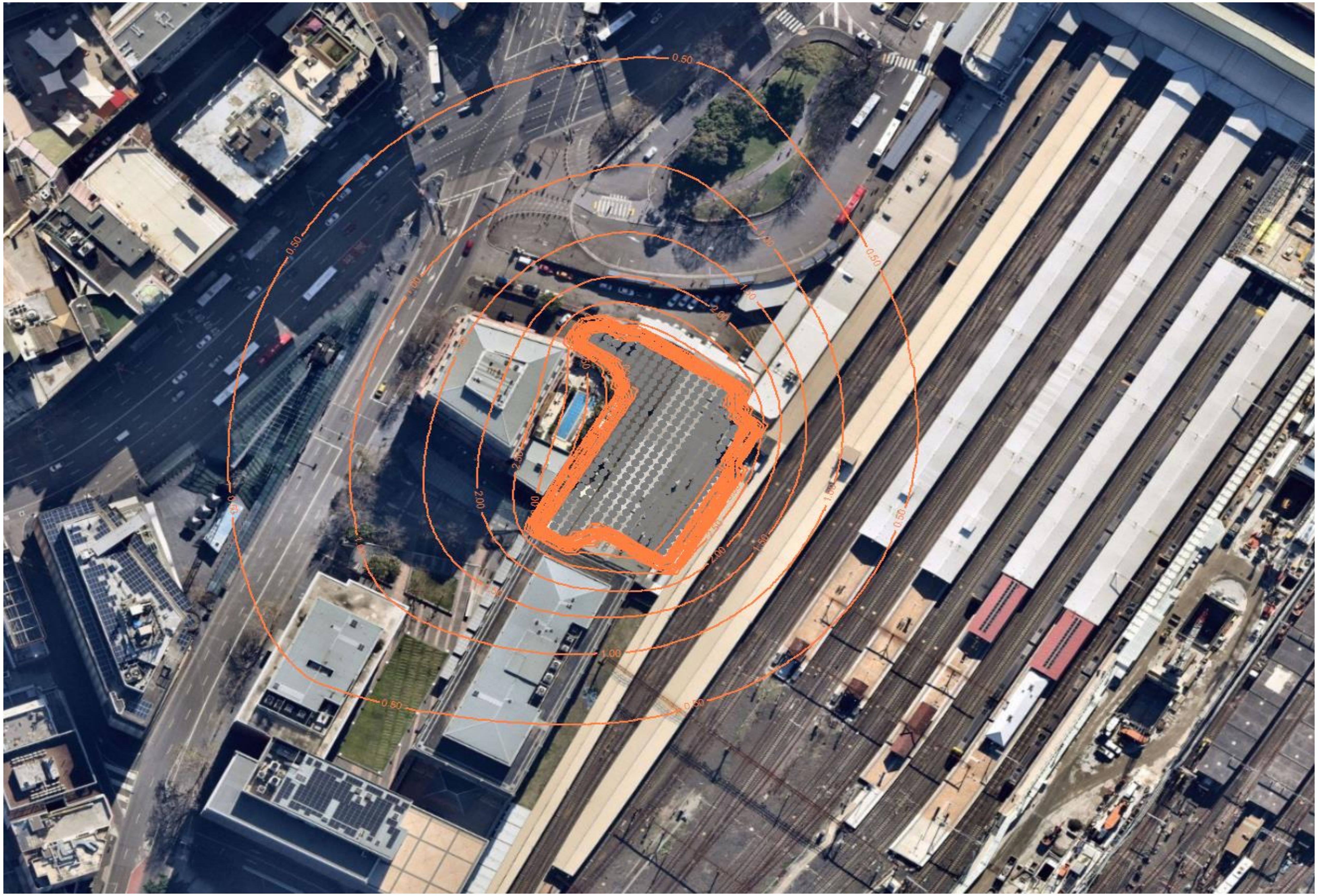

Douglas Partners
Geotechnics / Environment / Groundwater

| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: | PROJECT No: |
| OFFICE: Sydney | DRAWN BY: | | DRAWING No: M |
| SCALE: NTS | DATE: | | REVISION: |




Douglas Partners
Geotechnics / Environment / Groundwater

| | | | |
|---|---|---|---|
| CLI□□T□ Vertical First □t□Ltd | | TITL□□ □on□ □er□ □ro□nd□ □□er □□□□e A□□er De□ □□er□n□ □ro□o□ed Co□ □er□c□□De□e□o□□ en□ □□□□ □ee □□ree□□□□□□ □r□e□ | □R□□□CT □□□ □□□□□□□□ |
| □FFIC□□ S□d□e□ | DR□□ □ □□□ □□ | | DR□□ I□□ □□□ M□ |
| SC□L□□ □TS | D□T□□ □□□□□□□□ | | R□VISI□□□ □ |




**Douglas Partners**
Geotechnics | Environment | Groundwater

| | | | |
|---|---|---|---|
| CLI□□T□ Vertical First □t□Ltd | | TITL□□ □on□ □er□ Dr□□do□n Con□o□r | □R□□□CT □□□ □□□□□□□□ |
| □FFIC□□ S□d□e□ | DR□□ □ □□□ □□ | □ro□o□ed Co□ □er□c□□De□e□o□□en□ | DR□□ I□□ □□□ M□ |
| SC□L□□ □TS | D□T□□ □□□□□□□□ | □□□□ □ee □□ree□□□□□□ □r□e□ | R□VISI□□□ □ |

Douglas Partners Pty Ltd
[illegible]
www.douglaspartners.com.au
[illegible] Hermitage Road
West Ryde NSW [illegible]
[illegible]
West Ryde NSW [illegible]
Phone [illegible]

Perpetual Corporate Trust Ltd
c/- Generate Property Group
Level [illegible] Collins Street
Melbourne

[illegible]
Project [illegible]
[illegible] March [illegible]
R[illegible] Rev [illegible]
[illegible]

Attention: Neil MacLeod

Via email

**Addendum to Groundwater Modelling Report**
**Proposed Commercial Development**
**[illegible] Lee Street, [illegible]**

## 1. Introduction

This addendum report presents the results of an additional groundwater inflow assessment undertaken by Douglas Partners Pty Ltd for a proposed commercial development at [illegible] Lee Street, Haymarket. The assessment was commissioned by Generate Property Group on behalf of Vertical First Pty Ltd, and was undertaken in accordance with a consultancy agreement and our proposal dated [illegible] August [illegible] ([illegible]SYD[illegible] Rev [illegible]).

This additional inflow assessment follows on from and supplements previous groundwater modelling for the site undertaken by DP (Report [illegible] R[illegible] Rev [illegible] dated [illegible] October [illegible]) which used two dimensional (2D) finite difference modelling (FDM) techniques (MODFLOW) to provide estimates of groundwater inflow through the sandstone bedrock and the extent of groundwater table drawdown due to the proposed basement excavation. This report should be read in conjunction with the previous groundwater modelling report (attached).

The previous groundwater modelling did not include the estimation of groundwater inflow from the fill and alluvial soils through the shoring walls as the shoring walls were previously assumed to provide a a cut-off wall through the 'soil' portion of the basement excavation.

Based on the most recent "For Construction" shoring wall design package prepared by Taylor Thomson Whitting (TTW), it is understood that the shoring walls surrounding the site have been revised to be 'fully drained' and now comprise closely spaced piles with strip drains to be installed in the gaps between piles over their full depths which will discharge the inflows from both soils and rocks. This additional inflow assessment provides an estimation of the extra groundwater inflow from soils to be added to the previous estimation.

The development of the groundwater model also considers the results of an additional geotechnical investigation (Report [illegible] R[illegible] Rev [illegible] dated [illegible]) which focused on the area of the B2 'Link Tunnel' that will provide access to the neighbouring basements to the south (Dexus Fraser) and to the west [illegible]. The groundwater monitoring results from the additional monitoring period between September [illegible] and March [illegible] were also considered.

## 2. Geotechnical Investigation Report for [illegible] Tunnel

### 2.1 Boreholes

Three boreholes [illegible] and [illegible] were drilled vertically within the area of the proposed [illegible] Link Tunnel. The subsurface profile encountered in these boreholes is similar to that encountered in the main basement area, typically comprising fill over alluvial sandy soils, underlain by residual soils and sandstone bedrock. However, compared to other boreholes drilled within the main basement footprint adjacent to the southern site boundary, the [illegible] series boreholes (together with geotechnical information from neighbouring sites to the south) indicated the presence of an approximately [illegible] thicker alluvial sand layer underneath the alignment of the Devonshire Street Tunnel and extending further to the south. This thicker alluvial profile is likely to be associated with a [illegible] paleochannel running parallel to the southern site boundary. Further localised thickening of the alluvial sand layer was recorded in [illegible], but it was not conclusively established whether this is a consistent clean sand layer or interbedded with clay seams.

A borehole location plan and an interpreted cross section through the site (approximately parallel with the alignment of the Devonshire Street pedestrian Tunnel) are attached as Drawings [illegible] and [illegible].

Groundwater was observed in each of the boreholes during auger drilling prior to the commencement of mortar coring, with a standpipe piezometer installed in borehole [illegible] to allow further groundwater observations to be made and permeability tests to be completed.

### 2.2 Standpipe Piezometer

Groundwater level observations are summarised in Table [illegible] and a graph of the measured groundwater levels from the datalogger in [illegible] is attached, together with monitoring of other wells in the area. The water levels have been corrected for barometric pressure effects. The manual water level measurements obtained using a dipmeter were similar to measurements obtained using the data logger.

The standing water level within [illegible], which was screened within the alluvial soil, ranged between RL[illegible] and RL[illegible] over the measurement period between [illegible] and [illegible], including some major rainfall events during March [illegible]. This level is similar to the standing water level measured in a nearby standpipe located about [illegible] to the north ([illegible]), which is screened within the underlying Hawkesbury Sandstone (i.e. borehole [illegible] water level of RL[illegible] on [illegible] September [illegible]).

**Table 1: Groundwater Observations**

| Measurement Date | Standing Water Level Measurements in Boreholes | | | | | |
|---|---|---|---|---|---|---|
| | BH201 | | BH202 | | BH203 | |
| | Depth (m) | RL (1) | Depth (m) | RL (1) | Depth (m) | RL (1) |
| [illegible] | | | | | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | | | | |
| [illegible] | | | [illegible] | [illegible] | | |
| [illegible] | | | [illegible] | [illegible] | | |
| [illegible] | | | [illegible] | [illegible] | | |
| [illegible] | | | [illegible] | [illegible] | | |
| [illegible] | | | [illegible] | [illegible] | | |
| [illegible] | | | [illegible] | [illegible] | | |
| [illegible] | | | [illegible] | [illegible] | | |
| [illegible] | | | [illegible] | [illegible] | | |
| [illegible] | | | [illegible] | [illegible] | | |

□□tes□ □□□□le□ati□□ □RL□i□ □etres □□D□
□□□□ □ser□ati□□ d□ri□□ a□□er drilli□□□

## 2.3 □er□ e□□□□□□ □e□□n□

□er□ea□ilit□ testi□□ □as carried □□t t□ice □it□i□ t□e sta□d□i□e i□stalled i□ □□□□□ □si□□ a risi□□ □ead test □et□□d□ T□e □er□ea□ilit□ □□t□e scree□ed i□ter□al □as calc□lated □r□□ t□ese tests □si□□ t□e □□□rsle□a□al□tical □et□□d□

□ s□□ □ar□ □□t□e calc□lated □er□ea□ilit□res□lts □□□□ □□□□t□□et□er □it□ t□e □re□i□□s test res□lts □r□□ a□□t□er □□re□□le □□site scree□ed i□sa□d □□□□□are □rese□ted i□Ta□le □□

**Table 2: Calculated Permeability Results from Rising Head Test in Standpipe Piezometer.**

| Borehole ID | Material Types within Screened Interval | Calculated Permeability (m/sec) |
|---|---|---|
| [illegible] | □ll□□ial Sa□d a□d Silt□Cla□□a□d resid□al Silt□Cla□ | [illegible] t□ [illegible] |
| [illegible] | □ll□□ial Sa□d | [illegible] t□ [illegible] |

## [illegible]. Conceptual Hydrogeological Model

The results of the geotechnical and hydrogeological investigation and the groundwater measurements in standpipe piezometers installed on the site indicate that there is a relatively consistent permanent (perennial) groundwater table within the residual soils and sandstone that flows in a north westerly direction towards Lee Street.

The investigations suggest that there is also a higher intermittent perched groundwater near the soil/rock interface between alluvial sand and sandstone. The upper perched groundwater table is likely to be recharged by surface infiltration into the near surface sand layers following periods of heavy rainfall. The upper and lower groundwater tables appear to be relatively independent, separated by the low permeability residual clays, as there was minimal variability in groundwater levels observed in the sandstone bedrock even after some heavy rainfall periods between July [illegible] and June [illegible] and during March [illegible].

The additional investigation in the [illegible] Link Tunnel area ([illegible] series) indicated a deepened alluvial sand profile along the southern site boundary, likely to be associated with a paleochannel that is [illegible] to run parallel to and underneath Devonshire Street Tunnel and beyond towards south. The thickness of the saturated sand groundwater stratigraphy and the persistence of the standing groundwater table in the area are expected to increase in this area.

The conceptual hydrogeological model and the envisaged groundwater inflow sources are illustrated in Figure [illegible].

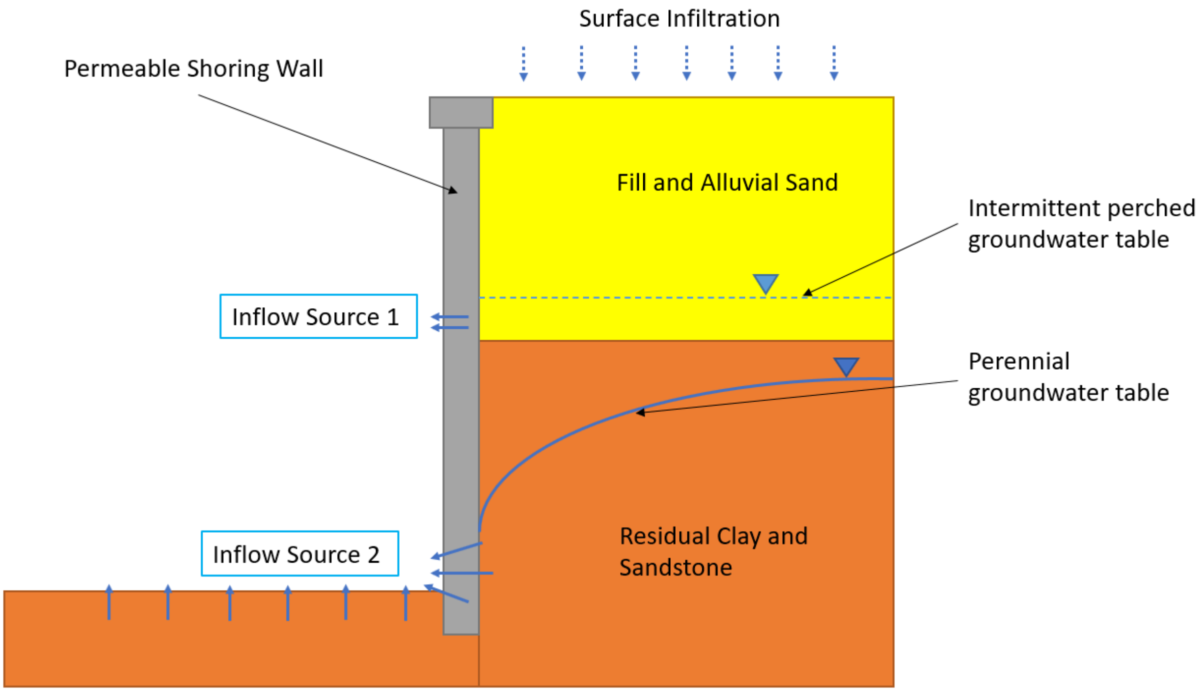



**Figure [illegible]: Conceptual Hydrogeological Model**

# 4. Groundwater Inflow Assessment

## 4.1 Methodology

The groundwater inflow assessment presented in this report estimates the additional groundwater inflow from alluvial soils through the gaps between soldier piles (i.e. Inflow Source [illegible]). To obtain estimates of the total inflows to the excavation this inflow should be added to the previous estimation of the inflows through the rock (i.e. Inflow Source [illegible]) presented in the previous groundwater modelling report (Ref: [illegible]).

The inflow from the soils follows an approximately horizontal flow pattern and therefore a simplified one-dimensional solution based on Darcy's law was used to estimate the groundwater inflow into the excavation. The equation is expressed as:

$$Q = K \times A \times i$$

where:

Q = inflow rate

K = average permeability of the soil

A = cross-sectional area through which the flow occurs calculated as the saturated thickness of the soils multiplied by the lengths of the faces around the perimeter of the excavation

i = hydraulic gradient

## 4.2 Assumptions

The following assumptions were adopted in the groundwater assessment:

- Groundwater inflow from alluvial soils only occurs along the eastern and southern site boundaries. The existing investigation data and site observations do not suggest alluvial soil is present along northern and western site boundaries.
- The primary flow direction within the alluvial soils was assessed to be from east to west with the hydraulic gradient calculated between the water heads measured in wells screened in sand on site and from the public groundwater information in the area (Central Station Platforms). A uniform hydraulic gradient ([illegible]) was adopted for the eastern boundary.
- For the southern boundary (parallel to the primary flow path) the same hydraulic gradient ([illegible]) was applied. The actual gradient in this secondary flow direction is expected to be lower.
- Groundwater level monitoring in the locations adjacent to the eastern boundary indicated minimal perched groundwater in the alluvial soils (i.e. [illegible] thick even after rainfall). A nominal [illegible] saturated thickness of alluvial sand was adopted for this area.
- Groundwater level monitoring in the locations adjacent to the southern boundary indicated an average [illegible] thickness of groundwater in the alluvial soils. A nominal [illegible] saturated thickness of alluvial sand was adopted for this area.

- Insitu permeability tests on site indicated that the permeability of the alluvial sands ranges from [illegible] m/sec to [illegible] m/sec. This permeability is much lower than the typical permeability values for sand obtained from our previous experience in the area and from published values. Typical values are usually in the range [illegible] m/sec to [illegible] m/sec. Therefore, for this analysis a higher typical permeability value of [illegible] m/sec was adopted.
- Although the perched groundwater above the sandstone is likely to be intermittent and the water storage in the alluvial soils is also probably limited, it was conservatively assumed that the saturated sand layer is perennial and the source of groundwater is infinite.
- The construction of the ceiling of the Li[illegible] Tunnel is likely to intercept the alluvial sand in the area [illegible] based on the design prepared by Tunnelling Solutions and [illegible] Consulting (the designers of the Li[illegible] Tunnel). It is understood that pilot investigation holes will be drilled prior to installation of the roof canopy tubes to identify the presence of any sand and to allow for jet grouting of the sand to form a low permeability barrier above the tunnel ceiling. Therefore, it was assumed in our assessment that no hydraulic linkage will form between the alluvial sand and the Li[illegible] Tunnel roof.

## 4.3 Re[illegible]

The assessment indicates that additional groundwater inflows of approximately [illegible] Litre per minute or [illegible] Mega Litre per year are likely to occur from soils through the gaps between soldier piles across the site. These values should be added to the estimates [illegible] through the [illegible] of the previous groundwater modelling to obtain the total inflows as summarised in Table [illegible].

**Table 3: Estimated Total Inflows to Excavation (i.e. Dewatering Pumping Rates)**

| Elapsed Time | Inflow Rate from Rock (Inflow Source 2) | | Inflow Rate from Soil (Inflow Source 1) | Estimated Total Inflow |
|---|---|---|---|---|
| | $m^3$ / day | ML / year | ML / year | ML / year |
| [illegible] Days | [illegible] | [illegible] (Cumulative during 1st year) | [illegible] | [illegible] (Cumulative during [illegible] year) |
| [illegible] Days | [illegible] | | | |
| [illegible] Days | [illegible] | | | |
| [illegible] Days | [illegible] | | | |
| [illegible] Days | [illegible] | | | |
| [illegible] Days | [illegible] | | | |
| [illegible] Year | [illegible] | | | |
| [illegible] Years | [illegible] | [illegible] | | [illegible] |
| [illegible] Years | [illegible] | [illegible] | | [illegible] |
| [illegible] Years | [illegible] | [illegible] | | [illegible] |
| Long-term | [illegible] | [illegible] | | [illegible] |

It should be noted that these volumes are best estimates of the average inflows. It is entirely possible that there could be local zones of higher permeability which could increase the inflows significantly. Accordingly, it is recommended that a factor of safety of at least [illegible] be applied to these numbers for design purposes and that these flow rates be monitored during excavation and construction.

It should also be noted that the inflows from alluvial sand are expected to be highly responsive to surface recharges during rainfall events causing uneven distributions of the inflow volumes between rain days and sunny days. The design of groundwater pump, storage, treatment and discharge system should consider the potential sudden increase of inflow during or following periods of heavy rainfall.

## [illegible]. Comments

- Additional groundwater inflow through the soils of [illegible] ML/year has been estimated following the revision of the proposed shoring wall scheme from a 'partial cut-off' wall to a 'fully drained" wall. This increase of the total inflow volume when the flow through the soils is combined with the previously predicted inflows through rock is considered to be manageable using conventional 'sump and pump' dewatering methods. However, the client, their project managers and consultants will need to consider the impact of the increased inflow on the required amount of 'water share' under the current approved Water Access Licence as well as on the design of groundwater storage, pump, treatment and discharge system(s).
- The perched water table in the alluvial sand is expected to have fluctuated historically above and below the soil/rock interface. The potential for settlement of the sand due to lowering of the groundwater table is likely to have already occurred. Therefore, even after the construction of a 'drained' basement, any neighbouring structures or pavements founded on fill or alluvial soils are therefore not expected to experience noticeable settlement due to the dewatering.
- No known groundwater users or any groundwater dependent ecosystems are using the alluvial sand layer as a groundwater source.
- The 'fully drained' basement scheme is not expected to increase the risk of groundwater ingress into the B2 Link Tunnel, as it reduces the volume of groundwater that would otherwise 'perch' on top of the tunnel roof and also alleviates the 'bunding' effect typically occurring around a tanked basement. Nevertheless, identification and pretreatment (via pilot holes and grout injection) of any sandy soils surrounding the tunnel ceiling area as proposed by the tunnel designer are considered essential.
- The current shoring scheme comprising closely-spaced piles with gaps has a relatively high risk of sand running through the gaps upon initial exposure during excavation prior to installation of strip drains and shotcrete to seal off the gaps, especially where sand is clean and saturated. This could potentially lead to ground loss and settlement behind the shoring walls. It is therefore essential that good construction practices be employed during construction to closely monitor the excavation in sand, filling the gaps as soon as possible and reducing the height of each excavation lift where necessary, and applying the permanent shotcrete seals in a prompt manner.

## [illegible]. Limitations

Douglas Partners (DP) has prepared this report for this project at [illegible] Lee Street, Haymarket in accordance with DP's proposal SYD190190.P.010.Rev0, and acceptance received from Generate Property Group on behalf of Vertical First Pty Ltd on [illegible] March [illegible]. The work was carried out under a consultancy agreement. This report is provided for the exclusive use of Vertical First Pty Ltd or their agents, for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the groundwater components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
**Douglas Partners Pty Ltd**

Reviewed by

**[illegible]**
Senior Associate

pp. **[illegible] MacGregor**
Principal

Attachments: About this Report
Drawings 1 and 2
Results of Groundwater Level Monitoring
Report on Groundwater Modelling [illegible]

# About this Report

Douglas Partners

## Introduction

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

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

## Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

## Borehole and Test Pit Logs

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

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

## Groundwater

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

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

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

## Reports

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

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

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

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

# About this Report

## Site Anomalies

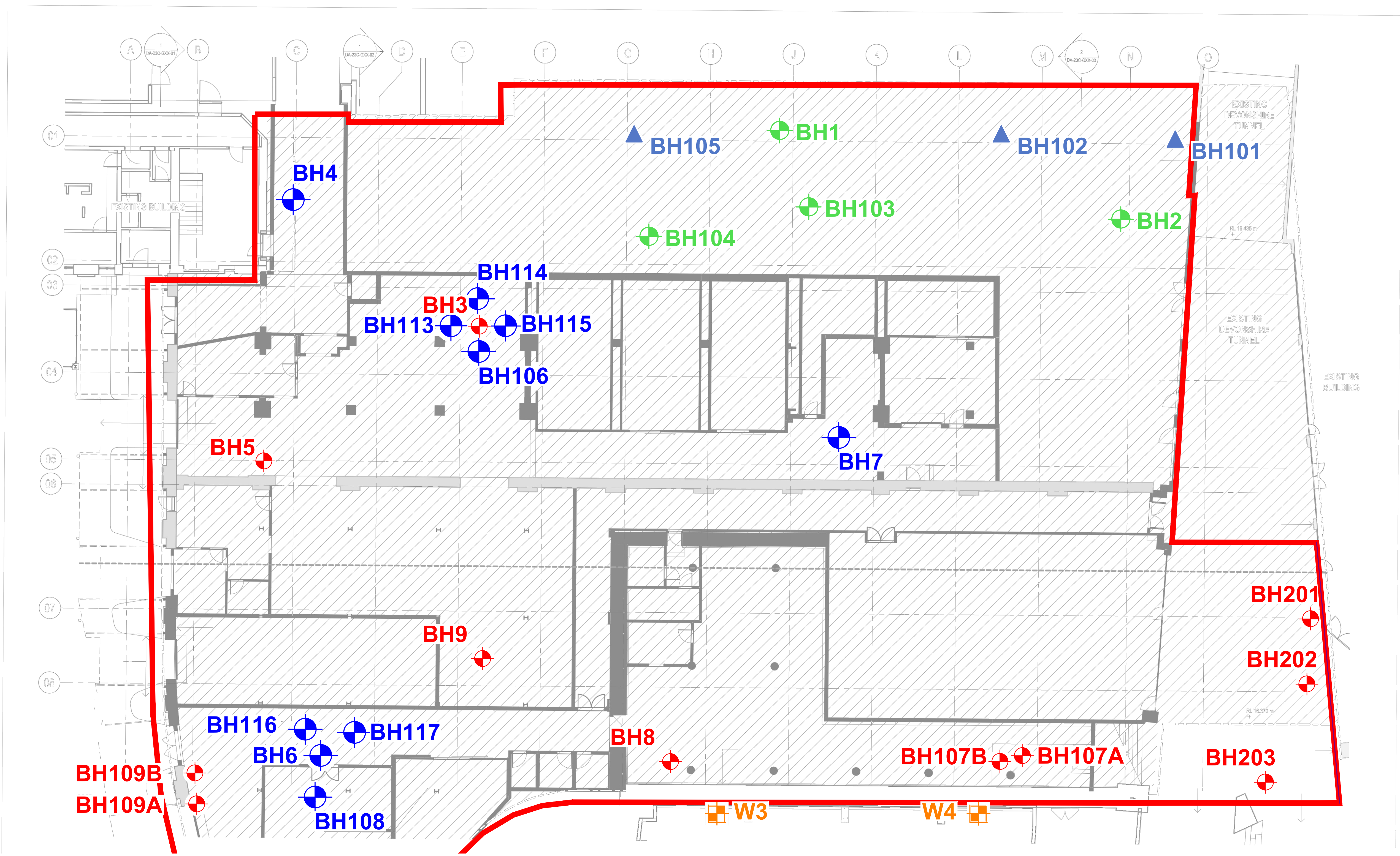
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later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

## Information for Contractual Purposes

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

## Site Inspection

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



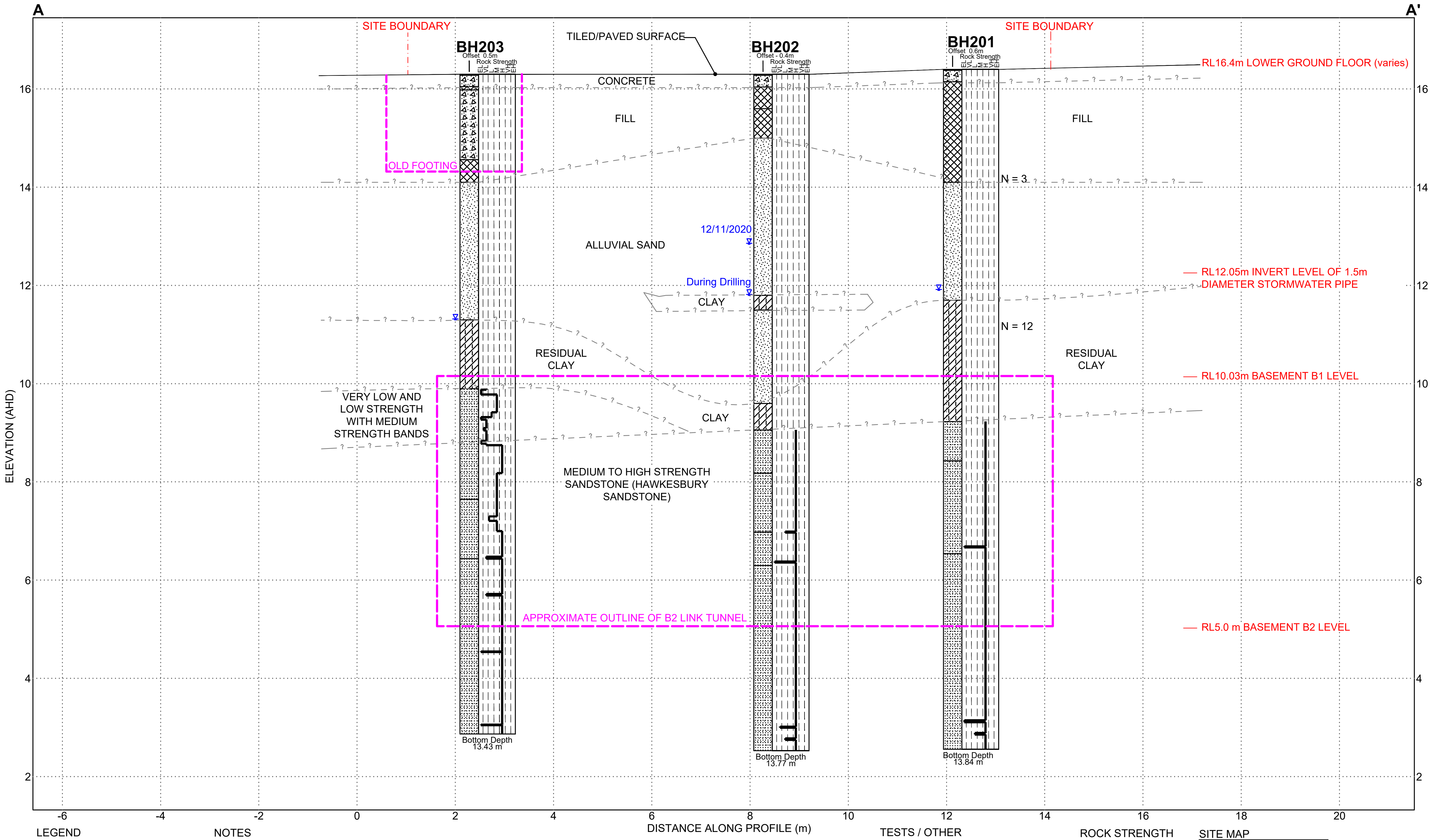

NOTE:
1: Base image taken from "DA-23B-G00-01" DEMOLITION PLAN LOWER GROUND PART 1", Rev 1 dated 28 August 2020 prepared by BVN Architecture Pty Ltd
2. North arrow aligned to True North as per "DA-23B-G00-01" DEMOLITION PLAN LOWER GROUND PART 1", Rev 1 dated 28 August 2020 prepared by BVN Architecture Pty Ltd.

0 1 2 3 4 5 6 7 8 9 10 15 20 25m
1:250 @ A3

**LEGEND**
- Environmental borehole - Lower Ground Floor
- Environmental borehole - Upper Ground Floor
- Geotechnical & Environmental borehole - Lower Ground Floor
- Geotechnical & Environmental borehole - Upper Ground Floor
- Retaining Wall Investigation borehole

**Douglas Partners**
*Geotechnics / Environment / Groundwater*

| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Test Locations - Lower Ground Floor Plan** | PROJECT No: 86767.07 |
| OFFICE: Sydney | DRAWN BY: HDS/LH | **Link Tunnel** | DRAWING No: 2 |
| SCALE: 1:250 @ A3 | DATE: 09.11.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 0 |




LEGEND

- Pavers
- Silty Clay
- Concrete
- Sandstone
- Fill
- Sand

NOTES

1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Stormwater invert levels inferred from the provided sketch from TTW Pty Ltd 'SK-0049 Issue 1' dated 18 Aug 2020 (levels to be confirmed)
4. Levels for lower ground floor, Basement B1 and B2 taken from Drawing 'DA-11D-XXX-04 Issue 2' dated 18 Sept 2020, prepared by BVN Architects Pty Ltd'
5. Stormwater pipe invert level is based on a straight line between survey invert levels.

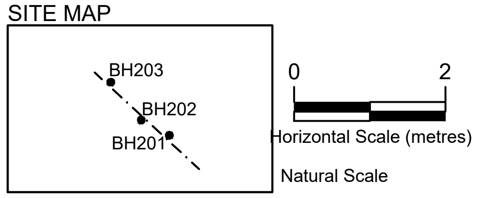
TESTS / OTHER

N - Standard penetration test value
- Water level
- Interpreted geotechnical boundary

ROCK STRENGTH

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

SITE MAP

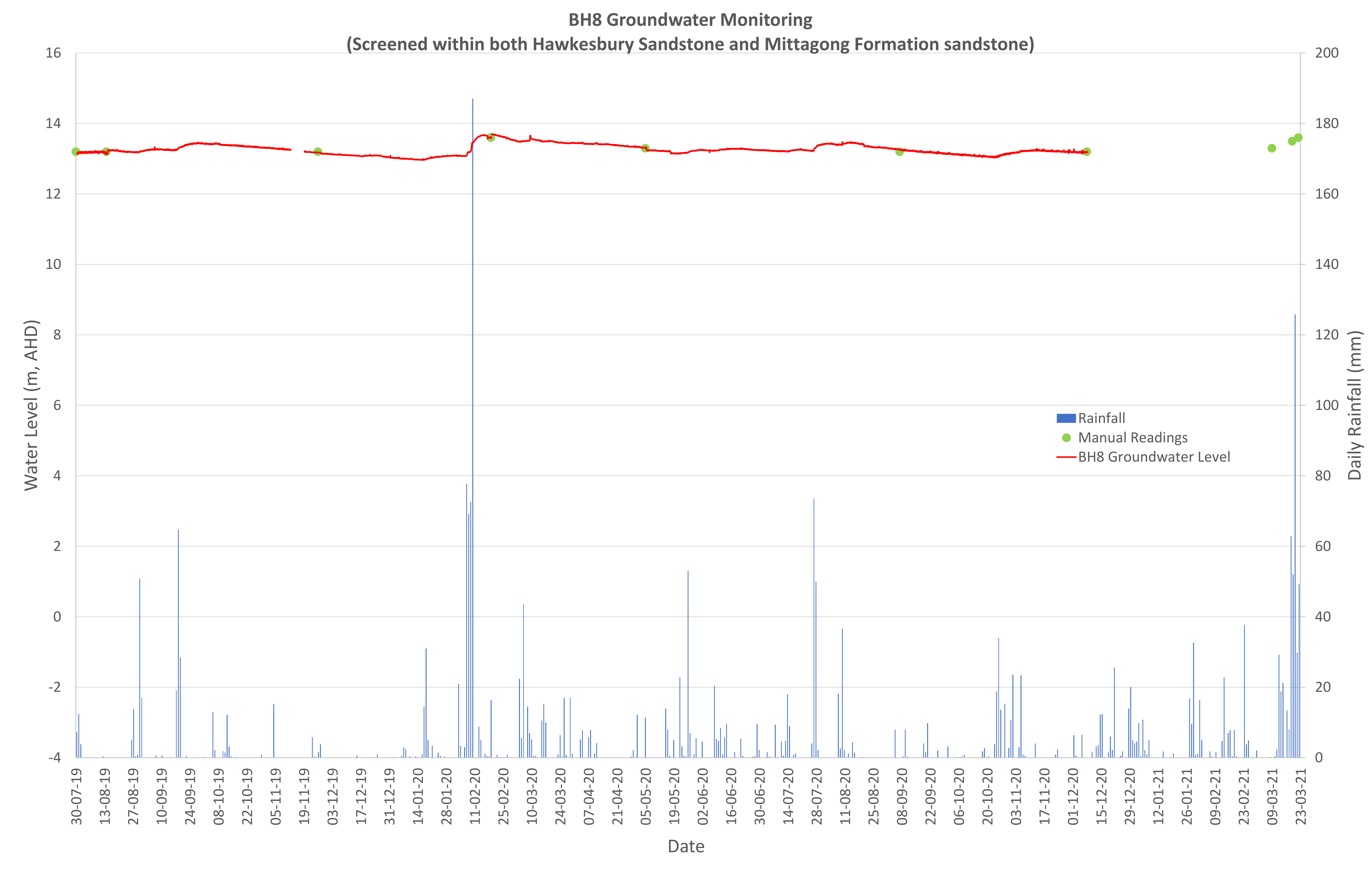


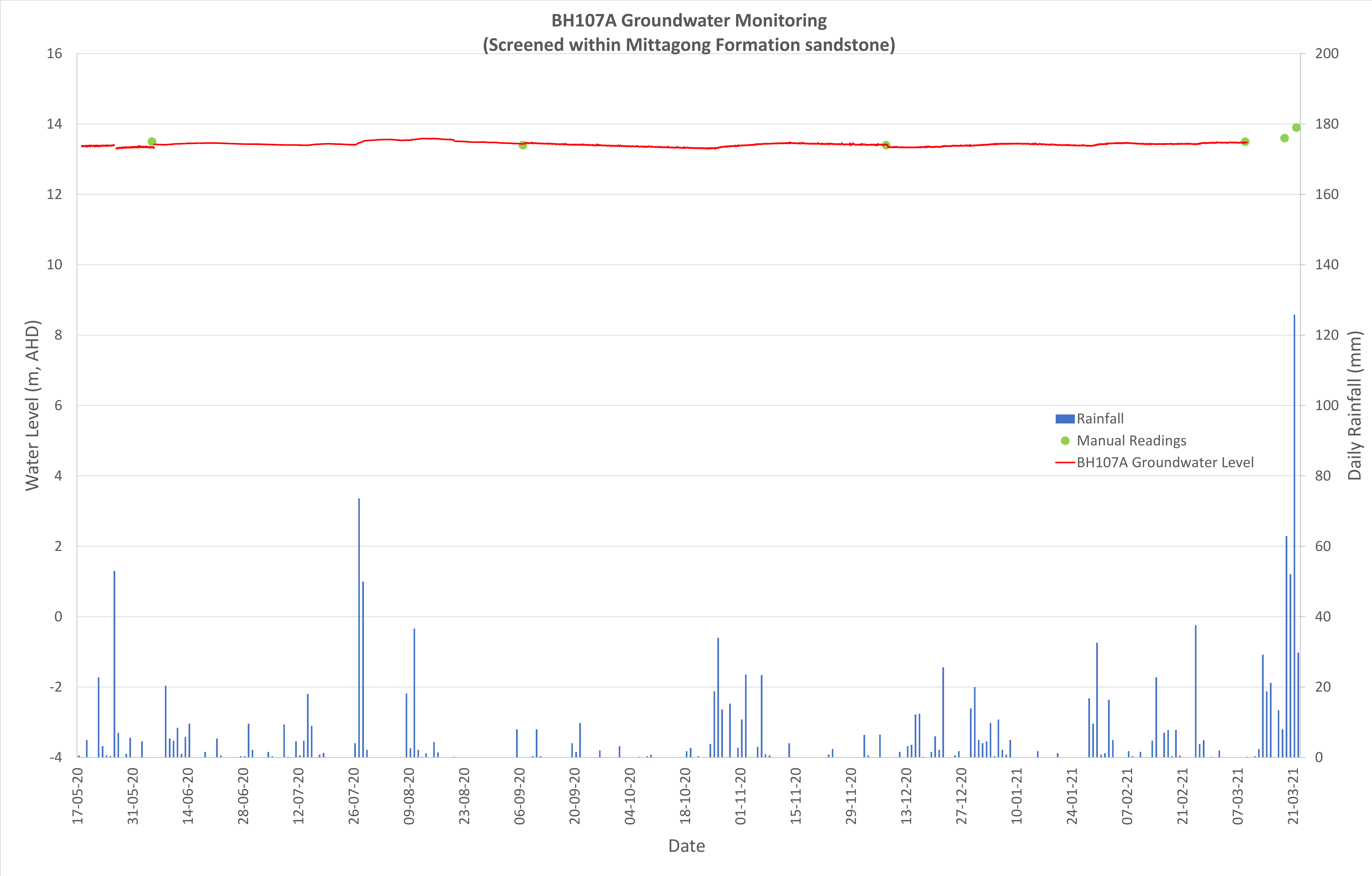

**Douglas Partners**
Geotechnics / Environment / Groundwater

| | | |
|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Inferred Geotechnical Cross-Section A-A'** |
| OFFICE: Sydney | DRAWN BY: HDS/CJ | **Link Tunnel** |
| SCALE: 1:75 (H) 1:75 (V) @ A3 | DATE: 17.11.2020 | **8-10 Lee Street, Haymarket** |

| | |
|---|---|
| PROJECT No: | 86767.07 |
| DRAWING No: | 3 |
| REVISION: | 0 |

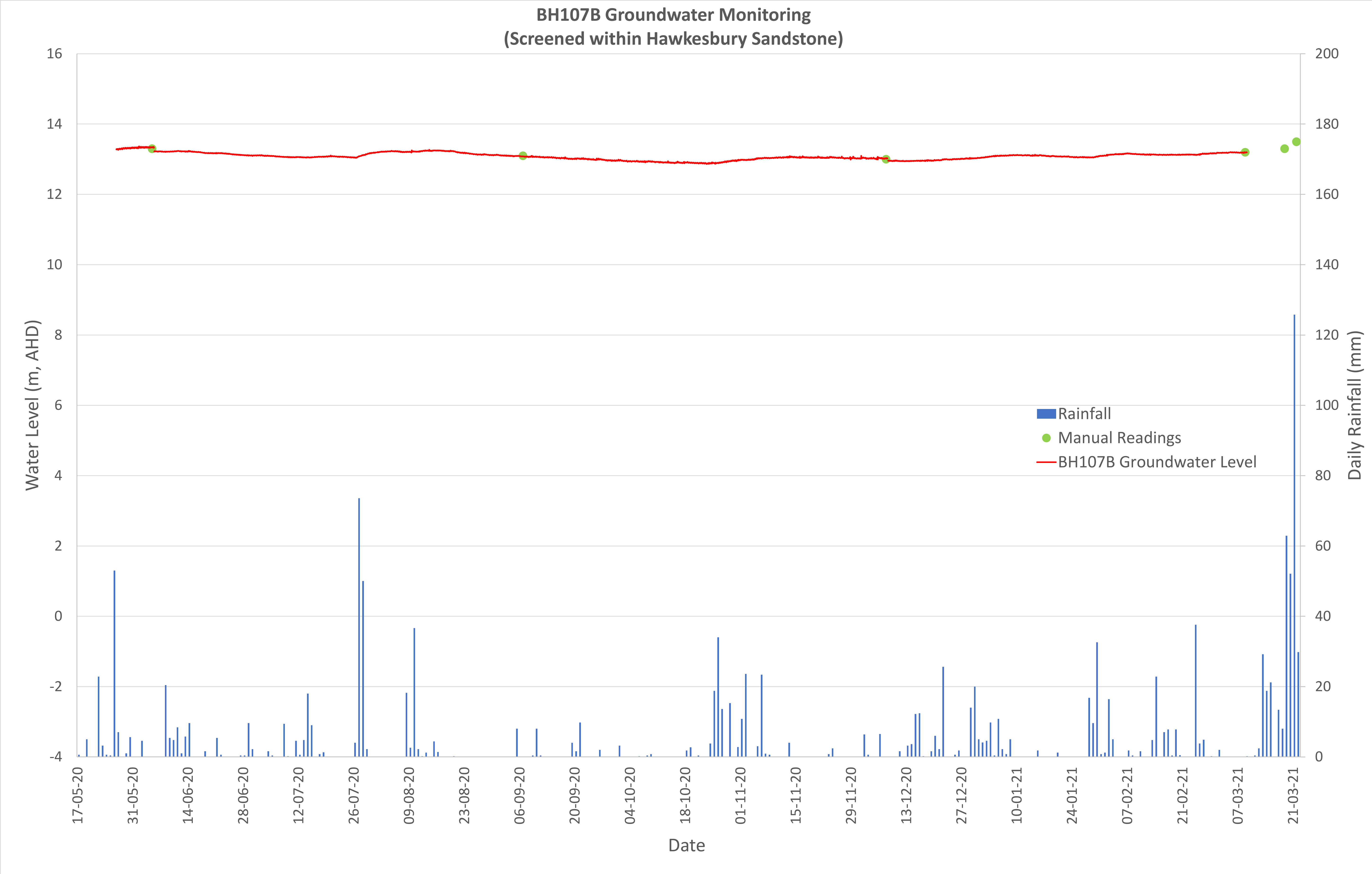
Douglas Partners
Geotechnics / Environment / Groundwater



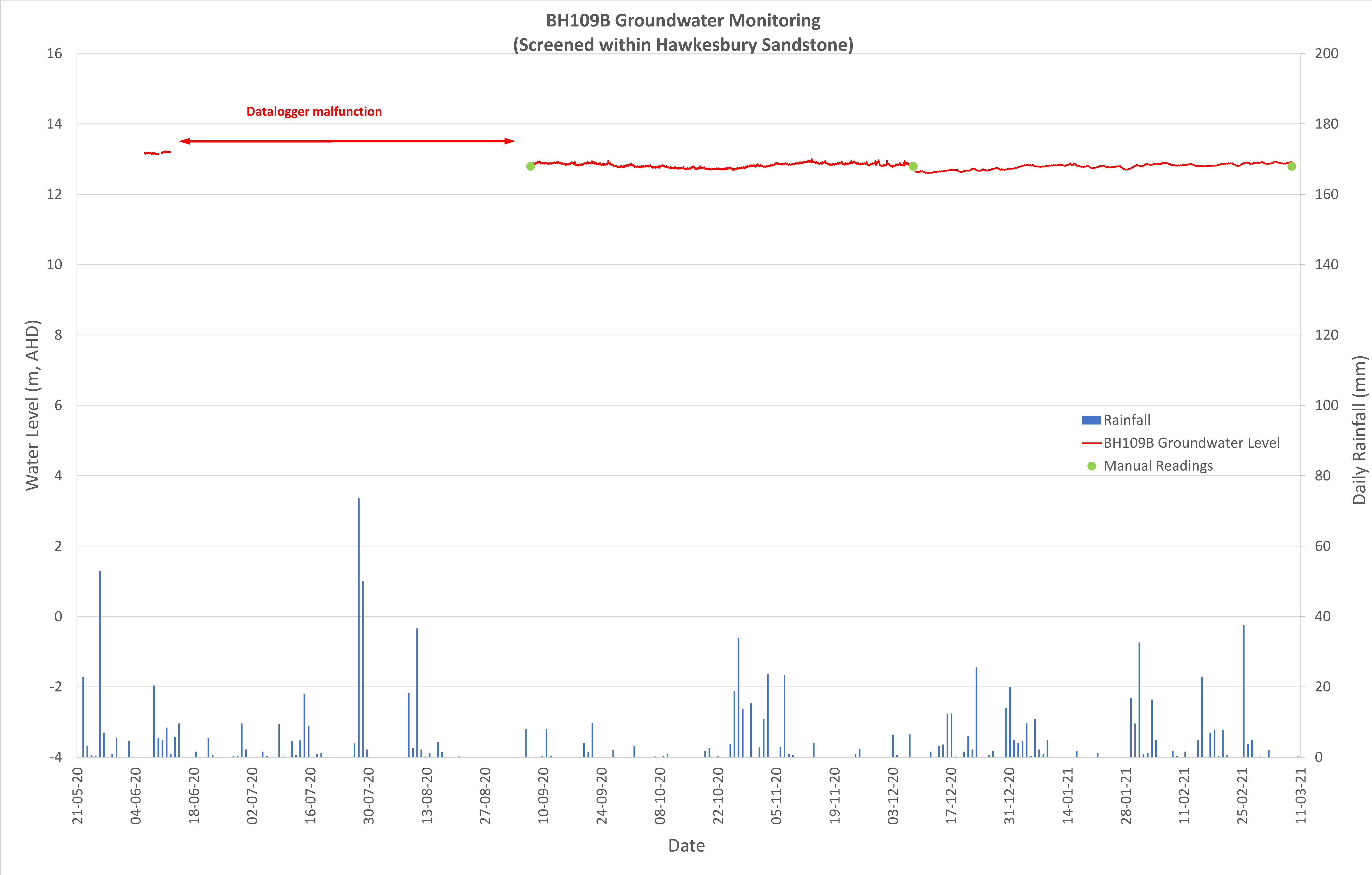


BH107A Groundwater Monitoring
(Screened within Mittagong Formation sandstone)
Water Level (m, AHD)
Daily Rainfall (mm)
Date
16
14
12
10
8
6
4
2
0
-2
-4
200
180
160
140
120
100
80
60
40
20
0
17-05-20
31-05-20
14-06-20
28-06-20
12-07-20
26-07-20
09-08-20
23-08-20
06-09-20
20-09-20
04-10-20
18-10-20
01-11-20
15-11-20
29-11-20
13-12-20
27-12-20
10-01-21
24-01-21
07-02-21
21-02-21
07-03-21
21-03-21
Rainfall
Manual Readings
BH107A Groundwater Level

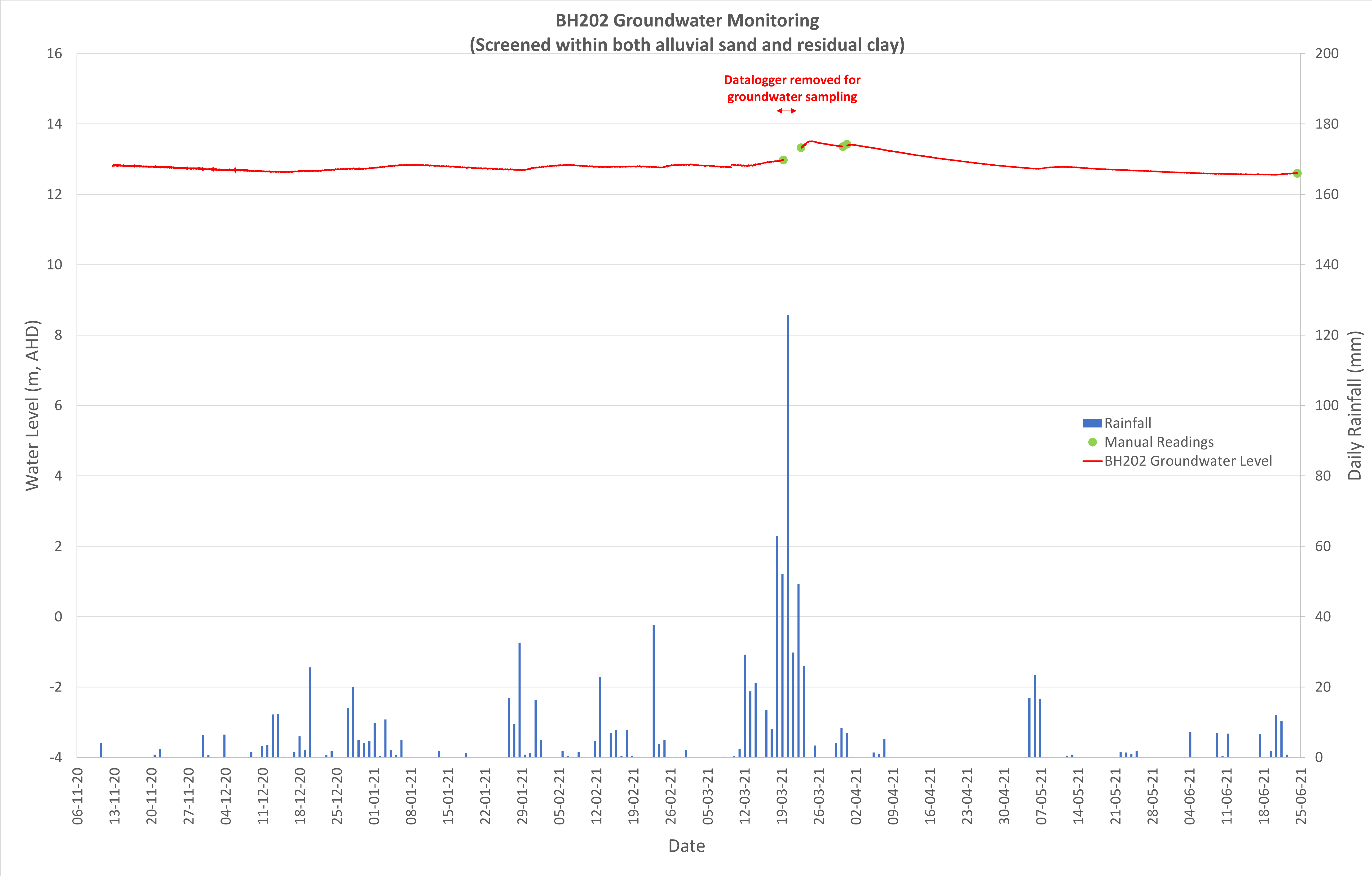
Douglas Partners
Geotechnics | Environment | Groundwater



Douglas Partners
Geotechnics / Environment / Groundwater



Douglas Partners
Geotechnics / Environment / Groundwater



Douglas Partners

Geotechnics / Environment / Groundwater

# Report on Groundwater Modelling

Proposed Commercial Development
[illegible] Lee Street Haymarket

[illegible]

Prepared for
Vertical First Pty Ltd

Project [illegible]
October [illegible]

Integrated Practical Solutions

**Douglas Partners**
Geotechnics | Environment | Groundwater

## Document History

D□c□□e□t details

| | | | |
|---|---|---|---|
| □r□ect □□□ | □□□□□□□□□ | D□c□□e□t □□□ | R□□□□Re□□ |
| D□c□□e□t title | Re□□rt □□ □r□□□d□ater M□delli□□<br>□r□□□sed C□□ □ercial De□el□□□e□t | | |
| Site address | □□□□ Lee Street□□a□□ar□et | | |
| Re□□rt □re□ared □□r | Vertical First □t□Ltd | | |
| File □a□e | □□□□□□□□□R□□□□Re□□ | | |
| □c□□e□D□c □□□ | D□□R□T□□□□□ | | |

D□c□□e□t stat□s a□d re□ie□

| Stat□s | □re□ared □□ | Re□ie□ed □□ | Date iss□ed |
|---|---|---|---|
| Re□isi□□ □ | □□el □□a□□ | Fi□□a Mac□re□□r | □□ct□□er □□□□ |
| Re□isi□□ □ | □□el □□a□□ | Fi□□a Mac□re□□r | □□ □ct□□er □□□□ |
| | | | |
| | | | |

Distri□□ti□□ □□c□□ies

| Stat□s | □lectr□□ic | □a□er | Iss□ed t□ |
|---|---|---|---|
| Re□isi□□ □ | □ | | □□s□Fi□□e□a□□□□e□□r □t□Ltd |
| | | | |
| | | | |
| | | | |

T□e □□dersi□□ed□□□ □e□al□□□D□□□las □art□ers □t□Ltd□c□□ir□ t□at t□is d□c□□e□t a□d all attac□ed dra□i□□s□l□□s a□d test res□lts □a□e □ee□c□ec□ed a□d re□ie□ed □□r err□rs□□□issi□□s a□d i□acc□racies□

| | Si□□at□re | Date |
|---|---|---|
| □□t□□r | | □□ □ct□□er □□□□ |
| Re□ie□er | pp. Fiona MacGregor | □□ □ct□□er □□□□ |

ISO 9001 Quality Management
FS 604853


D□□□las □art□ers □t□Ltd
□□□ □□ □□□ □□□ □□□
□□□□d□□□las□art□ers□c□□ □a□
□□ □er□ita□e R□ad
□ est R□de □S□ □□□□
□□ □□□ □□□
□ est R□de □S□ □□□□
□□□□e □□□□□□□□ □□□□

## Table of Contents

Page

| | |
|---|---|
| Appendix A: | About This Report |
| Appendix B: | Drawings |
| Appendix C: | Results of Groundwater Level Monitoring |
| Appendix D: | Results of In-situ Permeability Testing |
| Appendix E: | Modelling Results – Estimated Groundwater Table and Drawdown Contour |

# Report on Groundwater Modelling
# Proposed Commercial Development
# [illegible] Lee Street, Haymarket

## 1. Introduction

This report presents the results of groundwater modelling undertaken for a proposed commercial development at [illegible] Lee Street, Haymarket. The assessment was commissioned in an email by [illegible] Pty Ltd on behalf of Vertical First Pty Ltd (Vertical) and was undertaken in accordance with a consultancy agreement and our proposal dated [illegible] May [illegible].

This groundwater modelling follows on from a previous preliminary groundwater assessment undertaken by DP (Report [illegible].R.[illegible].Rev[illegible] dated [illegible] July [illegible]) which used a simple analytical method and was based on a simplified hydrogeological environment. This groundwater modelling supersedes the previous preliminary assessment and used more sophisticated [illegible]dimensional (2D) Finite Difference Modelling (FDM) techniques to provide more accurate estimates of groundwater inflow and the extent of groundwater table drawdown due to the proposed basement excavation. The development of the groundwater model also considers the most recent groundwater monitoring results from the period between [illegible] May [illegible] and [illegible] September [illegible].

It is understood that the proposed development at the site is to be divided into a ‘Developer Works Zone’ and a ‘State Works – Link Zone’. The Developer Works are to include excavation for a two-level basement on the western side of Central Station down to an elevation of RL [illegible] ([illegible]), followed by construction of a multi-storey commercial tower, whereas the State Works to the west of the tower include a two-level basement to a similar elevation with a port/s to connection to proposed future additional basements.

The basement excavation within the Developer Works Zone is expected to intersect the natural groundwater table. It is understood that the basement is currently designed as a ‘drained’ basement in both the construction phase and the full operational phase of the building life (or the long-term) to eliminate the need for the provision of waterproof basement walls and a hydrostatic slab.

Under the NSW Aquifer Interference Policy, the project has been deemed to be an aquifer interference activity requiring an authorisation from an approval body (for State Significant Developments under Water Management legislation). This groundwater assessment has been prepared to evaluate the feasibility of adopting a ‘drained’ basement for this project and includes:

- A summary of the geotechnical and hydrogeological investigations undertaken on site;
- Development of a conceptual hydrogeological model;
- Development of a 2D numerical groundwater model and calibrations to match the groundwater monitoring data;
- Estimation of transient groundwater inflow into a drained basement during and after the construction;
- Estimation of drawdown of the groundwater table caused by the drained basement; and
- Estimation of settlements at adjacent [illegible]structures due to the drained basement.

- Considerations of the NSW Aquifer Interference Policy; and
- Comments on groundwater contaminants for disposal options.

## 2. Previous Work

Two rounds of combined geotechnical, environmental and hydrogeological investigations have been completed by Douglas Partners Pty Ltd (DP). The information obtained from the site investigations was presented in the following four reports:

- DP Report [illegible] dated August [illegible] (Geotechnical Investigation);
- DP Report [illegible] dated September [illegible] (Supplementary Geotechnical Investigation);
- DP Report [illegible] dated [illegible] August [illegible] (Preliminary Contamination Site Investigation); and
- DP Report [illegible] dated [illegible] June [illegible] (Supplementary Contamination Site Investigation).

### 2.1 Boreholes

The boreholes drilled on the site included:

- On eastern side: [illegible] cored boreholes below the lowest basement floor level (i.e. boreholes [illegible] and [illegible]), [illegible] cored boreholes at Upper Ground floor level (i.e. boreholes [illegible] to [illegible] including [illegible] cored boreholes drilled from the concrete platform) and three boreholes drilled within the soil to depths [illegible] below the existing Upper Ground floor level (i.e. boreholes [illegible] and [illegible]);
- Within the Gate Gourmet catering facility at Lower Ground Floor level, four boreholes (boreholes [illegible] and [illegible], all for environmental testing purposes);
- Within the access corridor and storage areas west of the Gate Gourmet facility and at Lower Ground Floor level, seven boreholes ([illegible]) including three cored boreholes);
- Within the Adina Hotel basement access driveway at Lower Ground Floor level, one borehole (borehole [illegible] for environmental testing purposes);
- Upper Carriage Lane (pedestrian access ramp), three boreholes (boreholes [illegible] and [illegible], including two cored boreholes);
- [illegible] vertical boreholes drilled through the retaining wall footing (boreholes [illegible] and [illegible]);
- Within the Adina Hotel basement, two inclined boreholes drilled below an existing concrete underpin (boreholes [illegible] and [illegible]).

A previous geotechnical investigation carried out by DP for a neighbouring site to the south (i.e. 'Henry Deane Plaza': DP Report 27282B, dated 1999) included the drilling of a borehole near to the southern site boundary.

## 2.2 Standpipes and Permeability Testing

Standpipe piezometers were installed into ten of the boreholes at the site (i.e. [illegible]) and [illegible] to measure groundwater levels. The standpipes comprised screened PVC pipe with gravel backfill, a bentonite pellet seal and a 'gatic' cover at ground level. The installed pipes are screened within either alluvial sand (i.e. [illegible]) or within the underlying very low to high strength rock. [illegible] boreholes indicates the alternatives for the position of the well screen as:

- Option [illegible] within very low or low strength fine to medium grained sandstone interpreted to be Mittagong Formation (boreholes [illegible] and [illegible]); and
- Option [illegible] within the underlying medium to high strength medium grained sandstone interpreted to be Hawkesbury Sandstone (boreholes [illegible] and [illegible]).

Groundwater permeability testing and logger monitoring of groundwater levels in standpipes has been carried out at the site since [illegible], with the results presented in the following monitoring reports:

- DP Report [illegible].R.[illegible].Rev[illegible] dated [illegible] September [illegible]. Monitoring period [illegible] to August [illegible];
- DP Report [illegible].R.[illegible].Rev[illegible] dated [illegible] December [illegible]. Monitoring to [illegible] November [illegible];
- DP Report [illegible].R.[illegible].Rev[illegible] dated [illegible] March [illegible]. Monitoring to [illegible] February [illegible];
- DP Report [illegible].R.[illegible].Rev[illegible] dated [illegible] May [illegible]. Monitoring to [illegible] May [illegible]; and
- DP Report [illegible].R.[illegible].Rev[illegible] dated [illegible] September [illegible]. Monitoring to [illegible] September [illegible].

Either rising head or falling head permeability tests were completed within the installed standpipes.

# 3. Field Work Results

## 3.1 Boreholes

The locations of the boreholes and groundwater monitoring wells are shown on Drawing [illegible] (extract from Report [illegible].R.[illegible].Rev[illegible], Appendix [illegible]).

Six geotechnical cross sections (Sections [illegible] to F-F) showing the interpreted subsurface profile are presented as Drawings [illegible] to [illegible] (extract from Report [illegible].R.[illegible].Rev[illegible], Appendix [illegible]). The sections show interpreted geotechnical divisions of underlying soil and rock together with the proposed basement floor level.

The subsurface conditions encountered at the site can be summarised as:

| | |
|---|---|
| CONCRETE: | Single or multiple concrete slabs with or without a brick pavement/asphalt layer or surface ballast layer over; |
| FILL | Gravel, sand or clay fill to depths ranging between [illegible] m and [illegible] m on the eastern side of the [illegible] depth within the access corridor and [illegible] (i.e. the Lower Ground Floor level); |
| ALLUVIAL SAND: | Loose to medium dense alluvial sand, [illegible] m thick, over; |
| RESIDUAL SILTY CLAY: | Soft to hard residual silty clay with some ironstone gravel, [illegible] m thick, over; |
| RESIDUAL SANDY CLAY: | Very stiff to hard residual sandy clay, [illegible] m thick, over; |
| SANDSTONE (FINE to MEDIUM): | Very low to low strength fine to medium grained sandstone with some medium or high strength ironcemented bands [illegible] m thick. Numerous clay seams were encountered, over; |
| SANDSTONE (MEDIUM): | Medium or high strength medium grained sandstone. |

The upper fine to medium grained sandstone is interpreted to be part of the Mittagong Formation and the underlying medium grained sandstone is interpreted to be Hawkesbury Sandstone.

## 3.2 Groundwater Levels

Groundwater level observations are summarised in Tables [illegible] and [illegible] and graphs of the groundwater levels for each data logger (corrected for barometric pressure effects) are included in Appendix C. The graphs include rainfall record data obtained from Observatory Hill, Sydney (Bureau of Meteorology Station [illegible]).

With the exception of [illegible] water level data affected by disturbance (such as due to rising or falling head testing) has been removed for clarity of presentation. Data is missing from short time periods from boreholes [illegible] and [illegible] due to errors in placement of the logger within the borehole or due to a very short recording interval being selected leading to the filling of the datalogger memory ahead of schedule.

The water level within the alluvial sand as measured in borehole [illegible] rose by approximately [illegible] m following four consecutive days of heavy rain (over [illegible] mm of rainfall between [illegible] February and [illegible] February [illegible]) to an elevation of RL [illegible] m. In contrast, water levels for piezometers screened within the underlying very low to low strength sandstone (interpreted to be Mittagong Formation) were measured to rise by less than about [illegible] m in the same period. Water levels in piezometers screened within the underlying medium to high strength sandstone (interpreted to be Hawkesbury Sandstone) varied less than this over the same time period (e.g. refer graphs for [illegible] and [illegible] in Appendix C).

With the exception of borehole [illegible] which had a very slow rate of recharge, the manual water level measurements presented in Tables [illegible] and [illegible] are similar to the logger measurements obtained from data loggers. The typical standing water levels within the sandstone on the eastern and central parts of the site range between RL [illegible] and RL [illegible] whereas standing water levels within the sandstone on the western part of the site range between RL [illegible] and RL [illegible]. It is noted that the measured water levels are generally similar to the elevation of the adjacent [illegible] basement floor slab (i.e. RL [illegible]).

**Table 1: Groundwater Observations (Boreholes BH1, BH5, BH8, BH103 and BH104).**

| Measurement Date | Standing Water Level Measurements in Boreholes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BH1 | | BH5 | | BH8 | | BH103 | | BH104 | |
| | Depth (m) | RL[2] | Depth (m) | RL[2] | Depth (m) | RL[2] | Depth (m) | RL[2] | Depth (m) | RL[2] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | – | – | – | – |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | – | – | – | – |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | – | – | – | – | – | – |
| [illegible] | [illegible] | [illegible] | – | – | – | – | – | – | – | – |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | – | – | – | – |
| [illegible] | [illegible] (dry) | [illegible] (dry) | – | – | – | – | – | – | – | – |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | – | – | – | – |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | – | – | – | – |
| [illegible] | [illegible] (dry) | [illegible] (dry) | – | – | – | – | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | – | – | – | – | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] (dry) | [illegible] (dry) | – | – | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | – | – | [illegible] | [illegible] | – | – | – | – | – | – |

Notes: (1) "–" indicates Not Measured.
(2) Elevation (RL) in metres AHD.

**Table 2: Groundwater Observations (Boreholes BH107A, BH107B, BH109B, BH112A and BH112B).**

| Measurement Date | Standing Water Level Measurements in Boreholes | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | BH107A | | BH107B | | BH109B | | BH112A | | BH112B | |
| | Depth (m) | RL² | Depth (m) | RL² | Depth (m) | RL² | Depth (m) | RL² | Depth (m) | RL² |
| □□□□□□□□□□ | □□□ | □□□□ | □□□ | □□□□ | □ | □ | □ | □ | □ | □ |
| □□□□□□□□□□ | □ | □ | □ | □ | □□□□ | □□□□ | □□□ | □□□□ | □□□ | □□□□ |
| □□□□□□□□□□ | □□□ | □□□□ | □□□ | □□□□ | □□□□ | □□□□ | □□□ | □□□□ | □□□ | □□□□ |
| □□□□□□□□□ | □□□ | □□□□ | □□□ | □□□□ | □□□□ | □□□□ | □□□ | □□□□ | □□□ | □□□□ |
| □□□□□□□□□ | □□□ | □□□□ | □□□ | □□□□ | □□□ | □□□□ | □□□ | □□□□ | □□□ | □□□□ |
| □□□□□□□□□□ | □ | □ | □ | □ | □ | □ | □ | □ | □ | □ |

□□tes□ (1) "□" indicates Not Measured.
□□□□le□ati□□ □RL□i□ □etres □□D□
□□□Tra□sie□t □ater le□el d□e t□ sl□□ rec□ar□e rate – re□er □ra□□s attac□ed

## 3.3 Results of Permeability Testing

□er□ea□ilit□ testi□□ □as c□□ □leted □it□i□ eac□ sta□d□i□e □it□ a t□tal □□□□ tests c□□ □leted □et□ee□ □□ □□l□ □□□□ a□d □ □□□e □□□□□ Risi□□ □ead tests □ere carried □□t i□ eac□ sta□d□i□e □it□ t□e e□ce□ti□□ □□□ □□□□□□□ □it□ □alli□□ □ead tests c□□ □leted i□ t□ree sta□d□i□es □i□e □□□□□□□□□□□□□ a□d □□□□□□□ T□e □er□ea□ilit□ □□ t□e scree□ed i□ter□al □as calc□lated □si□□ t□e □□□rsle□ a□al□tical □et□□d□ T□e res□lts □□ t□e □er□ea□ilit□ testi□□ are □rese□ted i□ □□□e□di□ D□

□ s□□ □ar□ □□ t□e calc□lated □er□ea□ilit□ res□lts is □rese□ted i□ Ta□le □□

**Table 3: Calculated Permeability Results**

| Borehole ID | Material Types within Screened Interval | Calculated Permeability (m/sec) |
|---|---|---|
| □□□ □ | Sa□d | □□□ □ □□□ t□ □□□ □ □□□ |
| □□□ | Sa□dst□□e □i□e a□d □edi□□ □rai□ed □it□ cla□ sea□s i□ □□□er □etre □□ scree□ed i□ter□al | □□□ □ □□□ |
| □□□ □ | | □□□ □ □□□ |
| □□□□□ □ | Sa□dst□□e □i□e □rai□ed □it□ e□tre□el□ □eat□ered □a□ds □ract□red | □□□ □ □□□ t□ □□□ □ □□□ |
| □□□□□ □ | Sa□dst□□e □i□e t□ □edi□□ □rai□ed □sli□□tl□ □ract□red t□e□ □□□r□□e□ | □□□ □ □□□ t□ □□□ □ □□□ |
| □□□□□□ □ | Sa□dst□□e □i□e t□ □edi□□ □rai□ed □□i□□ stre□□t□ □it□ □er□l□□ stre□□t□ □a□ds □ract□red | □□□ □ □□□ t□ □□□ □ □□□ |
| □□□□□□ □ | Sa□dst□□e □i□e t□ □edi□□ □rai□ed □sli□□tl□ □ract□red t□e□ □□□r□□e□ | □□□ □ □□□ t□ □□□ □ □□□ |

| Borehole ID | Material Types within Screened Interval | Calculated Permeability (m/sec) |
|---|---|---|
| [illegible] | Sandstone, fine to medium grained, slightly fractured [illegible] | [illegible] |
| [illegible] | Sandstone, fine grained with very low strength bands (core loss) | [illegible] |
| [illegible] | Sandstone, medium grained, slightly fractured [illegible] | [illegible] to [illegible] |

Notes: (1) [illegible] tests carried out.
(2) Well screen includes an interval of core loss and clay seams below the top of rock.

Typical permeability values for sandstone from our previous experience in the area and from published values are usually in the range [illegible] m/sec to [illegible] m/sec. The calculated permeability values for the sand encountered in borehole [illegible] are not consistent with these values and are considered to be not representative of the permeability of the sand. Borehole [illegible] was positioned near to basement walls for the [illegible] building, as well as adjacent to deep concrete footings (founded on rock). It is considered that these factors have influenced the permeability test results for the sand layer in borehole [illegible].

A slow rate of groundwater recharge was observed for standpipes screened within high strength rock with few defects ([illegible]), with water levels appearing to be similar for standpipes near to each other screened within different materials (e.g. [illegible] and [illegible] screened within either the fine to medium grained sandstone or the underlying medium grained Hawkesbury Sandstone). The rapid increase in water level within the standpipe screened within the alluvial sand and the observation of groundwater near the soil/rock interface in some boreholes (e.g. [illegible]) indicates that a perched water table is probably present within the soils above rock level.

## 4. Proposed Development

It is understood that the proposed development will include the dismantling of the former 'Inward Parcels Shed' building (i.e. the YHA: to be rebuilt following construction) of the Level [illegible] megafloor/transfer deck (retention of the existing goods lift to Station platform level), removal of the carriage dormitories and rails, and excavation below the Lower Ground Floor level of the existing building for a two-level basement (to RL [illegible] m), followed by construction of a multi-storey commercial tower.

Based on the preliminary drawings provided, it is understood that the proposed two-level basement will extend close to the property boundaries to the north-east and west and to the Devonshire Street Pedestrian Tunnel to the south. For extension of the proposed basement along the eastern boundary of the site, the existing setback of the lower ground floor of the [illegible] building on this side is to be removed. The drawings indicate that a basement entry ramp is to be constructed along the northern side from Lee Street, and a connection is proposed from the second basement level to potential future basements to the south of the site (i.e. beneath the pedestrian tunnel).

This will require excavation depths of about [illegible] m on the eastern boundary and about [illegible] m along the other boundaries to below the proposed two-level basement FFL at RL [illegible] m.

It is understood that the detailed design of the shoring system for the 'drained' basement is yet to be decided. However, it is anticipated that a relatively watertight perimeter 'cut-off' wall socketed a minimum □□□ m into competent slightly fractured to unfractured sandstone will be required to prevent any direct inflow from high permeability fill/alluvial soils and upper fractured rock.

## 5. Geotechnical and Hydrogeological Model

The field work results are summarised on six geotechnical cross-sections in Appendix B which show the interpreted layers of fill/alluvial and residual soil and sandstone units between selected test locations. The interpreted boundaries shown on the sections are accurate only at the test locations and layers shown diagrammatically on the drawings are inferred. Yellow bands of lower or higher strength rock may be present within the generalised sandstone layers. Single or multiple concrete slabs were present at the surface over most of the site, with rail ballast encountered over concrete and bricks within the rail carriage depot/yard area.

The interpreted geotechnical model for the site is:

- soft to stiff or very loose to dense fill materials (clay or sand) up to □.□ m thick below the current ground surface, over
- a discontinuous layer of very loose to medium dense sand alluvium up to □.□ m thick, over
- soft to hard silty clay or sandy clay residual soil up to about □.□ m thick, overlying
- fine to medium grained sandstone of very low strength with high strength ironcemented bands (□□□□ □ thick) and then overlying
- medium to high strength, medium grained sandstone.

Groundwater measurements from standpipe piezometers on site indicate that there is a relatively consistent permanent (perennial) groundwater table within the residual soils and underlying (fine grained) fractured sandstone (Mittagong Formation) that flows in the north-westerly direction towards Lee Street, with an average level of around RL □□.□ m in the centre of the site. The measured groundwater levels in piezometers screened in the lower (medium grained, less fractured) sandstone (Hawkesbury Sandstone) were generally lower by approximately □.□ m in the centre of the site, increasing to □ m towards Lee Street. The interpreted groundwater contours and flow directions are illustrated in Drawings □ and □ in Appendix C.

An intermittent perched groundwater table is also indicated to be present near the soil/rock interface and also within the alluvial sand. The upper perched groundwater table is likely to be recharged by surface infiltration into sandy layers following periods of heavy rainfall. The groundwater tables in alluvium and in sandstone appeared to be relatively independent, separated by low permeable residual clay, as there was minimal variability in groundwater levels observed in the sandstone even after some heavy rainfall periods between □□□ □□□□ and □□□□ □□□□.

The seepage within the sandstone bedrock is likely to be controlled by discontinuities in the rock, such as the spacing, continuity and aperture of the bedding planes, faults and joints. The seams and other fractures in the weathered rock may also be acting as temporary water storage. Therefore, groundwater inflow is not expected to be uniform around the site and is probably concentrated around localised fracture zones. The regional groundwater flow is also expected to be affected by the nearby basements, pedestrian tunnels and new Sydney Metro underground station.

## 6. Groundwater Modelling

### 6.1 Methodology

Groundwater modelling was undertaken to assess the potential inflow rates into the proposed basements and the long term drawdown (or cone of depression) which could be induced by the construction of the basements.

Groundwater model simulations were conducted using MODFLOW (McDonald & Harbaugh, [illegible]) developed by the United States Geological Survey. Modflow is a three-dimensional groundwater head and flow model which is widely used and accepted as an industry standard. The model was based on site-specific data where possible as well as estimates of aquifer parameters based on experience in similar environments. The model was developed using the pre-processor or graphical interface program Visual MODFLOW Flex V[illegible] (Schlumberger Water Services).

### 6.2 Numerical Model Geometry

The aquifer surrounding the proposed development was simulated as a multi-layered numerical model to represent the subsurface conditions surrounding the site and to allow the vertical flow components to be simulated more accurately.

The aquifer boundaries of the model were extended approximately [illegible] m from the site boundaries in all directions to simulate the estimated groundwater catchment domain.

For the numerical model the geological units were subdivided into four layers corresponding to the main soil and rock units. The top of the model (i.e. top of Layer 1) was set to approximate the average ground surface across the site at RL [illegible] m. For simplicity, the conceptual model did not incorporate topography or variations in layer thickness. All layers were assigned as MODFLOW (Type [illegible]) layers (confined/unconfined). Details of the model layers together with the assigned hydraulic parameters for each layer are provided in Table [illegible].

### 6.3 Boundary Conditions and Aquifer Parameters

The northern and southern boundaries of the model were set as no-flow boundaries. Constant head conditions were applied to the eastern and western model boundaries.

The constant head 'far-end' boundary conditions were calibrated to generate a hydraulic gradient in the north westerly direction, while matching the measured groundwater levels at various monitoring points on site. For simplicity, the groundwater model was calibrated against the groundwater table of the upper fractured sandstone layer (Mittagong) as it gives higher results for predictions of groundwater inflow and drawdown compared to the results in the lower groundwater table in Hawkesbury Sandstone is adopted.

Aquifer parameters required for the model included horizontal ($K_h$) and vertical ($K_v$) hydraulic conductivity (or permeability) as well as specific yield or storage coefficient. Natural variations in the permeability of the sediments around the site are likely to occur due to the variations in the silt or clay content and grain size of the sands.

Typical permeability values for sandy soils from our previous experience in the area and from published values are usually in the range [illegible] m/sec to [illegible] m/sec. The calculated values from the in-situ permeability testing for the sand encountered in borehole [illegible] are not consistent with these values and are considered to be not representative of the permeability of the sandy soils. Therefore a typical permeability value of [illegible] m/sec was adopted for Layer [illegible] (fill and alluvium) in the model. In order to ensure that the modelling is not too optimistic, the vertical conductivity was set as equal to the horizontal hydraulic conductivity for this layer.

The hydraulic conductivity of the residual clay (Layer [illegible]) was assumed to be [illegible] m/sec with an assumed horizontal to vertical hydraulic conductivity ratio of [illegible].

The permeability or hydraulic conductivity of the rock units (Layers [illegible]) will vary according to changes in the secondary structural features, such as joints and fractures along which groundwater will flow. Whether the fractures have been filled (by clay) as well as the orientation and interconnection of fractures will also cause changes in the rock mass permeability.

The modelling was carried out adopting mean (geometric) values of all the in-situ permeability test results in the fine grained fractured sandstone (Mittagong Formation) and in the medium grained slightly fractured to unbroken sandstone (Hawkesbury Sandstone). A horizontal to vertical hydraulic conductivity ratio of [illegible] has been assumed for each of these layers.

The adopted hydraulic conductivity or permeability values for all four layers are summarised in Table [illegible].

**Table 4: Model Layer Summary**

| Model Layer | Top of Layer (RL m AHD | Layer Represents | Horizontal Hydraulic Conductivity (m/sec) | Vertical Hydraulic Conductivity (m/sec) |
|---|---|---|---|---|
| [illegible] | [illegible] | Fill and Alluvium | [illegible] | [illegible] |
| [illegible] | [illegible] | Residual Clay | [illegible] | [illegible] |
| [illegible] | [illegible] | Fractured Sandstone (Mittagong) | [illegible] | [illegible] |
| [illegible] | [illegible] | Slightly Fractured to Unbroken Sandstone (Hawkesbury) | [illegible] | [illegible] |

The initial model including the existing basement drainage in the adjacent Adina Hotel basement was calibrated to match the existing water levels on the site with the groundwater level (or potentiometric head) ranging from about RL [illegible] to RL [illegible] m. This calibration confirmed that the bedrock parameters chosen for the model appeared to be realistic. The calibrated initial (existing) groundwater levels are illustrated in Drawing M[illegible] in Appendix D.

## 6.4 Basement Dewatering – Drain Cells

The MODFLOW drain package can be used to simulate water loss from the groundwater system which occurs due to dewatering operations. Drain cells set with a high conductance ([illegible] m²/day) simulated the dewatering during and post construction of the basements. The drain cells represent the subfloor drainage and sump system located within the basement to dewater the site during construction and then to provide permanent drainage in the long term.

To simulate basement drainage in both the existing drained basement of Medina Hotel immediately adjacent to the site to the west and the proposed new basement, drain cells were set at the existing basement level of Medina Hotel and at the proposed new basement bulk excavation levels:

- Proposed new basement — Drain Cells: RL [illegible] m AHD;
- Existing basement of Medina Hotel — Drain Cells: RL [illegible] m AHD.

The predicted inflows into the drain cells representing the basement dewatering system were monitored throughout the model simulation using the Zone Budget module of MODFLOW.

## 6.5 Cut-off Walls

To reduce direct inflow through the sides of the excavation from the high permeability alluvial soils and upper fractured rock, it is understood that relatively impermeable walls are to be installed around the basement excavation except for the western boundary where the thickness of highly permeable soils is minimal.

Design of the cut-off walls is yet to be finalised but they are envisaged to comprise continuous piles with the gaps between piles sealed during construction by water-proofing. The proposed cut-off walls were included in the numerical model by applying a horizontal flow barrier (HFB) to the cells at the excavation faces, which was assigned a nominal [illegible] m thickness with a hydraulic conductivity of [illegible] m/s. The wall was simulated to extend down to RL [illegible] m (i.e. at least [illegible] m cut-off into the slightly fractured and stronger sandstone layer).

## 6.6 Groundwater Modelling Simulations

The model was initially run under a steady state flow condition with the Medina Hotel basement drain cell activated. Following calibration of the boundary conditions to match the existing groundwater measurement data, the cut-off walls and the drain cells for the proposed new basement were then activated and the model was run under transient flow conditions for a period of [illegible] years and then switched to long-term (steady state) flow conditions to assess the groundwater inflow rates into the basement during construction and then in the long term.

# 7. Groundwater Modelling Results

## 7.1 Groundwater Inflow

Groundwater inflow into the drain cells representing the excavation dewatering system was monitored throughout the model simulations using the 'zone budget' module of MODFLOW. The inflow rates represent the estimated total rate of groundwater flowing into the excavation and the volume per unit time requiring extraction via the dewatering system (sump and pump) in order to dewater the basement excavation during construction and for the long-term case.

Simulated results are summarised in Table [illegible]. During the early stages of construction, inflow rates will be higher and will then gradually decrease as the groundwater storage in the aquifer around the excavation decreases and the cone of depression in the potentiometric surface expands out from the basement.

The cumulative inflows during the first year of basement construction are predicted to be about [illegible] ML. In the long-term, inflows are predicted to be less than [illegible] ML per year.

**Table 5: Predictive Model Simulated Inflow Results (i.e. Dewatering pumping rates)**

| Elapsed Time | Dewatering Inflow Rate | | |
|---|---|---|---|
| | $m^3$ / day | L / min | ML / year |
| [illegible] Day | [illegible] | [illegible] | [illegible] (Cumulative during [illegible]st year) |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Days | [illegible] | [illegible] | |
| [illegible] Year | [illegible] | [illegible] | |
| [illegible] Years | [illegible] | [illegible] | [illegible] |
| [illegible] Years | [illegible] | [illegible] | [illegible] |
| [illegible] Years | [illegible] | [illegible] | [illegible] |
| Long-term | [illegible] | [illegible] | [illegible] |

It should be noted that these volumes are best estimates of the average inflows. It is entirely possible that there could be local zones of higher permeability which could increase the inflows significantly. Accordingly, it is recommended that a factor of safety of at least [illegible] be applied to these numbers for design purposes and that these flow rates be monitored during excavation and construction.

It should be noted that the simulated dewatering rates and drawdown are dependent on the dewatering scheme adopted for the site as included in the numerical models [illegible] the depth of the basement drainage and sumps or cut-off walls change then the currently predicted dewatering rates may change and further modelling will be required.

## 7.2 Predicted Groundwater Drawdown

Drawing M[illegible] in Appendix D shows the predicted long-term groundwater table following the completion of the proposed 'drained' basement. The long-term drawdown contours were produced by subtracting the predicted water levels from the initial groundwater levels and are illustrated on Drawing M[illegible] in Appendix D.

The model results indicate that the potential drawdown or impact on the water table may extend out to [illegible] m from the site boundaries on the upstream side and [illegible] m on the downstream side as shown by the [illegible] m drawdown contour in Drawing M[illegible].

The predicted drawdowns below key structures around the site are:

- Central Station (Regional Line Tracks and Platforms) — Drawdown [illegible] m
- Adina Hotel — Drawdown [illegible] m
- Existing Devonshire Street Tunnel — Drawdown [illegible] m
- Office Complex at [illegible] Lee Street — Drawdown [illegible] m
- Railway Square — Drawdown [illegible] m

## 7.3 Drawdown Induced Settlement

The upper perched water table within the fill and alluvial soils is expected to be governed by rainfall infiltration. Assuming that perimeter cut-off walls are constructed down into the sandstone, this perched water table is expected to continue fluctuating above and below the soil/rock interface even after the construction of the 'drained' basement. The neighbouring structures and pavement founded on fill or alluvial soils are therefore not expected to experience noticeable dewatering induced settlements.

The lower groundwater table in the sandstone, following the construction of the 'drained' basement, is expected to be close to the bulk excavation level immediately behind the excavation faces of the basement, corresponding to a maximum drawdown of approximately [illegible] m gradually reducing to less than [illegible] m drawdown at distances of about [illegible] m – [illegible] m away from the basement boundaries.

The maximum drawdowns below the adjacent key structures are predicted to be up to [illegible] m. Despite these relatively high levels of local drawdown, the drawdown is expected to occur mostly within sandstone. There should be minimal impact of this drawdown on adjacent structures founded on sandstone (i.e. total additional settlements or differential settlements [illegible] due to the high deformation moduli of the sandstone bedrock).

## 8. Potential Impact on Neighbouring Properties

An assessment of the potential effects of dewatering on neighbouring properties and groundwater dependent ecosystems has been summarised in Table 6.

**Table 6: Assessment of Potential Effects of Dewatering.**

| Item | Comment |
|---|---|
| Proximity to Groundwater Dependent Ecosystems (GDEs) | [illegible] groundwater dependent ecosystems within [illegible] kilometre radius of the site[1]. |
| Water supply losses to neighbouring groundwater users | A review of registered bores within a [illegible] radius to the surrounding site was undertaken. The search[2] identified [illegible] extraction bores within the search area, [illegible] monitoring bores were identified with the nearest one located approximately [illegible] from the site. All of the groundwater bores are located beyond the assessed zone of influence from the anticipated drawdown. |
| Potential subsidence of neighbouring structures | It is considered that the local lowering of the water levels within the sandstone will have no significant impact on the surrounding properties or structures. |
| Mounding of water on upgradient of structure | Significant mounding of groundwater is not expected. A drained basement would eliminate potential mounding. |

Notes: [1] Based on the search results undertaken in Groundwater Dependent Ecosystem (GDE) Atlas on the Bureau of Meteorology's (BoM) website

[2] Based on the search results undertaken in Australian Groundwater Explorer on the BoM's website.

## 9. Aquifer Interference Policy Considerations

The NSW Aquifer Interference Policy (AIP) indicates that the term "aquifer" is commonly understood to mean a groundwater system that is sufficiently permeable to allow water to move within it and which can yield productive volumes of groundwater. A groundwater system is defined as any type of saturated geological formation that can yield low or high volumes of water. However, for the purpose of the AIP, the term aquifer has the same meaning as groundwater system and includes low yielding and saline systems.

The basement dewatering on site is expected to occur in the sandstone profile of relatively low permeability with low yield, and is considered to be a "less productive groundwater source" as outlined in the AIP.

It is expected that the measured water levels within the rock on the site are probably associated with seepage flowing through bedding planes/fractures and joints in the rock. Once the groundwater level stabilises following initial excavation, these seepage flows are likely to be relatively minor during periods of dry weather and may increase slightly following periods of wet weather.

Table [illegible] in Section [illegible] of the AIP outlines minimal impact considerations. The AIP indicates that *"if predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable"*. The following minimal impact considerations are outlined for less productive groundwater sources:

- less than or equal to □□□ cumulative variation in water table □□□ □ from any high priority groundwater dependent ecosystem, high priority culturally significant site; or less than a □ m decline at any water supply work;
- a cumulative pressure head decline of not more than a □ m at any water supply work;
- any change in groundwater quality should not lower the beneficial use category of the groundwater source beyond □□□ □ from the activity.

The minimal consideration impacts relate to impacts on groundwater dependent ecosystems and groundwater users. The proposed excavation on the site is considered to comply with the low minimal consideration requirements for the following reasons:

- the water take for the basement does not involve pumping or extraction of large volumes of groundwater. Water seepage through the rock is to be collected in sub-floor drainage and directed to the storm water or sewer system (subject to approval by Council or by Sydney Water);
- there are no registered groundwater users within □□□ □ of the site;
- DP is not aware of any groundwater dependent ecosystems within one kilometre radius of the site;
- DP is not aware of any water sharing agreements in the area; and
- the water table can be easily measured during the construction period and in the long term if required.

## 10. Disposal of Groundwater Contaminants

Selected groundwater samples were tested for common contaminants during the contamination site investigations in order to assess potential disposal options. The results are presented in the following DP Reports and summarised below:

- Report on Detailed Site (Contamination) Investigation, report □□□□□□□□R□□, dated □□□□st □□□□ (DP □□□□□□) and
- Report on Supplementary Site (Contamination) Investigation, report □□□□□□□□R□□, dated □□□e □□□□ (DP □□□□□□).

DP has installed a total of nine groundwater wells screened in Hawkesbury Sandstone include:

- an upgradient groundwater well (□□□□□□);
- a downgradient groundwater well (□□□□□□□); and
- three groundwater wells within the northern central (□□□□□s) to western portion (□□□□□□□□) and close to the northern boundary (□□□□□□□□□) of the site.

DP has installed a total of three groundwater wells screened in Mittagong Formation include:

- an upgradient groundwater well (□□□□□□);
- a downgradient groundwater well (□□□□□□□); and
- a groundwater well in the south western portion of the site (□□□□□□).

The location of the above groundwater wells is depicted on Drawings [illegible] report. The nested wells including [illegible] and [illegible] were installed to target different rock strata. The sampling design of the well locations/rock strata was reviewed and approved by an [illegible] accredited auditor (Rod Harwood, Harwood Environmental Consultant) in September [illegible]. In addition, an up-gradient well was installed in the sand profile (depicted as [illegible] during the DP [illegible] investigation) located near the south-eastern boundary of the site.

No obvious signs of environmental concern (i.e. light non-aqueous phase liquids (LNAPLs) or odours) were noticed during field investigations. There were, however, detectable concentrations of total recoverable hydrocarbons (TRH) in groundwater wells [illegible] and [illegible] and [illegible] which may exhibit minor hydrocarbon odours.

In summary, laboratory test results confirmed the presence of some contaminants of potential concern (COPC) in the groundwater. Copper and zinc were detected at concentrations above the groundwater site assessment criteria (SAC) while polycyclic aromatic hydrocarbons ([illegible]), total recoverable hydrocarbons (TRH) and other metals were detected at levels below the SAC. [illegible] was only detected in the two down-gradient wells ([illegible] and [illegible]) indicating that the source of the [illegible] could be from the fill on site. However, soil leachability (TCLP) testing results do not indicate that [illegible] is likely to leach from the fill into the groundwater.

The elevated levels of copper and zinc in groundwater are common in heavily urbanised areas. Elevated levels of copper and zinc were identified in both the up-gradient and down-gradient groundwater wells. The source of the copper and zinc is uncertain but could be linked to the copper and zinc concentrations in the fill layer on site or to the services network at or in proximity to the site. However, considering that elevated levels of copper and zinc were not evident in the fill, the copper and zinc levels identified in the groundwater wells at the site are likely to represent regional background levels rather than site specific levels.

DP has carried out extensive groundwater contamination assessments across the site including two up-gradient groundwater wells to determine the quality of groundwater flowing into the site. Given that only of the fill material will be removed as part of the basement excavation, an on-site source (e.g. primarily from historical fill material) of existing groundwater contamination would be removed. The overall risk of encountering existing groundwater contamination (i.e. from on-site and off-site sources based on the recent groundwater investigations (DP [illegible] and DP [illegible]) appears to be low. There is, however, a risk of encountering groundwater contamination via the rock joints from future off-site sources or losses (e.g. accidental chemical spill near the site) which occur within approximately a [illegible] radius from the site (based on the drawdown modelling).

Further sampling and testing of the groundwater are likely to be required by the City of Sydney Council to assess the quality and suitability of the groundwater prior to discharge to the storm water system. Alternatively, groundwater could be discharged into sewers subject to approval from Sydney Water or to a licensed liquid waste facility. No disposal of groundwater to storm water or sewer can be carried out until a permit is issued by Council (for storm water disposal) or Sydney Water (sewer disposal). It is likely that a groundwater management plan will be required as part of the application for a dewatering licence.

On the basis of the current information, any water collected on site should be stored in a holding tank for further assessment of contaminants (including iron [illegible] oil and grease, suspended solids, volatile organic compounds (VOC) and hardness prior to disposal. It is anticipated that the groundwater will be suitable for disposal following appropriate treatment (subject to monitoring results).

If treatment of contaminants is required for Council stormwater discharge or Sydney Water sewer discharge, a remediation contractor can be engaged to devise a concept and/or detailed design for the treatment system. This would generally involve the following (or similar):

- Settlement tanks to remove the suspended solids from the dewatered excavation;
- Oil/water separator vessels to recover floating product and separate sinking product (if any);
- Sand filtration to remove fine sediment from the water stream;
- Aeration to remove BOD; and
- Granular activated carbon (GAC) filtration and resultant filtration to adsorb contaminants.

## 11. Conclusions

The site investigations have identified fill and alluvial soils over residual clay and weak sandstone rock grading medium to high strength sandstone. The perennial groundwater level has been measured at about RL [illegible] m in standpipes on the site within the medium to high strength rock. A perched intermittent groundwater table is present within the near surface fill and alluvial soils but is not expected to be impacted by the proposed excavation provided that perimeter watertight cut-off walls are constructed and extended [illegible] m into the slightly fractured or better sandstone.

The proposed excavation is expected to extend to approximately [illegible] m below the measured groundwater level in medium to high strength sandstone.

An estimate of groundwater inflow into the new basement has been undertaken using 3D Finite Difference modelling techniques. The annual inflow rates have been estimated to be in the order of [illegible] ML for the first year post-basement construction gradually decreasing to [illegible] ML per year for the long term. However, based on our experience in other deep excavations into sandstone bedrock in the area, DP expects that the actual seepage into the excavation will be much lower than these predicted values due to the low volumes of water contained within the joints and defects in the rock.

As the predicted annual inflow is more than [illegible] ML/year, the proposed basement, if constructed as a 'drained' basement, will generally require a Water Access Licence and a Water Supply approval for construction and long-term dewatering from the relevant approval bodies such as [illegible] (DoI Water / [illegible]). Monitoring, groundwater contamination testing and long-term on-site treatment may be required prior to discharge.

Due to the high deformation modulus (low compressibility) of the sandstone, a long-term drawdown of the groundwater level is not expected to cause any significant settlement of the neighbouring structures.

In conclusion, it is considered from a hydrogeological point of view that a 'drained' basement is feasible without any significant impact to surrounding groundwater systems or property. This will be subject to review and approval from Council and relevant authorities.

## 12. Limitations

Douglas Partners (DP) has prepared this report for this project at [illegible] Lee Street, Haymarket in accordance with DP's proposal SYD190190.P.003.Rev5, and acceptance received from Avenor Pty Ltd on behalf of Vertical First Pty Ltd ([illegible]). The work was carried out under a consultancy agreement. This report is provided for the exclusive use of Vertical First Pty Ltd or their agents, for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the groundwater components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

**Douglas Partners Pty Ltd**

# Appendix A

## About This Report

## Introduction

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

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

## Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

## Borehole and Test Pit Logs

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

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

## Groundwater

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

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

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

## Reports

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

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

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

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

# *About this Report*

### Site Anomalies

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

### Information for Contractual Purposes

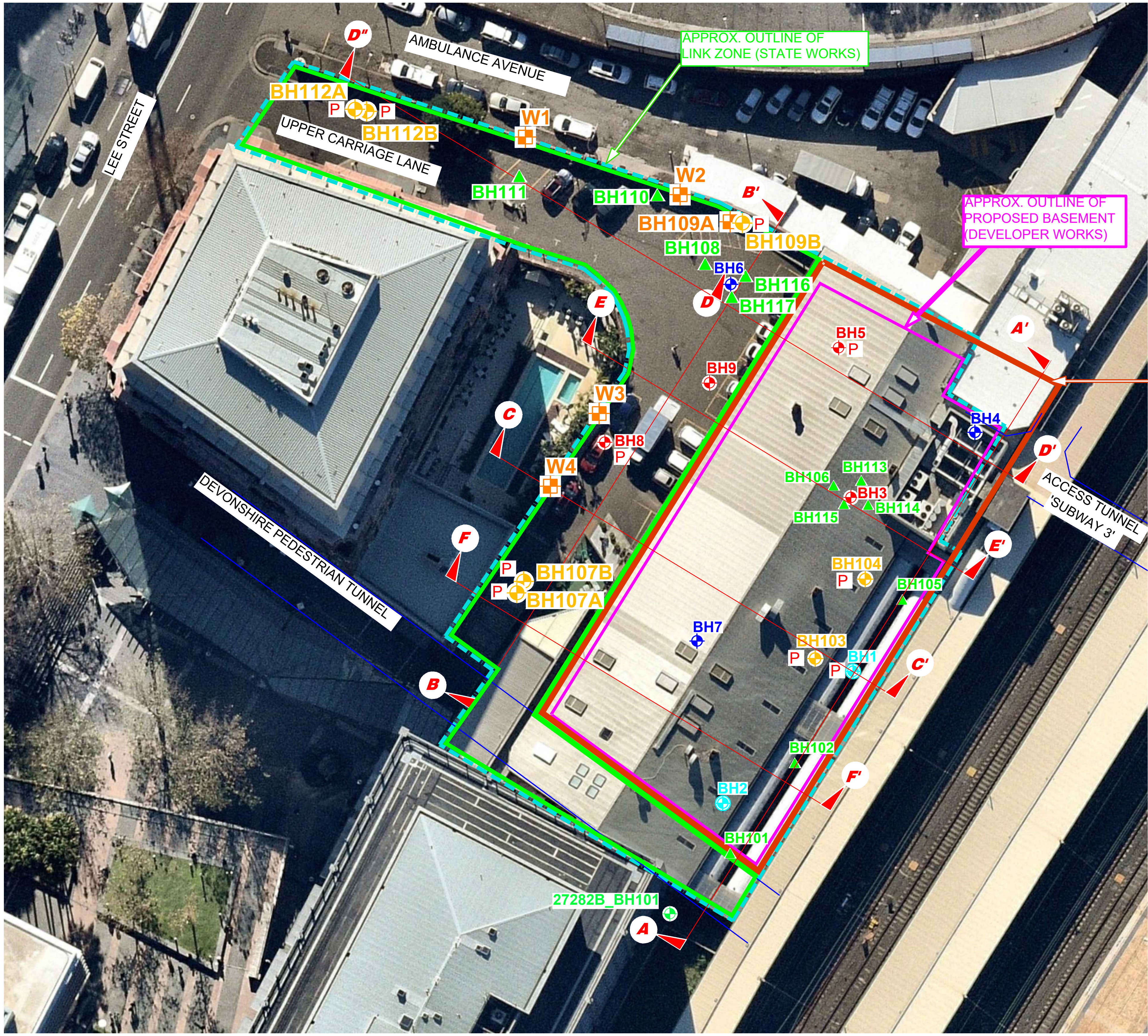
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

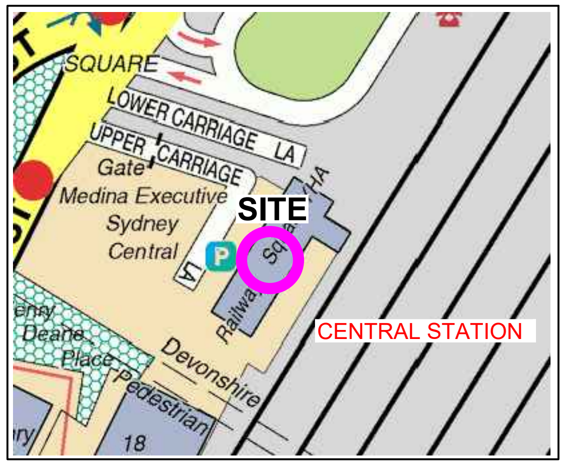
### Site Inspection

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

# Appendix B

Drawings




**Locality Plan**

## LEGEND

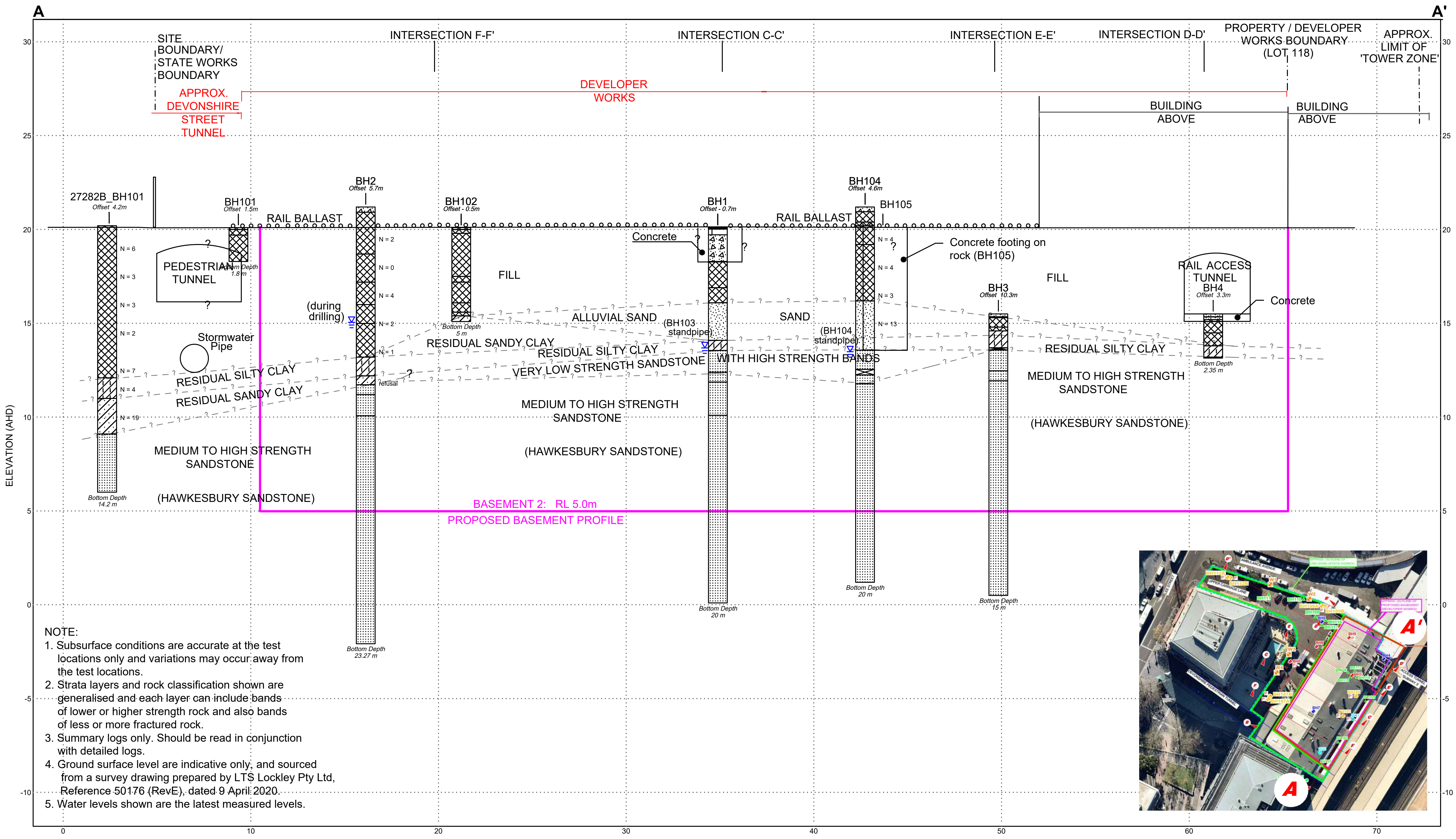
- Previous geotechnical borehole (DP Project 27282B, dated 1999)
- Environmental borehole - Lower Ground Floor (DP Report 86767.01.R.001.DftB, dated 29 August 2019)
- Geotechnical & environmental borehole - Lower Ground Floor (DP Report 86767.00.R.001.Rev0, dated 26 August 2019)
- Geotechnical & environmental borehole - Upper Ground Floor (DP Report 86767.00.R.001.Rev0, dated 26 August 2019)
- Environmental borehole
- Geotechnical & environmental borehole
- Geotechnical borehole
- P Standpipe piezometer
- A A' Geotechnical Cross Section A-A'
- Approximate site boundary

NOTE:
1: Base image from Nearmap.com (Dated 1 July 2019)
2: Test locations are approximate only and are shown with reference to existing features.
3. Approximate Development Outlines are as provided by Avenor Pty Ltd on 12 August 2019.

0 5 10 15 20 30 40 50m
1:500 @ A3

**Douglas Partners**
Geotechnics | Environment | Groundwater

| | | | |
|---|---|---|---|
| CLIENT: Atlassian Pty Ltd | | TITLE: **Test Location Plan** **Proposed Commercial Development** **8-10 Lee Street, HAYMARKET** | PROJECT No: 86767.00 |
| OFFICE: Sydney | DRAWN BY: HDS | | DRAWING No: 1 |
| SCALE: 1:500 @ A3 | DATE: 16.06.2020 | | REVISION: 8 |



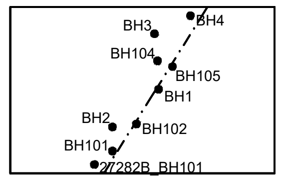

NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.

LEGEND

| | |
|---|---|
| Concrete | Sand |
| Bricks | Silty Clay |
| Fill | Sandstone |
| Sandy Clay | Core Loss |

TESTS / OTHER
N - Standard penetration test value
Water level

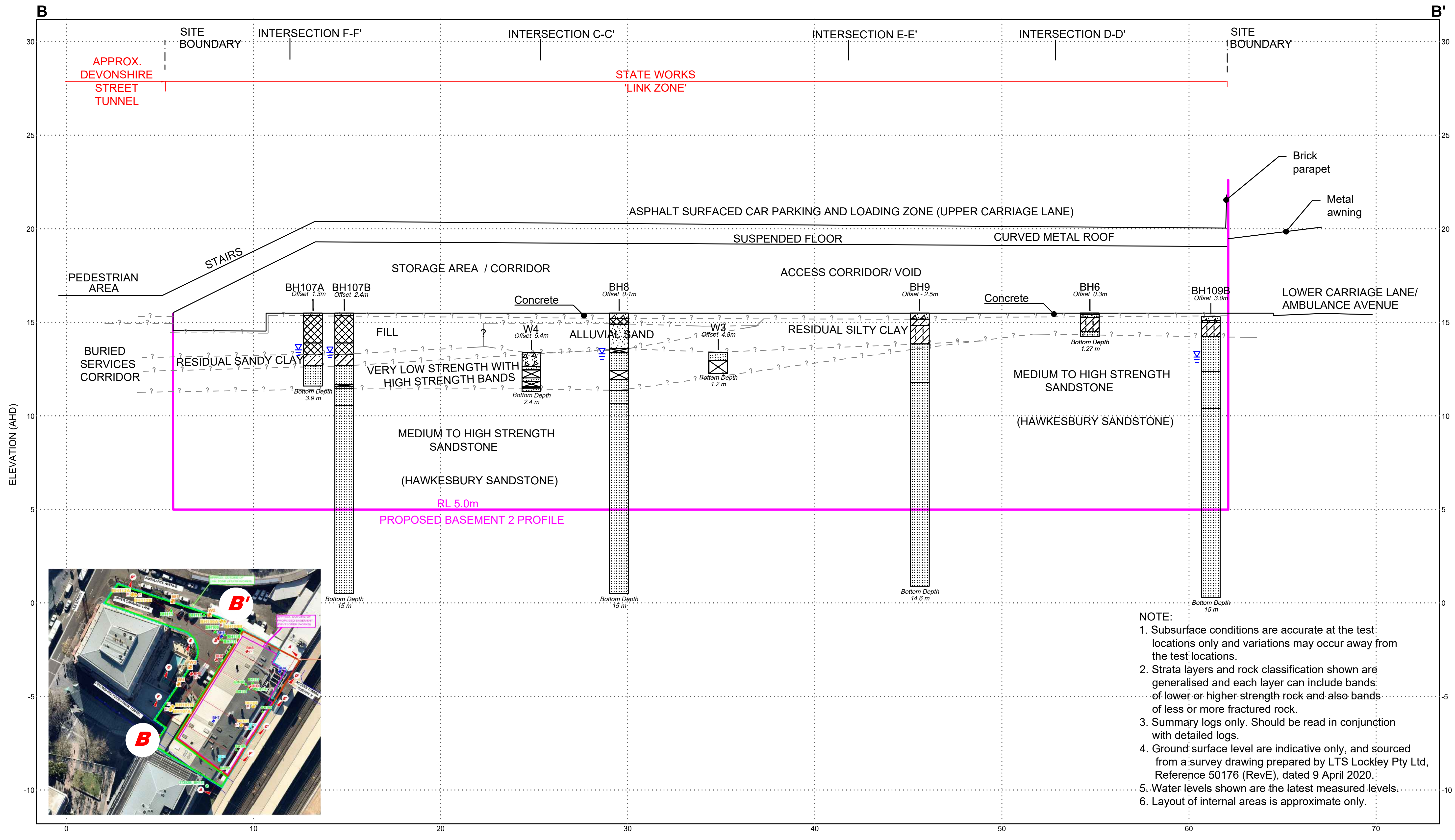
SITE MAP




0 4
Horizontal Scale (metres)
Natural Scale

Douglas Partners
Geotechnics | Environment | Groundwater

| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Interpreted Geotechnical Cross-Section A-A'** | PROJECT No: 86767.00 |
| OFFICE: Sydney | DRAWN BY: HDS | **Proposed Commercial Development** | DRAWING No: 2 |
| SCALE: 1:200 (H) 1:200 (V) @ A3 | DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 3 |



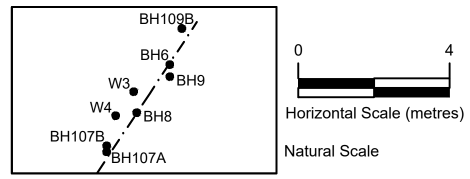

NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.

LEGEND

- Core Loss
- Asphaltic Concrete
- Clay
- Concrete
- Filling
- Sand
- Sandstone
- Silty Clay
- Silty Clay

TESTS / OTHER
N - Standard penetration test value
Water level

SITE MAP

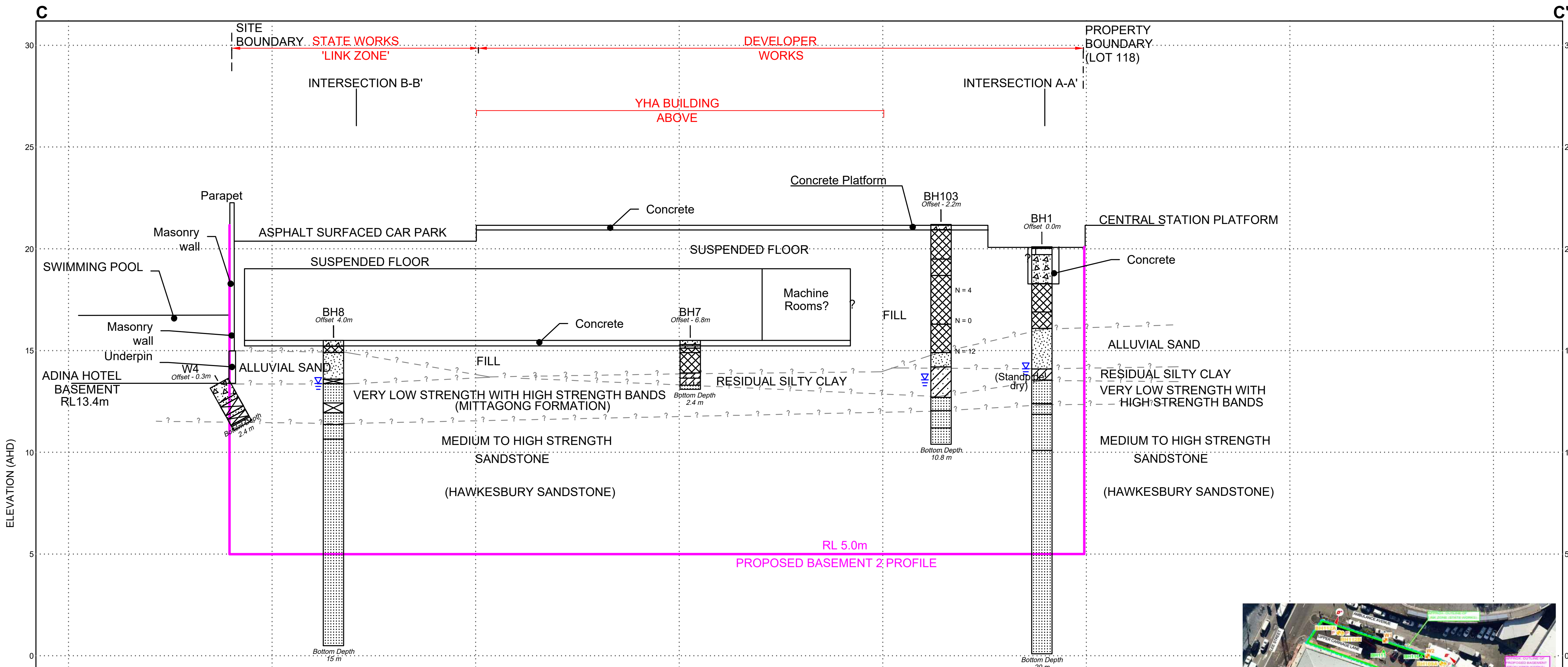



**Douglas Partners**
Geotechnics / Environment / Groundwater

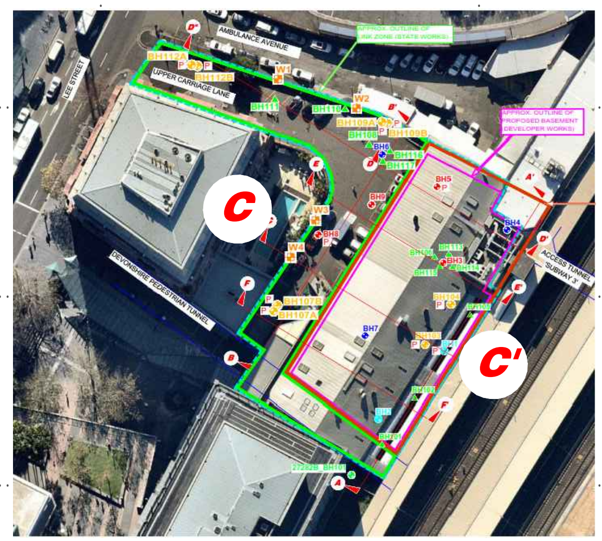
| | |
|---|---|
| CLIENT: Vertical First Pty Ltd | |
| OFFICE: Sydney | DRAWN BY: HDS |
| SCALE: 1:200 (H) 1:200 (V) @ A3 | DATE: 16.06.2020 |

TITLE: **Interpreted Geotechnical Cross-Section B-B'**
**Proposed Commercial Development**
**8-10 Lee Street, HAYMARKET**

| | |
|---|---|
| PROJECT No: | 86767.00 |
| DRAWING No: | 3 |
| REVISION: | 3 |




NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.




0 10 20 30 40 50 60 70

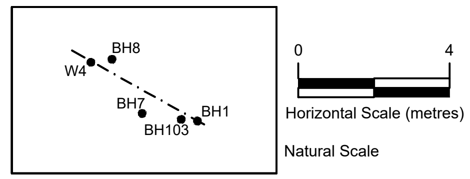
DISTANCE ALONG PROFILE (m)

LEGEND

| | |
|---|---|
| Core Loss | Sand |
| Bricks | Sandstone |
| Concrete | Silty Clay |
| Filling | Sandy Clay |

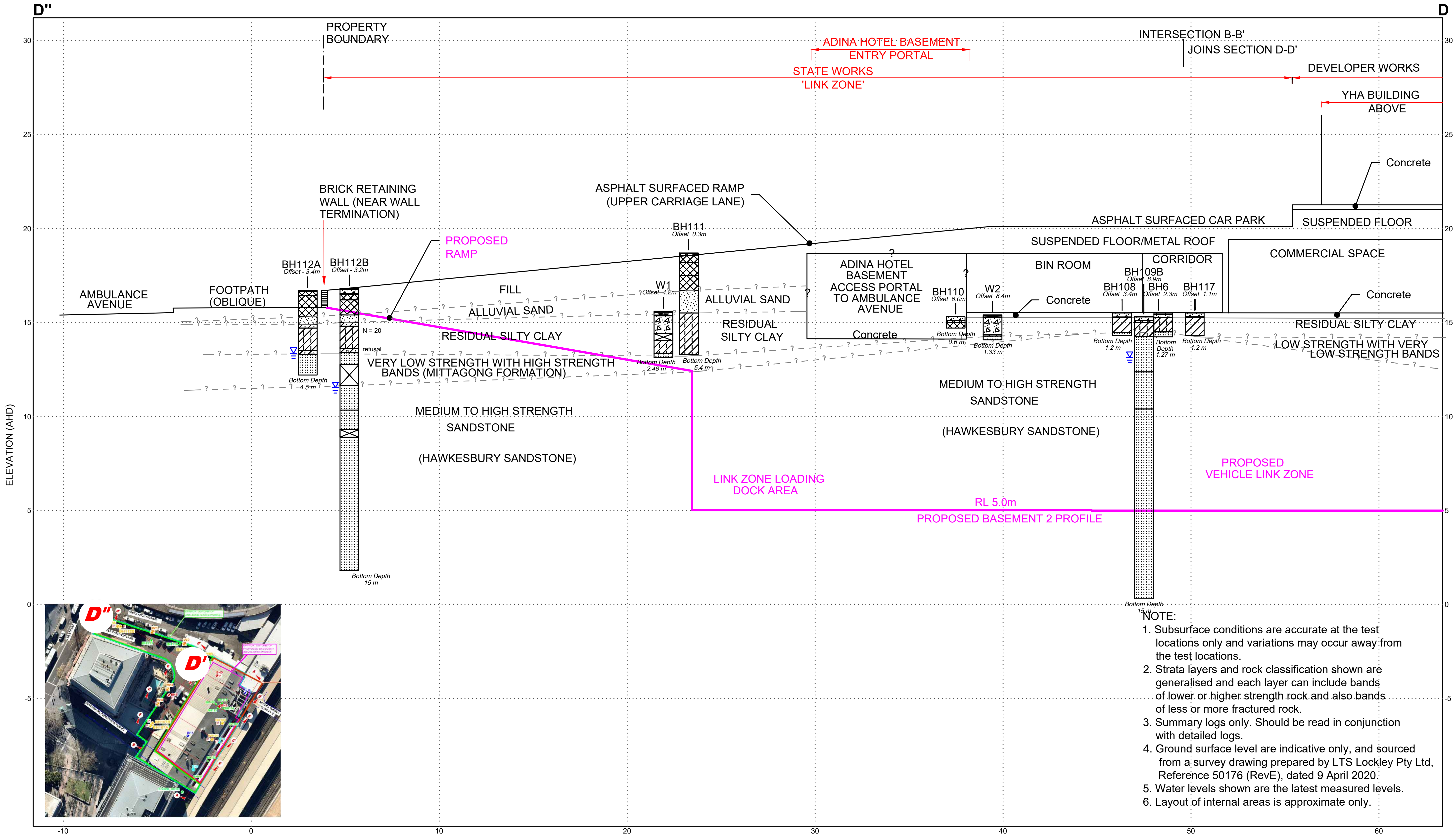
TESTS / OTHER
N - Standard penetration test value
Water level

SITE MAP




**Douglas Partners**
*Geotechnics / Environment / Groundwater*

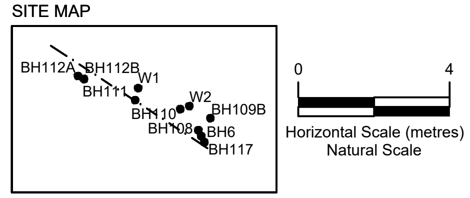
| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Interpreted Geotechnical Cross-Section C-C'** | PROJECT No: 86767.00 |
| OFFICE: Sydney | DRAWN BY: HDS | **Proposed Commercial Development** | DRAWING No: 4 |
| SCALE: 1:200 (H) 1:200 (V) @ A3 | DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 3 |




LEGEND

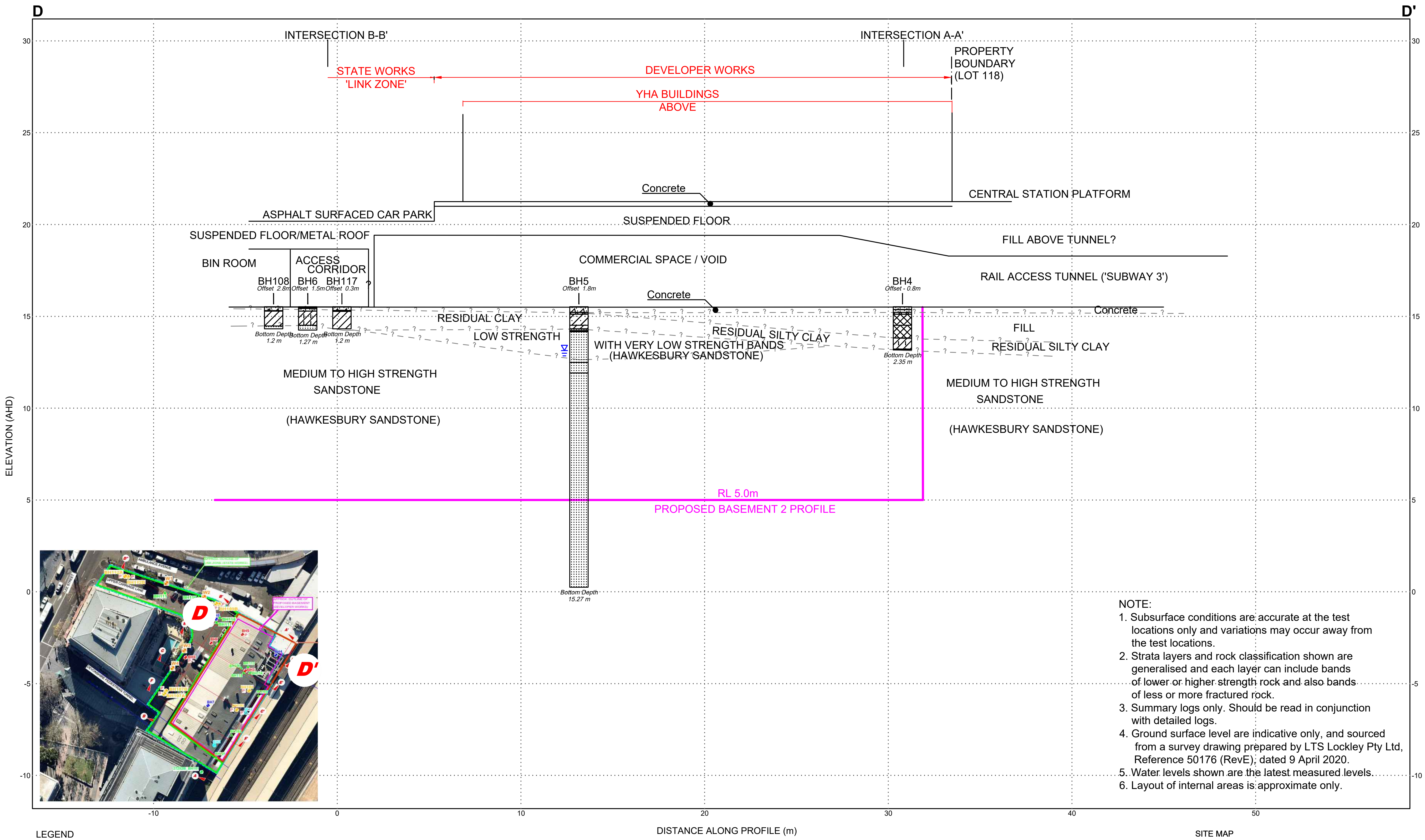
| | | |
|---|---|---|
| Core Loss | Fill | Silty Clay |
| Asphaltic Concrete | Sand | |
| Clay | Sandstone | |
| Concrete | Sandy Clay | |

SITE MAP




**Douglas Partners**
Geotechnics | Environment | Groundwater

| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Interpreted Geotechnical Cross-Section D''-D (extended)** | PROJECT No: 86767.00 |
| OFFICE: Sydney | DRAWN BY: HDS/ PSCH | **Proposed Commercial Development** | DRAWING No: 5 |
| SCALE: 1:200 (H) 1:200 (V) @ A3 | DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 2 |



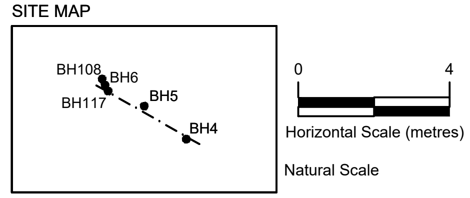

NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.

LEGEND

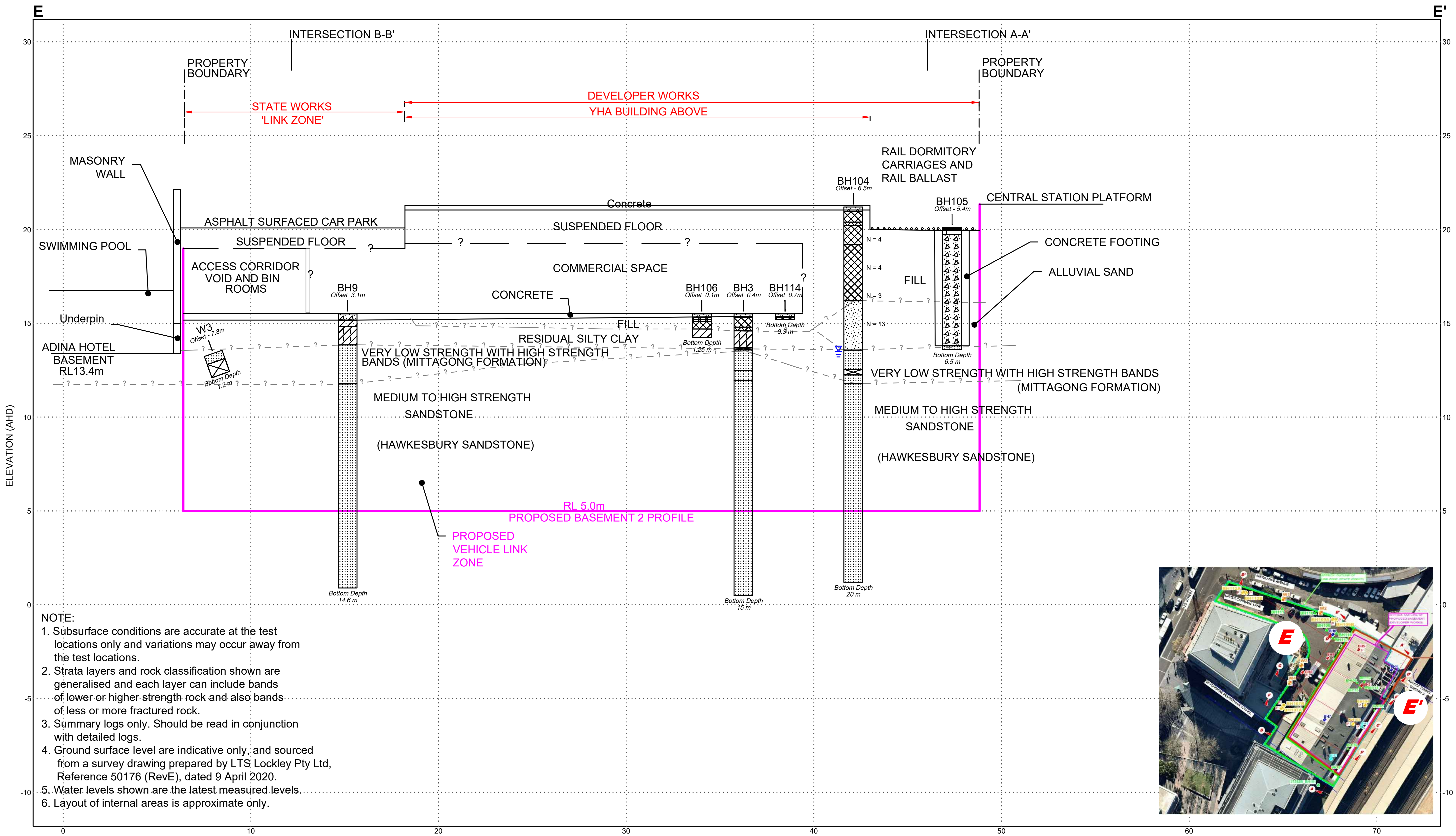
- Core Loss
- Asphaltic Concrete
- Concrete
- Fill
- Sandstone
- Sandy Clay
- Silty Clay
- Clay

TESTS / OTHER
N - Standard penetration test value
- Water level

SITE MAP




| | | | |
|---|---|---|---|
| **Douglas Partners** Geotechnics / Environment / Groundwater | CLIENT: Vertical First Pty Ltd | TITLE: **Interpreted Geotechnical Cross-Section D-D'** | PROJECT No: 86767.00 |
| | OFFICE: Sydney — DRAWN BY: HDS | **Proposed Commercial Development** | DRAWING No: 5A |
| | SCALE: 1:200 (H) 1:200 (V) @ A3 — DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 3 |




NOTE:

1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.

LEGEND

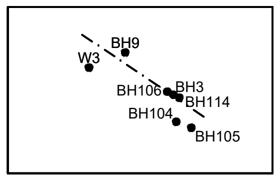
- Core Loss
- Bricks
- Clay
- Concrete
- Fill
- Sand
- Sandstone
- Silty Clay

TESTS / OTHER

N - Standard penetration test value

Water level

SITE MAP

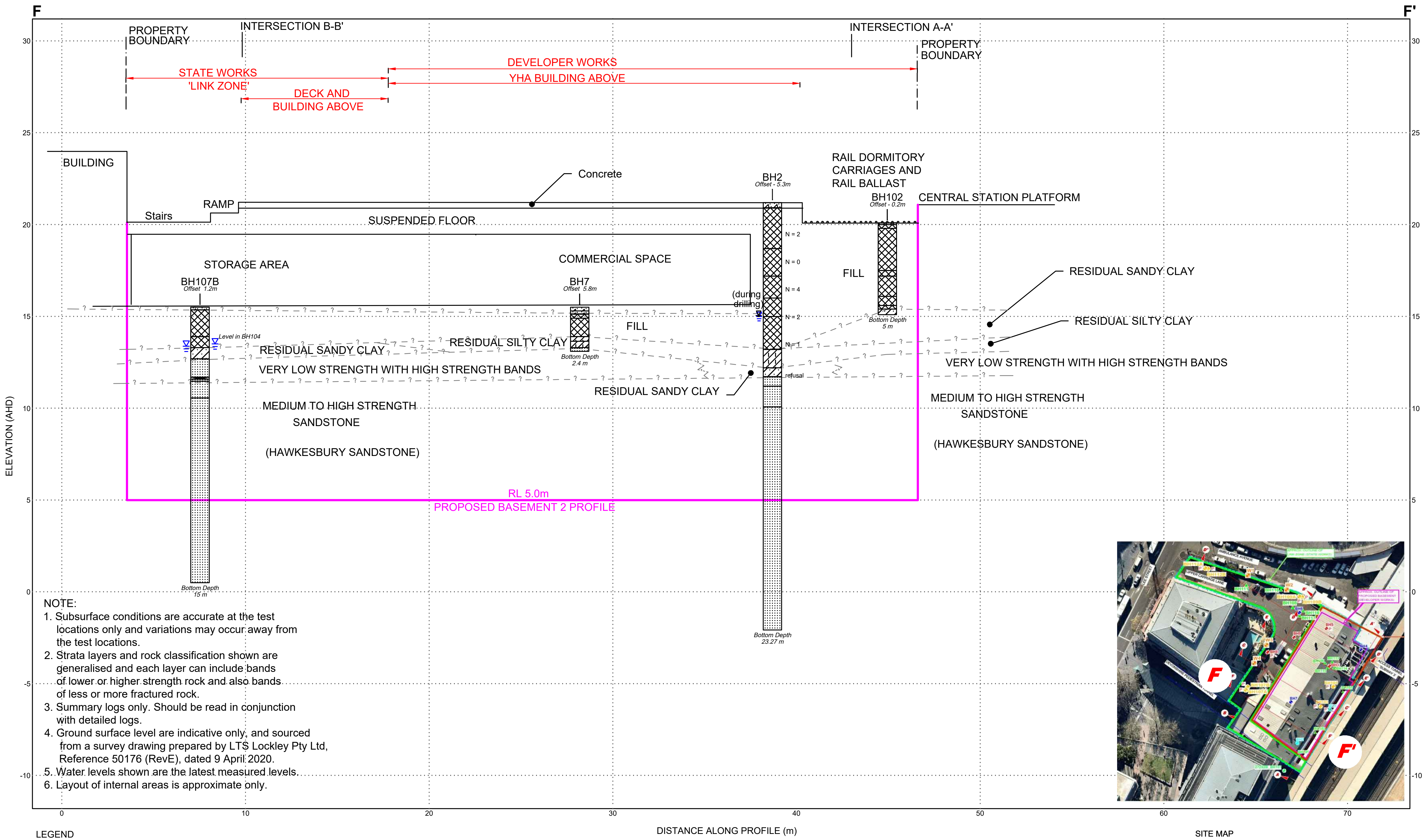



0 4

Horizontal Scale (metres)

Natural Scale

| | | | |
|---|---|---|---|
| **Douglas Partners** Geotechnics / Environment / Groundwater | CLIENT: Vertical First Pty Ltd | TITLE: **Interpreted Geotechnical Cross-Section E-E'** | PROJECT No: 86767.00 |
| | OFFICE: Sydney / DRAWN BY: HDS/ PSCH | **Proposed Commercial Development** | DRAWING No: 6 |
| | SCALE: 1:200 (H) 1:200 (V) @ A3 / DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 2 |



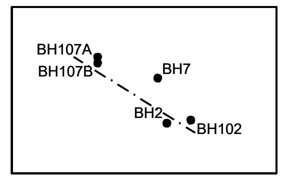

NOTE:
1. Subsurface conditions are accurate at the test locations only and variations may occur away from the test locations.
2. Strata layers and rock classification shown are generalised and each layer can include bands of lower or higher strength rock and also bands of less or more fractured rock.
3. Summary logs only. Should be read in conjunction with detailed logs.
4. Ground surface level are indicative only, and sourced from a survey drawing prepared by LTS Lockley Pty Ltd, Reference 50176 (RevE), dated 9 April 2020.
5. Water levels shown are the latest measured levels.
6. Layout of internal areas is approximate only.

LEGEND

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

TESTS / OTHER
N - Standard penetration test value
Water level

SITE MAP



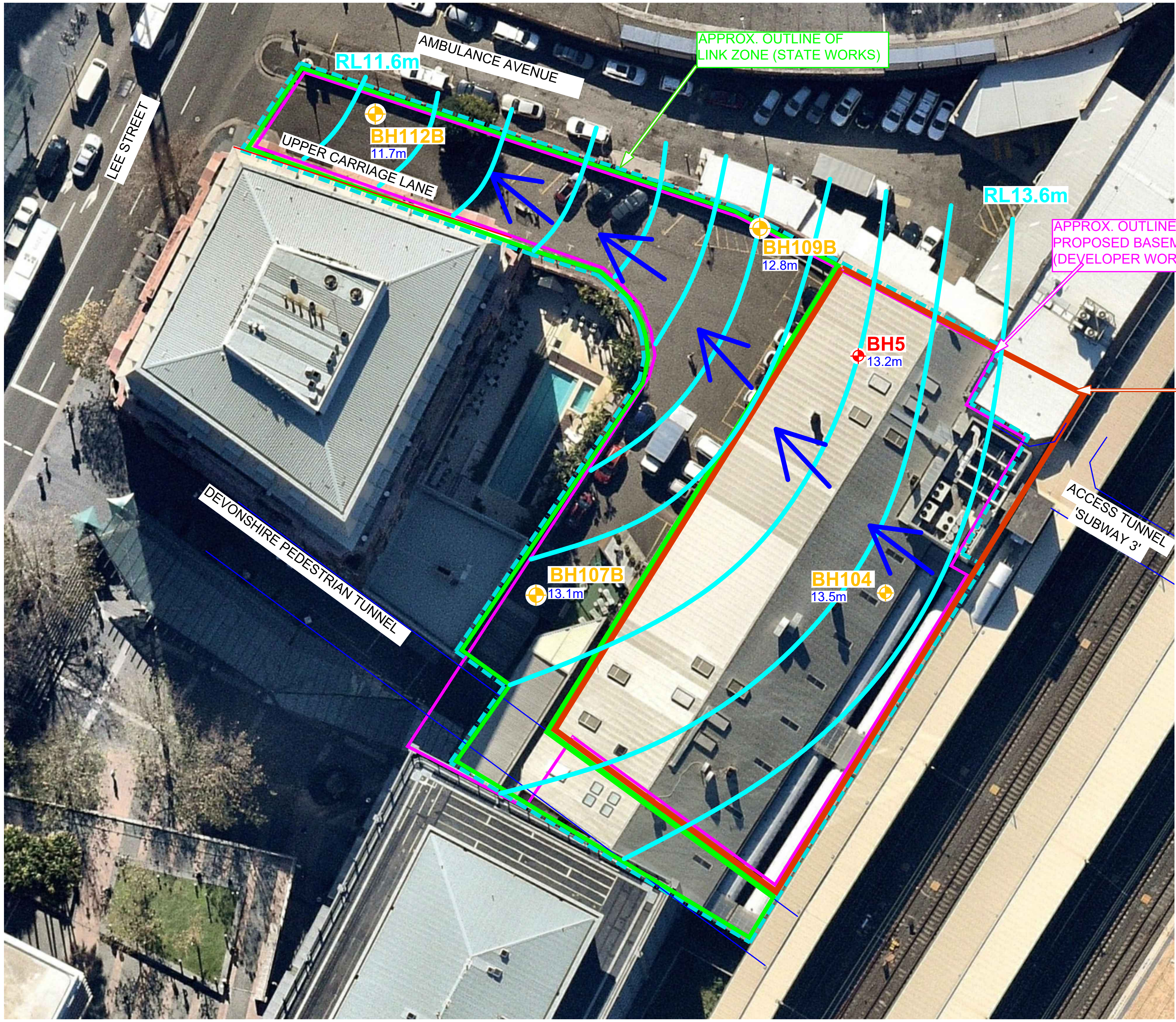

0 4
Horizontal Scale (metres)
Natural Scale

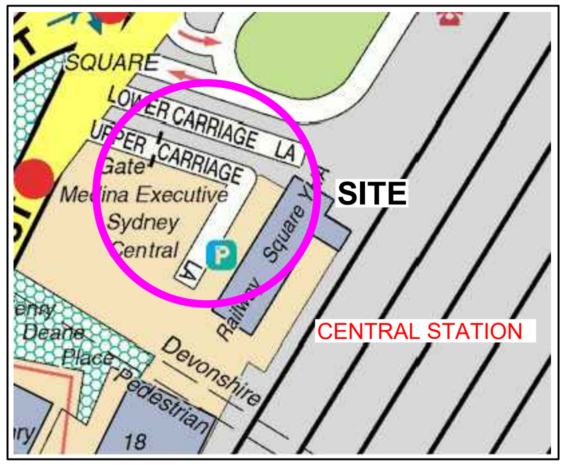
Douglas Partners
Geotechnics | Environment | Groundwater

| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Interpreted Geotechnical Cross-Section F-F'** | PROJECT No: 86767.00 |
| OFFICE: Sydney | DRAWN BY: HDS | **Proposed Commercial Development** | DRAWING No: 7 |
| SCALE: 1:200 (H) 1:200 (V) @ A3 | DATE: 16.06.2020 | **8-10 Lee Street, HAYMARKET** | REVISION: 2 |

# Appendix C

Results of Groundwater Level Monitoring




**Locality Plan**

0 5 10 15 20 30 40 50m

1:500 @ A3

**NOTE:**

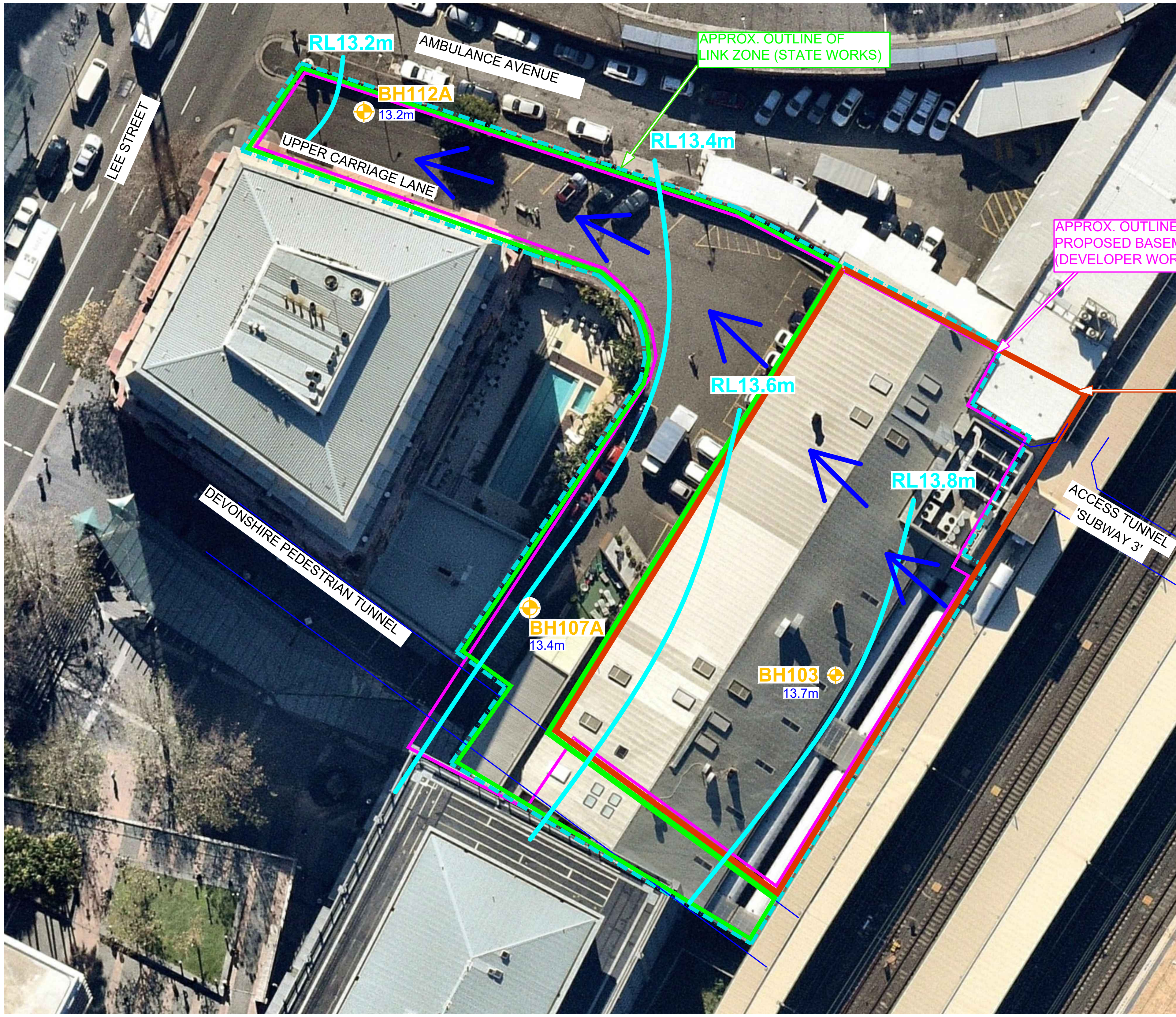
1. Base image from Nearmap.com (Dated 1 July 2019)
2. Test locations are approximate only and are shown with reference to existing features.
3. Approximate Development Outlines are as provided by Avenor Pty Ltd on 12 August 2019.
4. Groundwater level measurements taken on 05.05.2020 (BH5 and BH104) and 07.09.2020 (BH109B, 107B and 112B)
5. Bores not relevant to this drawing have been removed; refer to Drawing 1 or Report for location of all boreholes.
6. Groundwater contours shown for the site extents only.

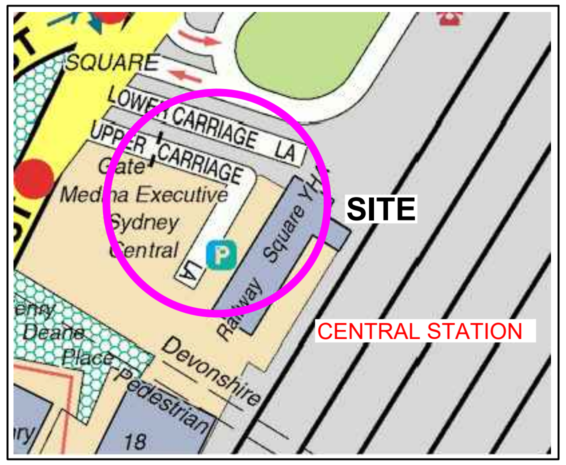
**LEGEND**

- Geotechnical & environmental borehole - Lower Ground Floor (DP Report 86767.00.R.001.Rev0, dated 26 August 2019)
- Geotechnical & environmental borehole (DP Report 86767.00.R001.Rev0, dated 26 August 2019)
- Inferred groundwater contour (RL(m))
- Direction of flow
- 13.2m Water elevation
- RL13.6m Contour elevation
- Approximate site boundary

**Douglas Partners**
Geotechnics / Environment / Groundwater

| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Groundwater Levels and Flow Direction from Piezometers Screened in Hawkesbury Sandstone** **Proposed Commercial Development, 8-10 Lee Street, HAYMARKET** | PROJECT No: 86767.06 |
| OFFICE: Sydney | DRAWN BY: BZ | | DRAWING No: 3 |
| SCALE: 1:500 @ A3 | DATE: 21.09.2020 | | REVISION: 0 |




**Locality Plan**

**NOTE:**

1. Base image from Nearmap.com (Dated 1 July 2019)
2. Test locations are approximate only and are shown with reference to existing features.
3. Approximate Development Outlines are as provided by Avenor Pty Ltd on 12 August 2019.
4. Groundwater level measurements taken on 05.05.2020 (BH5 and BH104) and 07.09.2020 (BH109B, 107B and 112B)
5. Bores not relevant to this drawing have been removed; refer to Drawing 1 or Report for location of all boreholes.
6. Groundwater contours shown for the site extents only.

0 5 10 15 20 30 40 50m

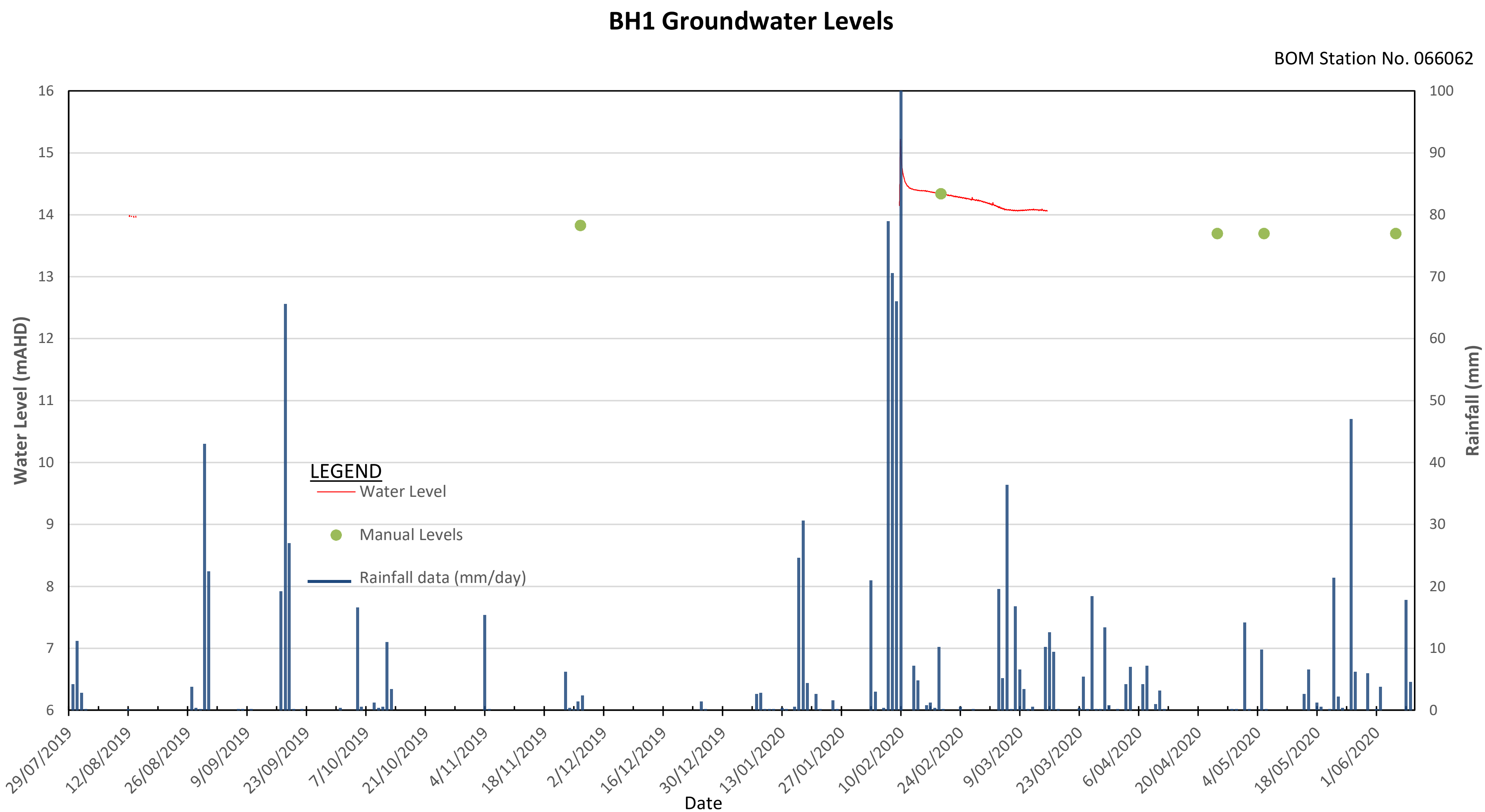
1:500 @ A3

## LEGEND

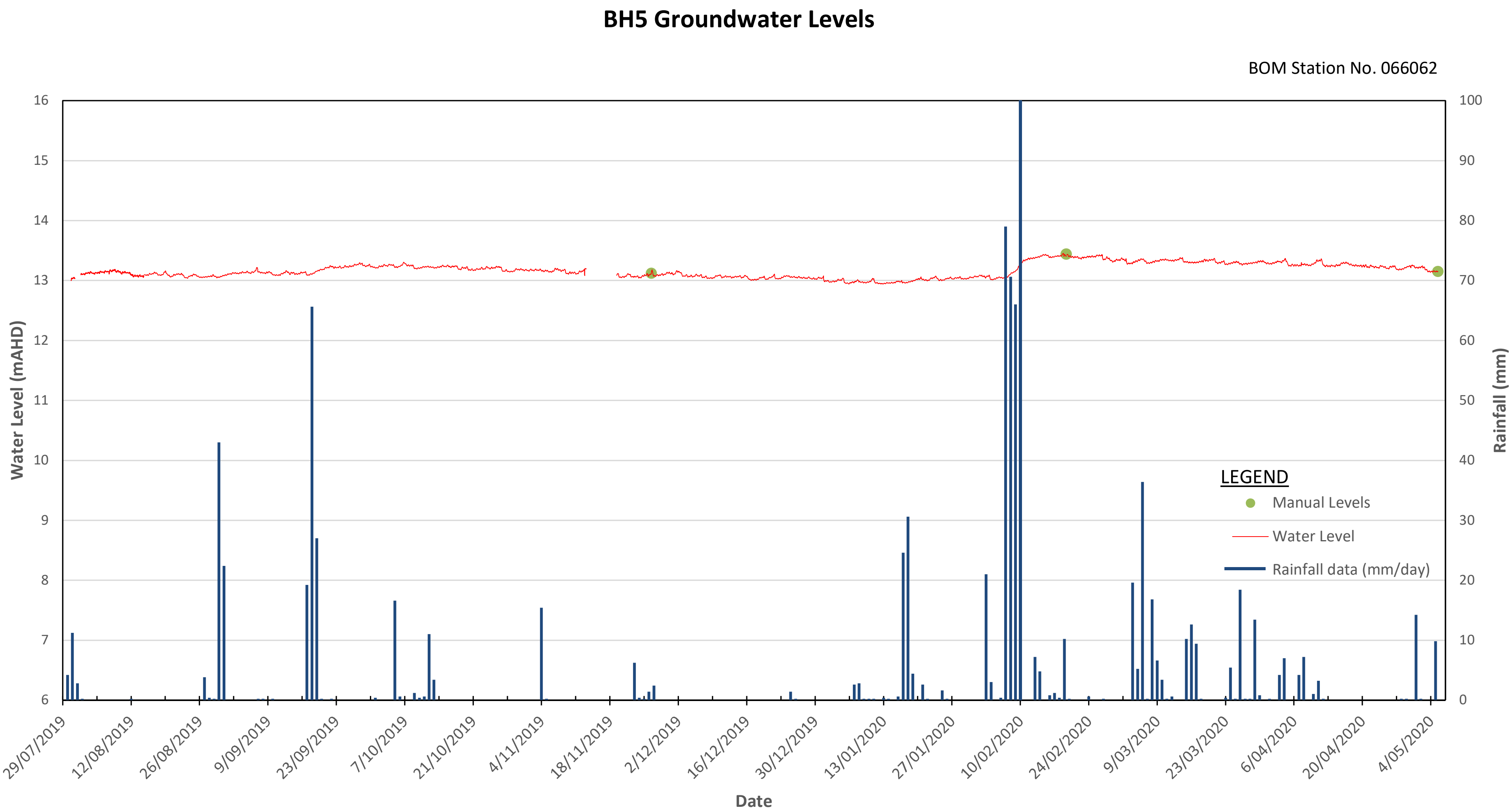
- Geotechnical & environmental borehole - Lower Ground Floor (DP Report 86767.00.R.001.Rev0, dated 26 August 2019)
- Geotechnical & environmental borehole (DP Report 86767.00.R001.Rev0, dated 26 August 2019)
- Inferred groundwater contour (RL(m))
- Direction of flow
- 13.2m Water elevation
- RL13.6m Contour elevation
- Approximate site boundary

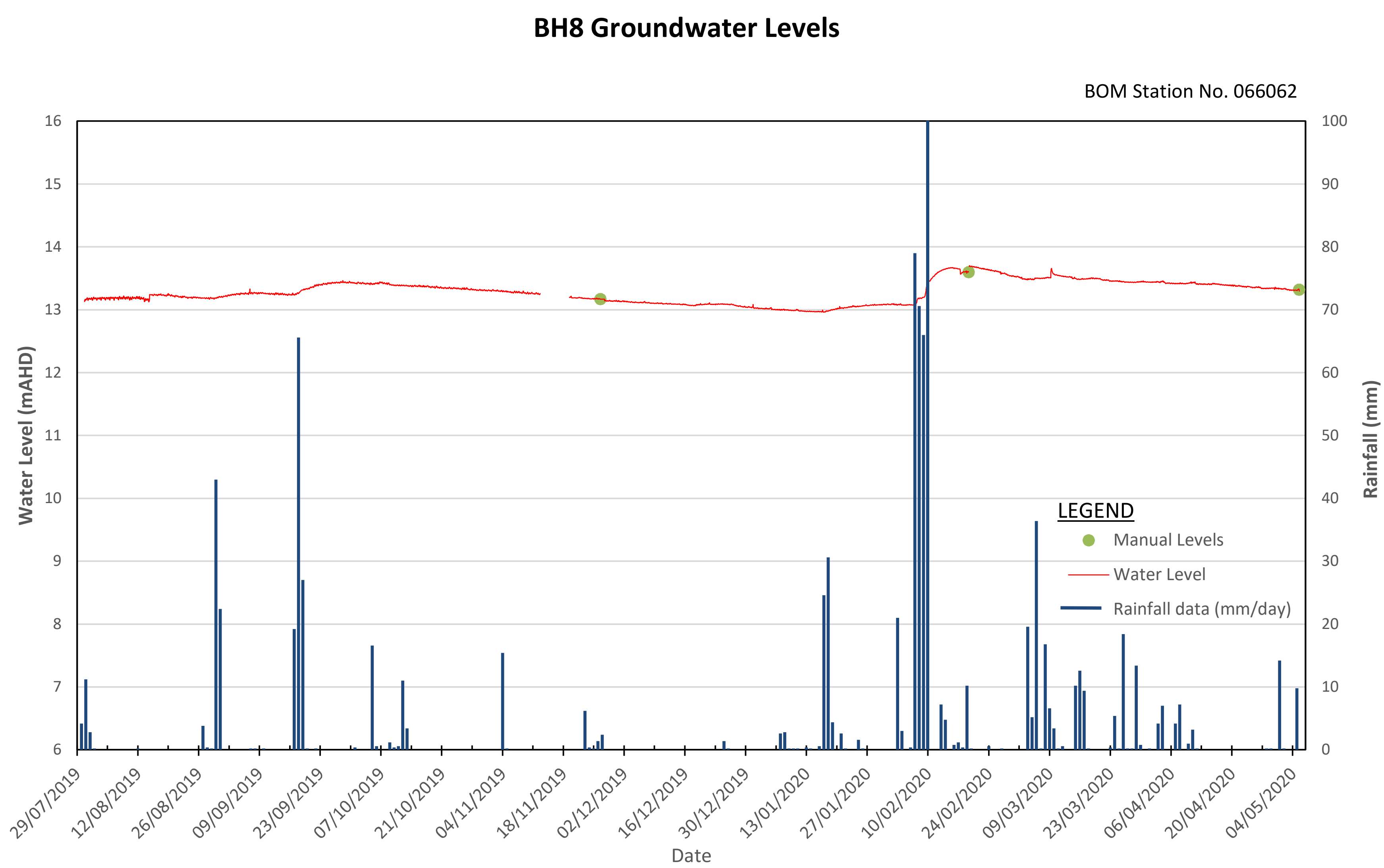
**Douglas Partners**
*Geotechnics | Environment | Groundwater*

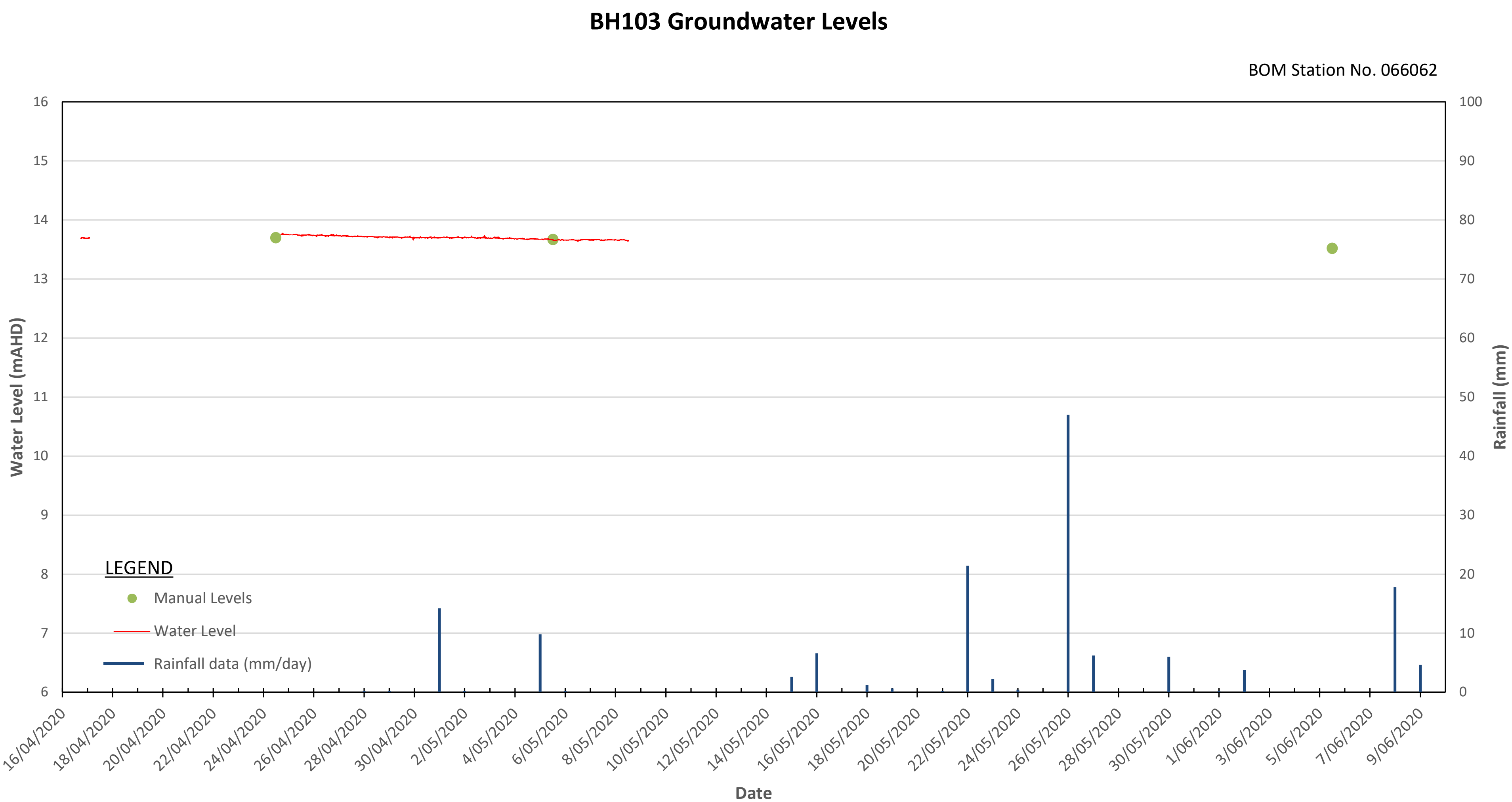
| | | | |
|---|---|---|---|
| CLIENT: Vertical First Pty Ltd | | TITLE: **Groundwater Levels and Flow Direction from Piezometers Screened in Mittagong Formation** **Proposed Commercial Development, 8-10 Lee Street, HAYMARKET** | PROJECT No: 86767.06 |
| OFFICE: Sydney | DRAWN BY: BZ | | DRAWING No: 4 |
| SCALE: 1:500 @ A3 | DATE: 21.09.2020 | | REVISION: 0 |

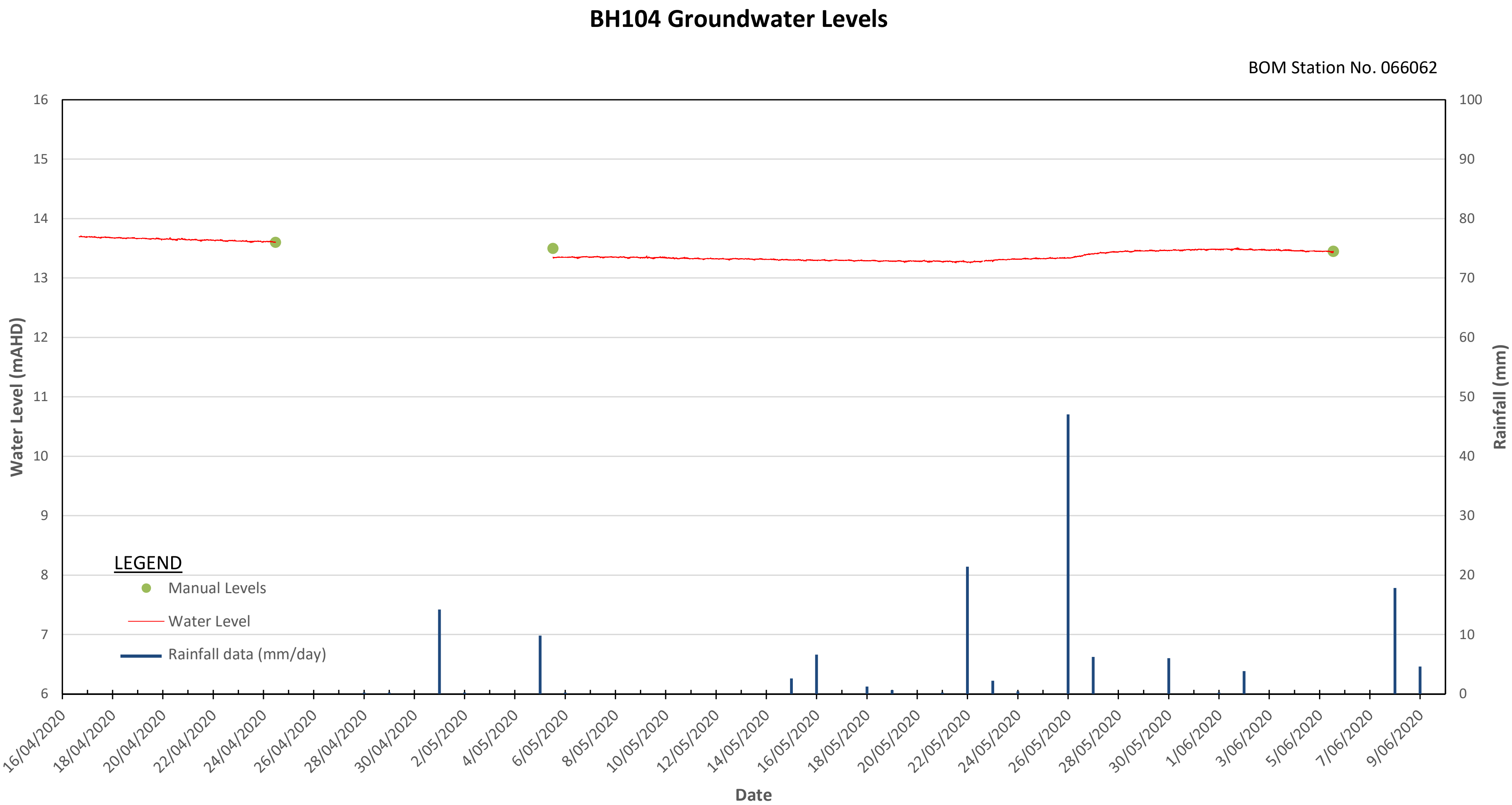


BH1 Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
29/07/2019
12/08/2019
26/08/2019
9/09/2019
23/09/2019
7/10/2019
21/10/2019
4/11/2019
18/11/2019
2/12/2019
16/12/2019
30/12/2019
13/01/2020
27/01/2020
10/02/2020
24/02/2020
9/03/2020
23/03/2020
6/04/2020
20/04/2020
4/05/2020
18/05/2020
1/06/2020
Date

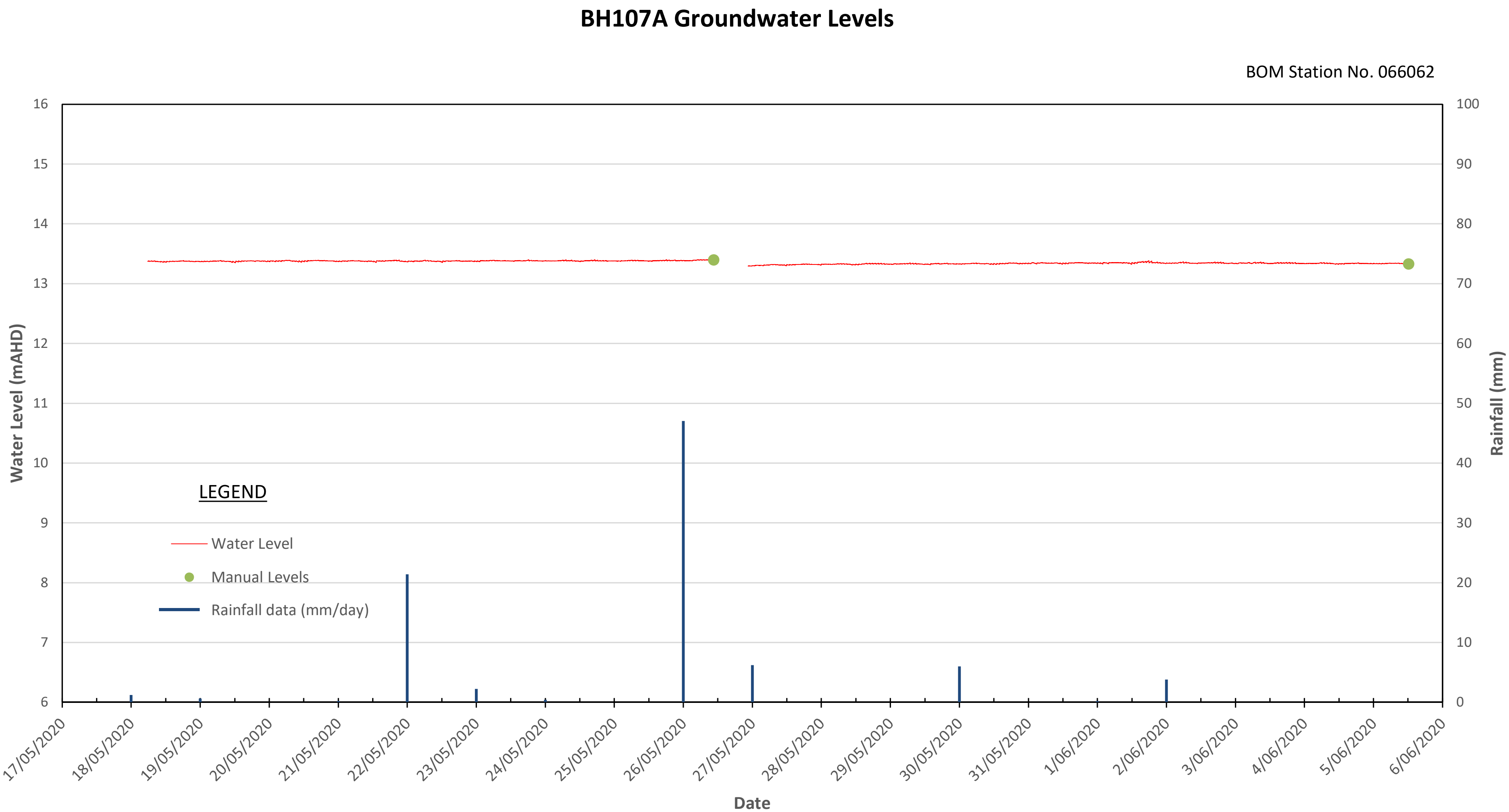

BH5 Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
Date
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
29/07/2019
12/08/2019
26/08/2019
9/09/2019
23/09/2019
7/10/2019
21/10/2019
4/11/2019
18/11/2019
2/12/2019
16/12/2019
30/12/2019
13/01/2020
27/01/2020
10/02/2020
24/02/2020
9/03/2020
23/03/2020
6/04/2020
20/04/2020
4/05/2020
LEGEND
Manual Levels
Water Level
Rainfall data (mm/day)

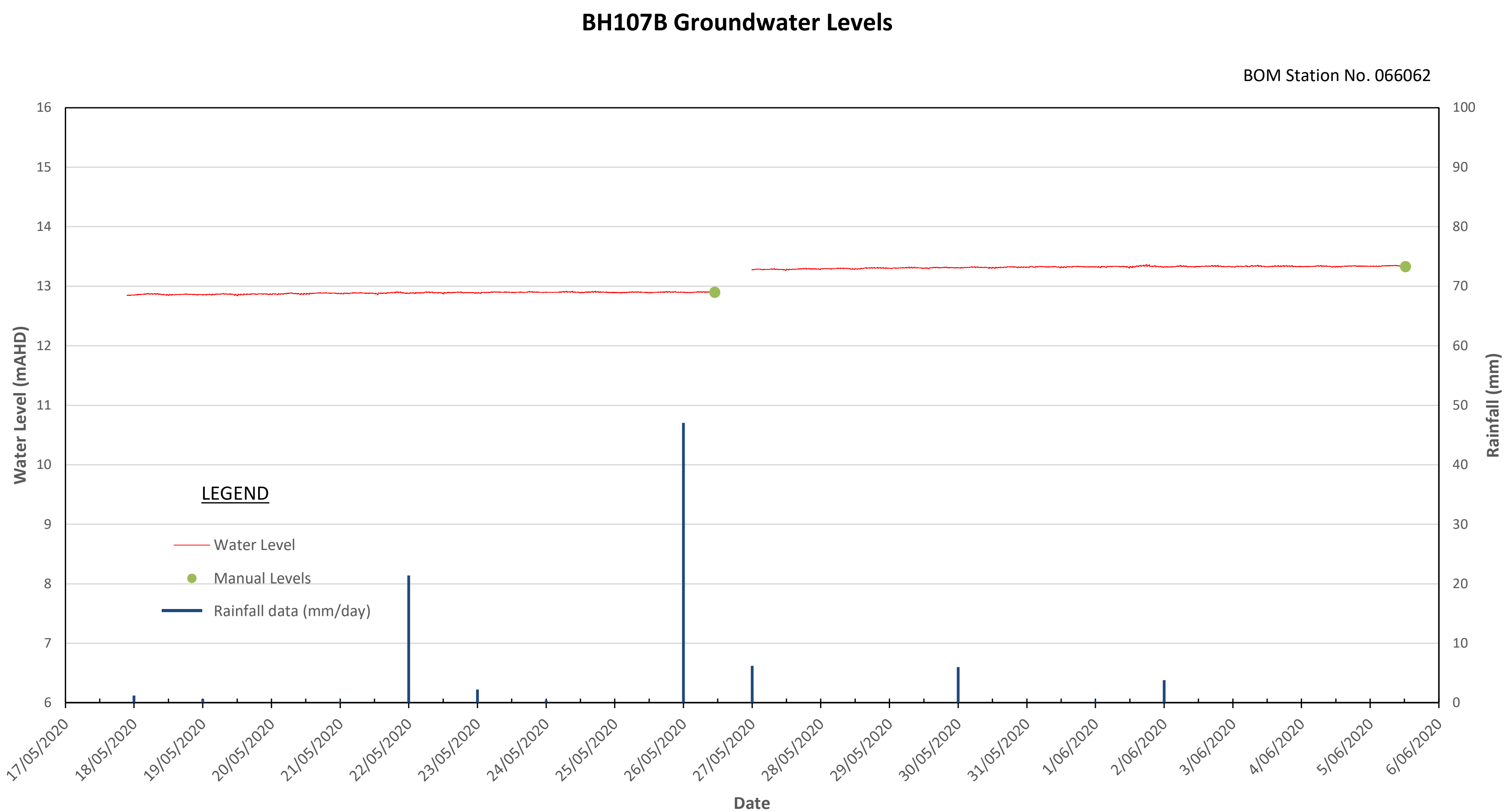

BH8 Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
Date
LEGEND
Manual Levels
Water Level
Rainfall data (mm/day)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
29/07/2019
12/08/2019
26/08/2019
09/09/2019
23/09/2019
07/10/2019
21/10/2019
04/11/2019
18/11/2019
02/12/2019
16/12/2019
30/12/2019
13/01/2020
27/01/2020
10/02/2020
24/02/2020
09/03/2020
23/03/2020
06/04/2020
20/04/2020
04/05/2020


BH103 Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
LEGEND
Manual Levels
Water Level
Rainfall data (mm/day)
16/04/2020
18/04/2020
20/04/2020
22/04/2020
24/04/2020
26/04/2020
28/04/2020
30/04/2020
2/05/2020
4/05/2020
6/05/2020
8/05/2020
10/05/2020
12/05/2020
14/05/2020
16/05/2020
18/05/2020
20/05/2020
22/05/2020
24/05/2020
26/05/2020
28/05/2020
30/05/2020
1/06/2020
3/06/2020
5/06/2020
7/06/2020
9/06/2020
Date

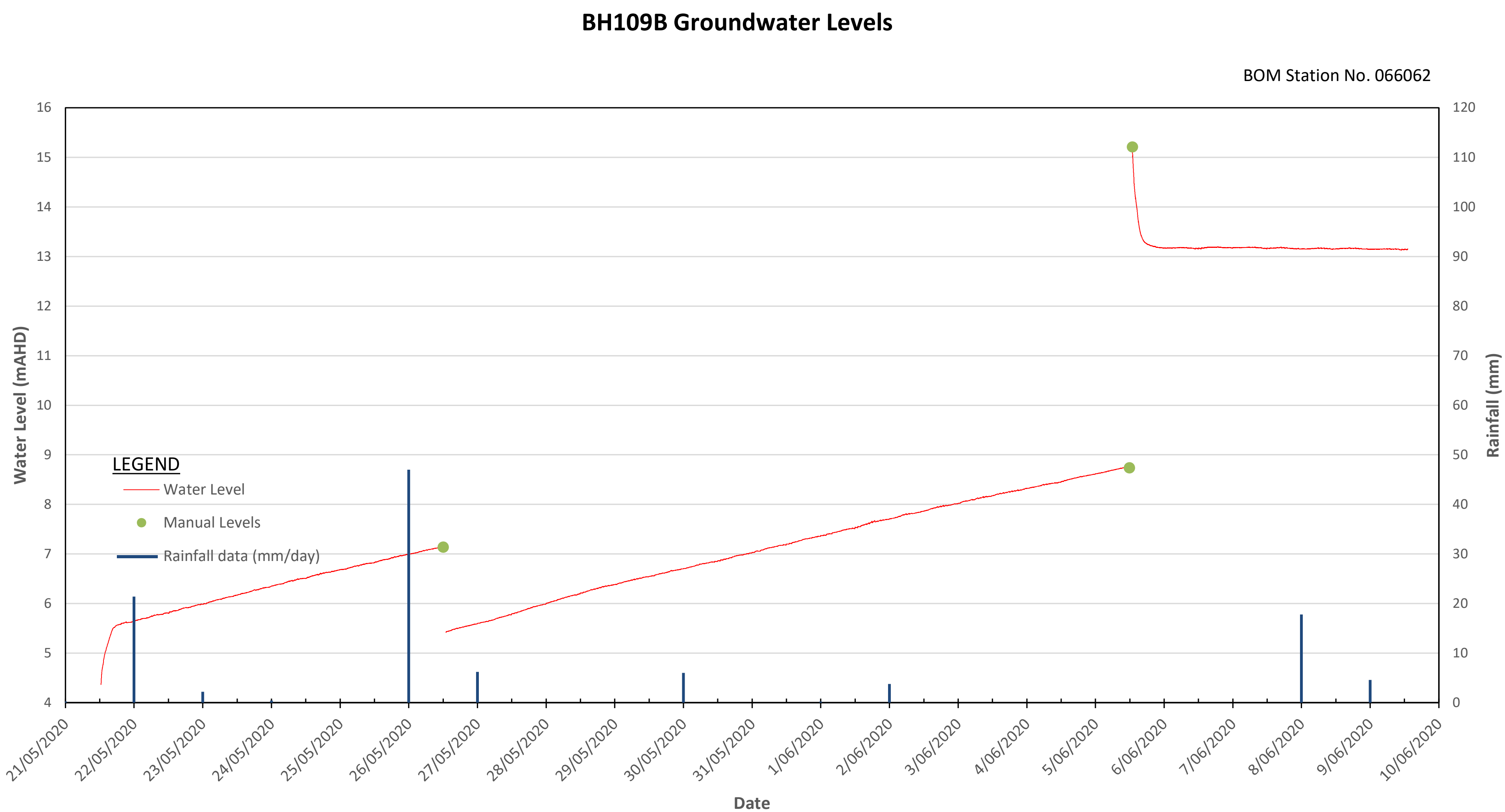


BH104 Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
Date
LEGEND
Manual Levels
Water Level
Rainfall data (mm/day)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
16/04/2020
18/04/2020
20/04/2020
22/04/2020
24/04/2020
26/04/2020
28/04/2020
30/04/2020
2/05/2020
4/05/2020
6/05/2020
8/05/2020
10/05/2020
12/05/2020
14/05/2020
16/05/2020
18/05/2020
20/05/2020
22/05/2020
24/05/2020
26/05/2020
28/05/2020
30/05/2020
1/06/2020
3/06/2020
5/06/2020
7/06/2020
9/06/2020

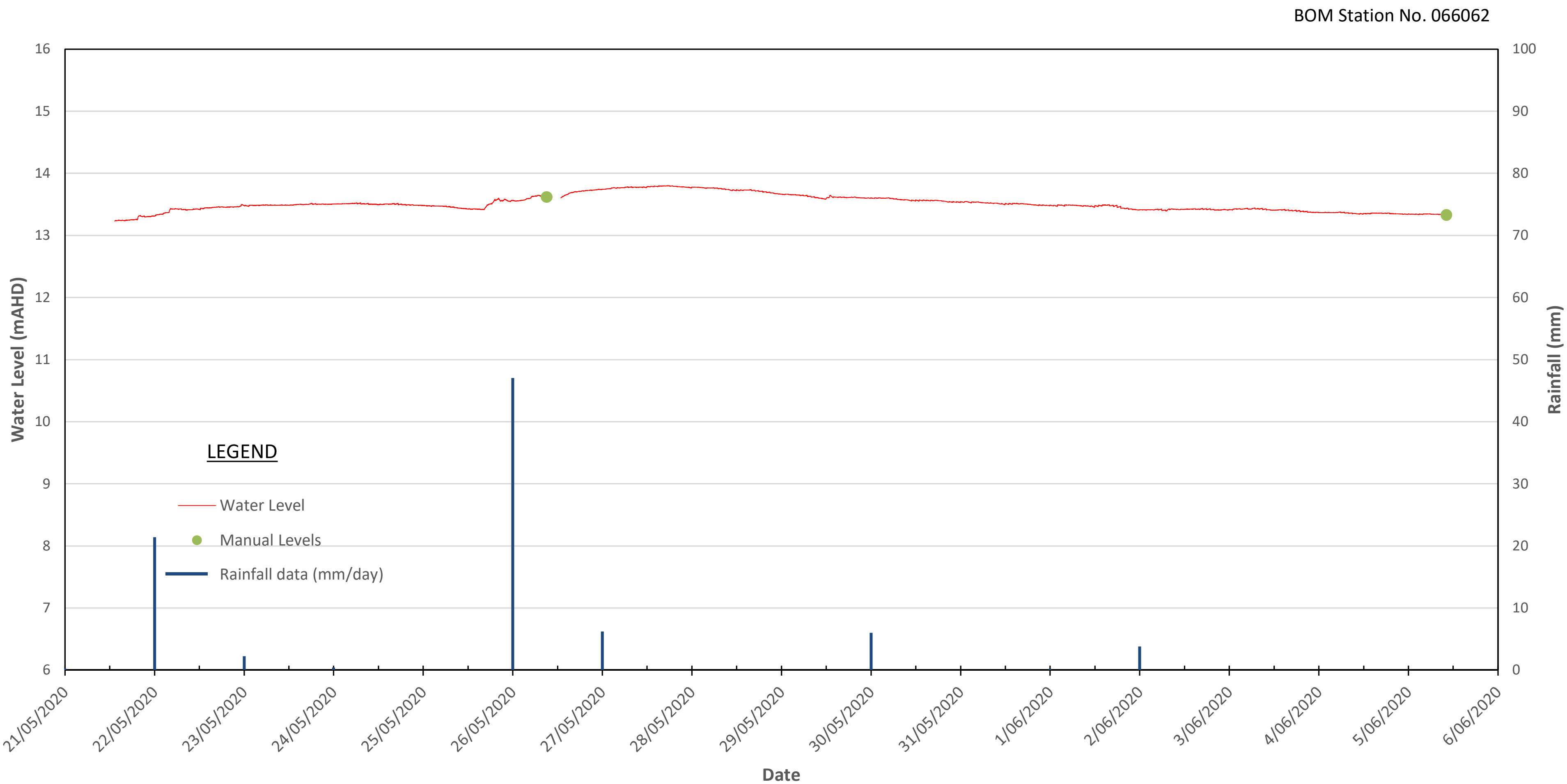

BH107A Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
Date
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
17/05/2020
18/05/2020
19/05/2020
20/05/2020
21/05/2020
22/05/2020
23/05/2020
24/05/2020
25/05/2020
26/05/2020
27/05/2020
28/05/2020
29/05/2020
30/05/2020
31/05/2020
1/06/2020
2/06/2020
3/06/2020
4/06/2020
5/06/2020
6/06/2020

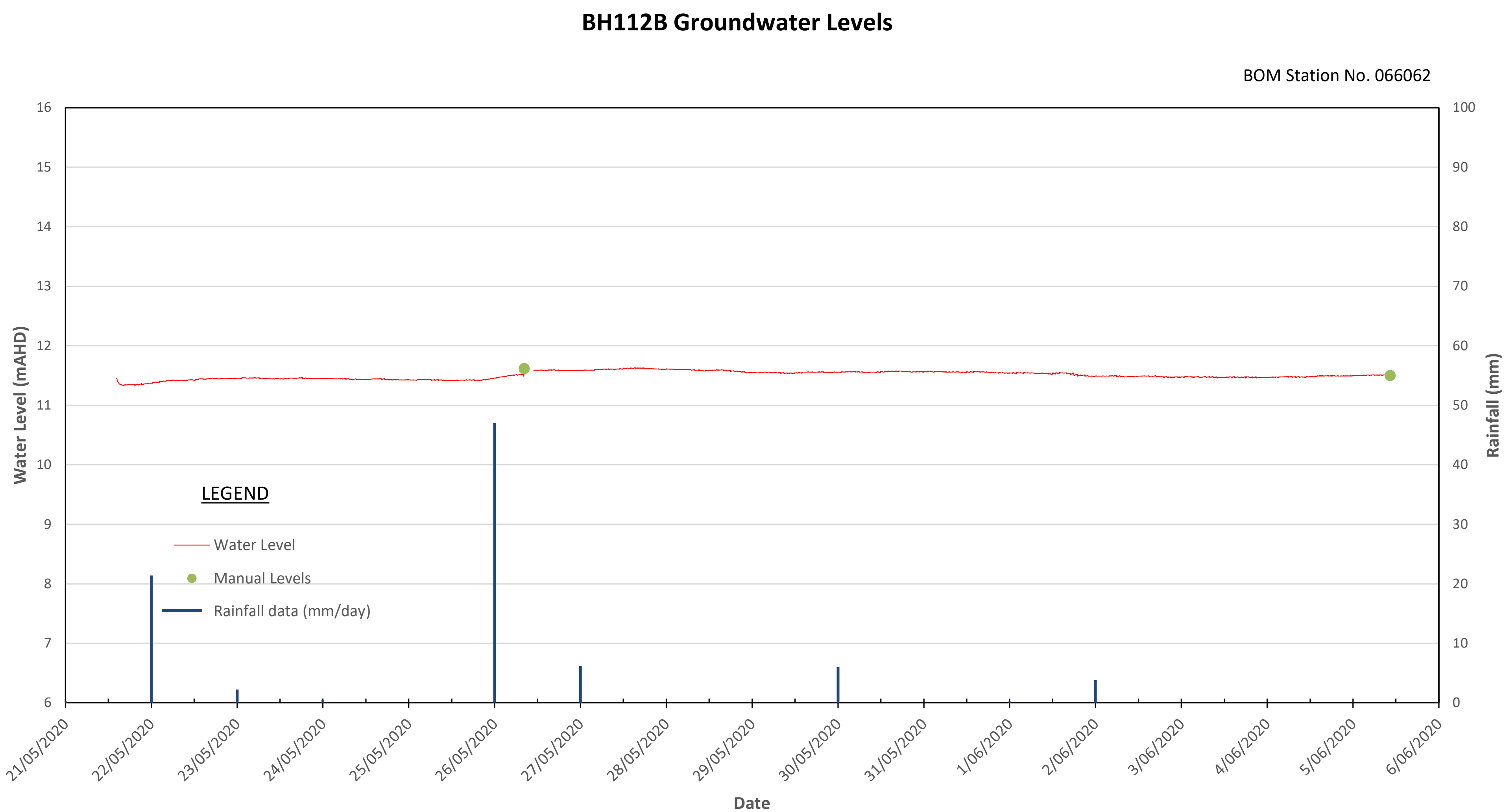


BH107B Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
17/05/2020
18/05/2020
19/05/2020
20/05/2020
21/05/2020
22/05/2020
23/05/2020
24/05/2020
25/05/2020
26/05/2020
27/05/2020
28/05/2020
29/05/2020
30/05/2020
31/05/2020
1/06/2020
2/06/2020
3/06/2020
4/06/2020
5/06/2020
6/06/2020
Date


BH109B Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
Date
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
16
15
14
13
12
11
10
9
8
7
6
5
4
120
110
100
90
80
70
60
50
40
30
20
10
0
21/05/2020
22/05/2020
23/05/2020
24/05/2020
25/05/2020
26/05/2020
27/05/2020
28/05/2020
29/05/2020
30/05/2020
31/05/2020
1/06/2020
2/06/2020
3/06/2020
4/06/2020
5/06/2020
6/06/2020
7/06/2020
8/06/2020
9/06/2020
10/06/2020

# BH112A Groundwater Levels





BH112B Groundwater Levels
BOM Station No. 066062
Water Level (mAHD)
Rainfall (mm)
16
15
14
13
12
11
10
9
8
7
6
100
90
80
70
60
50
40
30
20
10
0
LEGEND
Water Level
Manual Levels
Rainfall data (mm/day)
21/05/2020
22/05/2020
23/05/2020
24/05/2020
25/05/2020
26/05/2020
27/05/2020
28/05/2020
29/05/2020
30/05/2020
31/05/2020
1/06/2020
2/06/2020
3/06/2020
4/06/2020
5/06/2020
6/06/2020
Date

# Appendix D

Results of In-situ Permeability Testing

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Atlassian Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commerical Development | Test date: | 31-Jul-19 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | JJH |

**Test Location**

| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | **Test No.** | BH1 | |
| Material type: | FILL/sandy CLAY, then SAND | Easting: | 333983.4 | m |
| | | Northing | 6249262.5 | m |
| | | Surface Level: | 20.1 | m AHD |

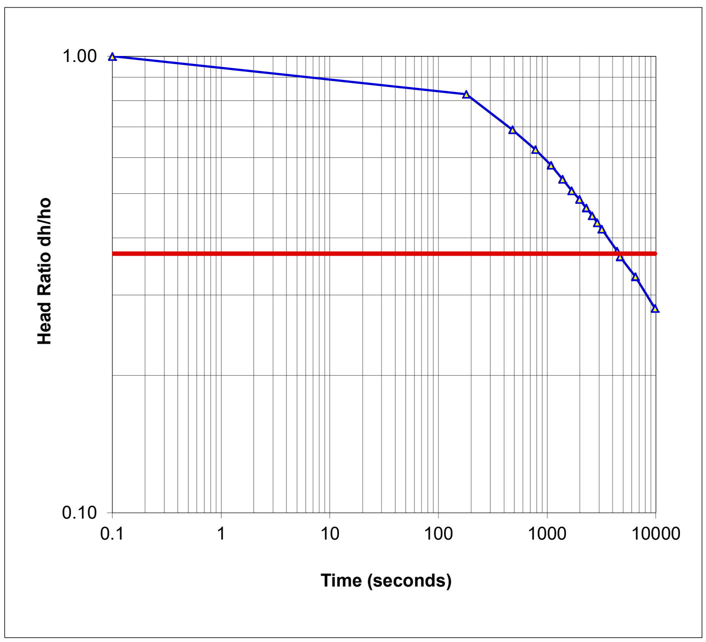
**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 114.3 | mm | Depth to water before test | 5.95 | m |
| Well screen diameter (2R) | 114.3 | mm | Depth to water at start of test | 0.00 | m |
| Length of well screen (Le) | 2 | m | | | |

PVC screen 6.3m-4.3m, sand 6.3-4.2m; blank from 4.3m onwards, bentonite from 4.2m onwards

**Test Results**

| Time (sec) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0.1 | 0 | 5.95 | 1.000 |
| 180.0 | 1.03 | 4.92 | 0.827 |
| 480.0 | 1.84 | 4.11 | 0.691 |
| 780.0 | 2.23 | 3.72 | 0.625 |
| 1080.0 | 2.51 | 3.44 | 0.578 |
| 1380.0 | 2.74 | 3.21 | 0.539 |
| 1680.0 | 2.93 | 3.02 | 0.508 |
| 1980.0 | 3.05 | 2.90 | 0.487 |
| 2280.0 | 3.18 | 2.77 | 0.466 |
| 2580.0 | 3.28 | 2.67 | 0.448 |
| 2880.0 | 3.38 | 2.57 | 0.432 |
| 3180.0 | 3.46 | 2.49 | 0.418 |
| 4380.0 | 3.72 | 2.23 | 0.374 |
| 4680.0 | 3.78 | 2.17 | 0.364 |
| 6480.0 | 3.99 | 1.96 | 0.329 |
| 9780.0 | 4.28 | 1.67 | 0.281 |




To = 4500 seconds

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **6.5E-07** | m/sec |
| | **=** | **0.232** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

## Permeability Testing - Falling Head Test Report

Client: Atlassian Pty Ltd
Project: Proposed Commerical Development
Location: 8-10 Lee Street, Haymarket

Project No: 86767.00
Test date: 14-Aug-19
Tested by: KR

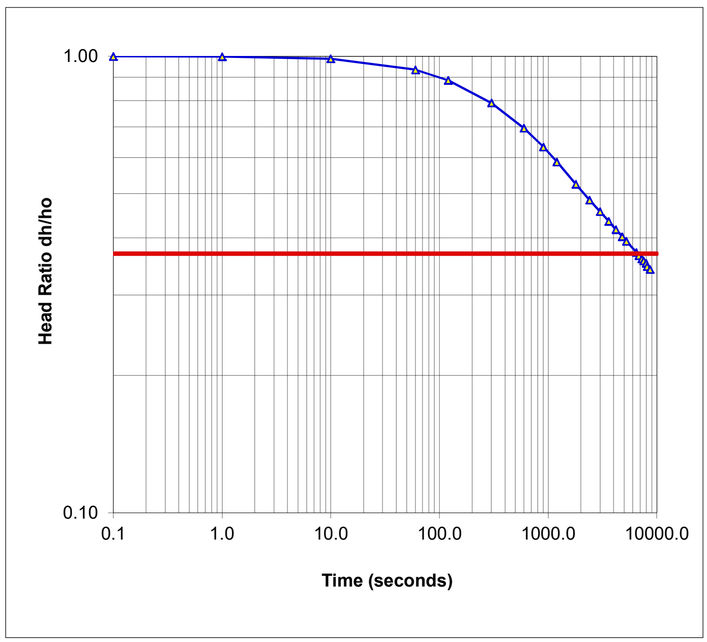
**Test Location**
Description: Standpipe in borehole
Material type: FILL/sandy CLAY, then SAND

**Test No.** BH1
Easting: 333983.4 m
Northing 6249262.5 m
Surface Level: 20.1 m AHD

**Details of Well Installation**
Well casing diameter (2r) 114.3 mm
Well screen diameter (2R) 114.3 mm
Length of well screen (Le) 2 m
Depth to water before test 6.27 m
Depth to water at start of test 0.36 m
PVC screen 6.3m-4.3m, sand 6.3-4.2m; blank from 4.3m onwards, bentonite from 4.2m onwards

**Test Results**

| Time (sec) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0.1 | 0.36 | 5.91 | 1.000 |
| 1.0 | 0.36 | 5.91 | 0.999 |
| 10.0 | 0.43 | 5.84 | 0.988 |
| 60.0 | 0.74 | 5.53 | 0.935 |
| 120.0 | 1.03 | 5.24 | 0.886 |
| 300.0 | 1.59 | 4.68 | 0.791 |
| 600.0 | 2.15 | 4.12 | 0.697 |
| 900.0 | 2.52 | 3.75 | 0.633 |
| 1200.0 | 2.80 | 3.47 | 0.587 |
| 1800.0 | 3.17 | 3.10 | 0.525 |
| 2400.0 | 3.41 | 2.86 | 0.484 |
| 3000.0 | 3.57 | 2.70 | 0.457 |
| 3600.0 | 3.70 | 2.57 | 0.435 |
| 4200.0 | 3.80 | 2.47 | 0.417 |
| 4793.0 | 3.89 | 2.38 | 0.403 |
| 5250.0 | 3.94 | 2.33 | 0.394 |
| 6450.0 | 4.07 | 2.20 | 0.372 |
| 6810.0 | 4.11 | 2.17 | 0.366 |
| 7230.0 | 4.14 | 2.13 | 0.360 |
| 7530.0 | 4.16 | 2.11 | 0.357 |
| 7950.0 | 4.19 | 2.09 | 0.353 |
| 8130.0 | 4.22 | 2.05 | 0.347 |
| 8670.0 | 4.25 | 2.02 | 0.342 |




To = 6500 seconds

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

**Hydraulic Conductivity** **k = 4.5E-07** m/sec
**= 0.161** cm/hour

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
[illegible]
[illegible]

## Permeability Testing (Rising or Falling Head) Test Report

| | | | |
|---|---|---|---|
| Client: | Atlassian Pty Ltd | Project No: | [illegible] |
| Project: | Proposed Commercial Development | Test date: | [illegible] |
| Location: | [illegible] Lee Street, Haymarket | Tested by: | [illegible] |

**Test Location**

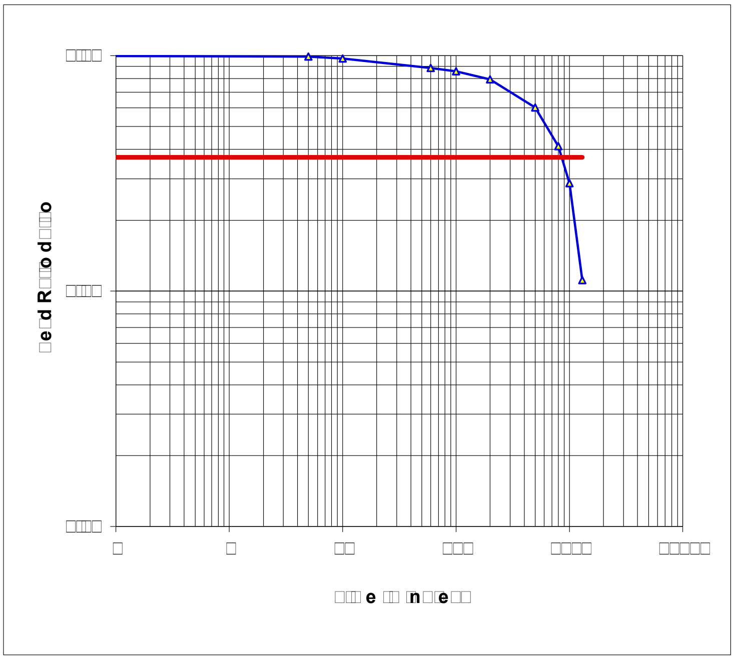
| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | Test No. | [illegible] | |
| Material type: | Sandstone | Easting: | [illegible] | m |
| | | Northing: | [illegible] | m |
| | | Surface Level: | [illegible] | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (r): | [illegible] | [illegible] | Depth to water before test | [illegible] | m |
| Well screen diameter (R): | [illegible] | [illegible] | Depth to water at start of test | [illegible] | m |
| Length of well screen (Le): | [illegible] | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in head (dh) (m) | dh/h0 |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |



T[illegible] = [illegible] mins
[illegible] secs

**Theory:** Falling head permeability calculated using equation from Hvorslev

$k = r^2 \ln(Le/R) / (2\,Le\,T)$ [illegible]

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

**Hydraulic Conductivity** k = [illegible] m/sec
k = [illegible] cm/hour

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
[illegible]
[illegible]

## Permeability Testing Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Atlassian Pty Ltd | Project No: | [illegible] |
| Project: | Proposed Commercial Development | Test date: | [illegible] |
| Location: | [illegible] Lee Street, Haymarket | Tested by: | [illegible] |

**Test Location**

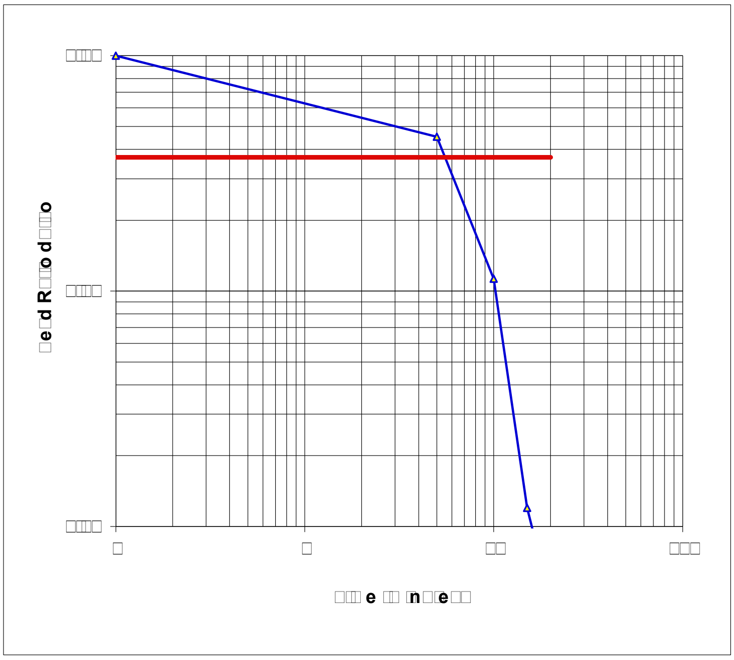
| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | Test No. | [illegible] | |
| Material type: | Sandstone | Easting: | [illegible] | [illegible] |
| | | Northing: | [illegible] | [illegible] |
| | | Surface Level: | [illegible] | [illegible] AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (r): | [illegible] | [illegible] | Depth to water before test | [illegible] | [illegible] |
| Well screen diameter (R): | [illegible] | [illegible] | Depth to water at start of test | [illegible] | [illegible] |
| Length of well screen (Le): | [illegible] | [illegible] | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head (dh) (m) | dh/ho |
|---|---|---|---|
| | | | |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |




T0 = [illegible] mins
[illegible] secs

**Theory:** Falling head permeability calculated using equation by Hvorslev:

$[illegible] r^2 ln(Le/R) / 2 Le T_0$ — where r = radius of casing
R = radius of well screen
Le = length of well screen
$T_0$ = time taken to rise or fall to [illegible] of initial change

**Hydraulic Conductivity** [illegible] = [illegible] m/sec
[illegible] = [illegible] cm/hour

**Douglas Partners**
Geotechnics / Environment / Groundwater

D□□□las □art□ers □t□Ltd
□□□ □□ □□□ □□□ □□□
□□□□d□□□las□art□ers□c□□ □a□

# □er□ e□□□□□ □e□□□n□ □R□□n□ or □□□□n□ □e□d □e□□Re□or□

| | | | |
|---|---|---|---|
| Clie□t□ | □tlassia□ □t□Ltd | □r□ect □□□ | □□□□□□□□ |
| □r□ect□ | □r□□□sed C□□ □ercial De□el□□□ e□t | Test date□ | □□□□□r□□□ |
| L□cati□□□ | □□□□ Lee Street□□a□□ ar□et | Tested □□□ | □□ |

**□e□□□oc□□on**

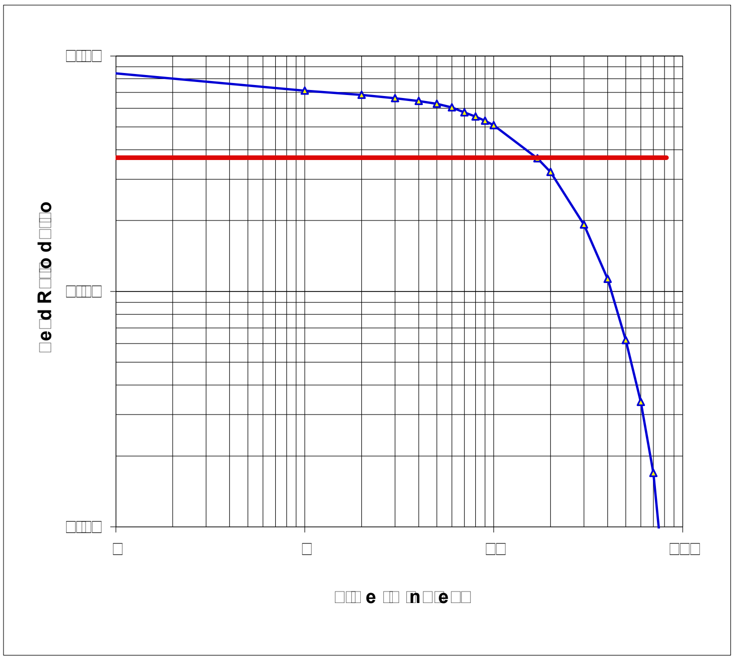
| | | | | |
|---|---|---|---|---|
| Descri□ti□□□ | Sta□d□i□e i□ □□re□□le | □asti□□□ | □□□□□□ | □ |
| Material t□□e□ | Sa□dst□□e | □□rt□i□□ | □□□□□□□ | □ |
| | | S□r□ace Le□el□ | □□□ | □ □□D |

**De□□□□ o□□ e□□n□□□□□□on**

| | | | | | |
|---|---|---|---|---|---|
| □ ell casi□□ dia□eter □□r□ | □□ | □ □ | De□t□ t□ □ater □e□□re test | □□□ | □ |
| □ ell scree□ dia□eter □□R□ | □□ | □ □ | De□t□ t□ □ater at start □□test | □□□□ | □ |
| Le□□t□ □□□ell scree□ □Le□ | □□□ | □ | | | |

**□e□□Re□□□□**

| Ti□e □□i□□ | De□t□ □□ □ | C□a□□e i□ □ead□d□ □□ □ | d□ □□ □ |
|---|---|---|---|
| | | | |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□ | □□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□ | □ | □□□□□ |



T□ □ □□ □i□s
□□□□ secs

| | | |
|---|---|---|
| □□eor□: | Falli□□ □ead □er□ea□ilit□calc□lated □si□□ e□□ati□□ □□ □ □□rsle□ | |
| | □ □ □r[□] l□Le□R□□□Le T□ | □□ere r □ radi□s □□casi□□ |
| | | R □ radi□s □□□ell scree□ |
| | | Le □ le□□t□ □□□ell scree□ |
| | | T□ □ ti□e ta□e□ t□ rise □r □all t□ □□□ □□i□itial c□a□□e |

| | | | |
|---|---|---|---|
| □ □dr□□□c Cond□c□□□□ | □ □ | □.□□□□ | □ □sec |
| | □ | □.□□□ | c□ □□□□r |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Rising or Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 24-Apr-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | AS |

**Test Location**

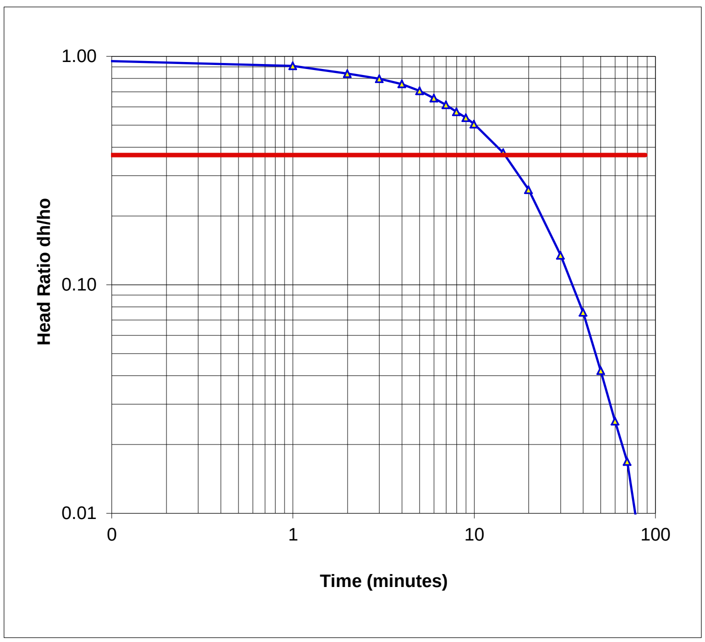
| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | **Test No.** | BH103 | |
| Material type: | Sandstone | Easting: | 333978 | m |
| | | Northing | 6249263 | m |
| | | Surface Level: | 21.2 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 7.44 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 8.63 | m |
| Length of well screen (Le) | 0.8 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: dH (m) | dH/Ho |
|---|---|---|---|
| 0 | 8.63 | 1.19 | 1.000 |
| 1 | 8.52 | 1.08 | 0.908 |
| 2 | 8.44 | 1.00 | 0.840 |
| 3 | 8.39 | 0.95 | 0.798 |
| 4 | 8.34 | 0.90 | 0.756 |
| 5 | 8.28 | 0.84 | 0.706 |
| 6 | 8.22 | 0.78 | 0.655 |
| 7 | 8.17 | 0.73 | 0.613 |
| 8 | 8.12 | 0.68 | 0.571 |
| 9 | 8.08 | 0.64 | 0.538 |
| 10 | 8.04 | 0.60 | 0.504 |
| 14.5 | 7.89 | 0.45 | 0.378 |
| 20 | 7.75 | 0.31 | 0.261 |
| 30 | 7.6 | 0.16 | 0.134 |
| 40 | 7.53 | 0.09 | 0.076 |
| 50 | 7.49 | 0.05 | 0.042 |
| 60 | 7.47 | 0.03 | 0.025 |
| 70 | 7.46 | 0.02 | 0.017 |
| 80 | 7.45 | 0.01 | 0.008 |
| 88 | 7.44 | 0 | 0.000 |




To = 14.5 mins
870 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **1.4E-06** | m/sec |
| | **=** | **0.493** | cm/hour |

D□□□las □art□ers □t□Ltd
□□□ □□ □□□ □□□ □□□
□□□□d□□□las□art□ers□c□□ □a□

# □er□ e□□□□□ □e□□□n□ □R□□n□ or □□□□n□ □e□d □e□□Re□or□

| | | | |
|---|---|---|---|
| Clie□t□ | □tlassia□ □t□Ltd | □r□ect □□□ | □□□□□□□□ |
| □r□ect□ | □r□□□sed C□□ □ercial De□el□□□ e□t | Test date□ | □□□□□r□□□ |
| L□cati□□□ | □□□□ Lee Street□□a□□ar□et | Tested □□□ | □□ |

**□e□□□oc□□□on**

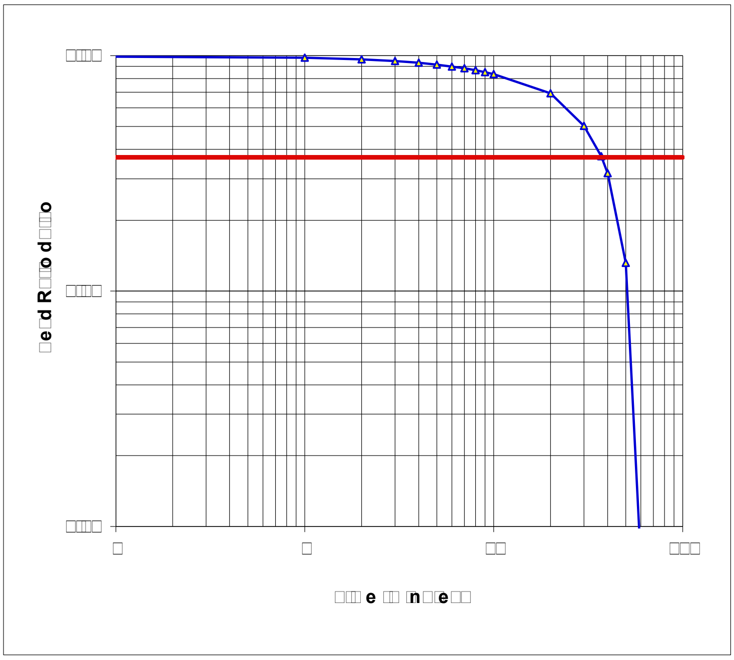
| | | | | |
|---|---|---|---|---|
| Descri□ti□□□ | Sta□d□i□e i□ □□re□□le | **□e□□No.** | □□□□□ | |
| Material t□□e□ | Sa□dst□□e | □asti□□□ | □□□□□□ | □ |
| | | □□rt□i□□ | □□□□□□□ | □ |
| | | S□r□ace Le□el□ | □□□□ | □ □□D |

**De□□□□ o□□ e□□n□□□□□□on**

| | | | | | |
|---|---|---|---|---|---|
| □ ell casi□□ dia□eter □□r□ | □□ | □ □ | De□t□ t□ □ater □e□□re test | □□□ | □ |
| □ ell scree□ dia□eter □□R□ | □□ | □ □ | De□t□ t□ □ater at start □□test | □□□□ | □ |
| Le□□t□ □□□ell scree□ □Le□ | □ | □ | | | |

**□e□□Re□□□□**

| Ti□e □□i□□ | De□t□ □□ □ | C□a□□e i□ □ead□d□ □□ □ | d□ □□ □ |
|---|---|---|---|
| | | | |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□□ | □□□□□ |
| □ | □□□□□ | □□□□ | □□□□□ |
| □ | □□□□ | □□□□ | □□□□□ |
| □ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□ | □□□□ | □□□□ | □□□□□ |
| □□□ | □□□□ | □□□□ | □□□□□ |



T□ □ □□ □i□s
□□□□ secs

**□□eor□:** Falli□□ □ead □er□ea□ilit□calc□lated □si□□ e□□ati□□ □□ □ □□rsle□

□ □ □r[□] l□□Le□R□□□Le T□

□□ere r □ radi□s □□casi□□
R □ radi□s □□□ell scree□
Le □ le□□t□ □□□ell scree□
T□ □ ti□e ta□e□ t□ rise □r □all t□ □□□ □□i□itial c□a□□e

| | | | |
|---|---|---|---|
| **□□dr□□□c Cond□c□□□□** | □ □ | □.□□□□□ | □ □sec |
| | □ | □.□□□□ | c□ □□□□r |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

## Permeability Testing - Rising Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 22-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

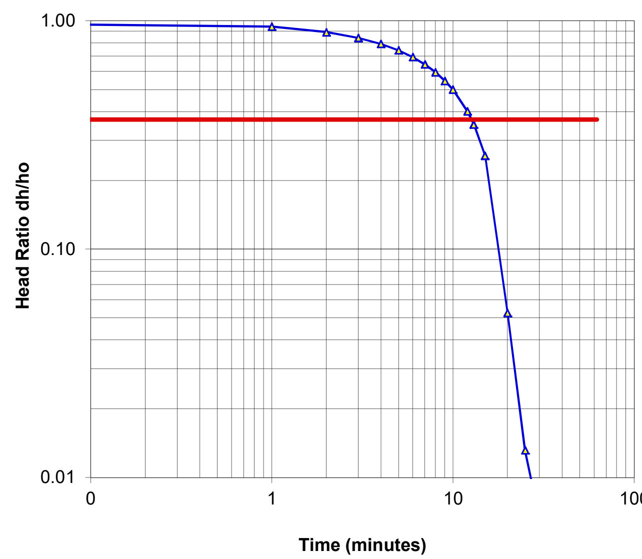
| | | | | |
|---|---|---|---|---|
| **Test Location** | | **Test No.** | BH104 | |
| Description: | Standpipe in borehole | Easting: | 333983 | m |
| Material type: | Sandstone | Northing | 6249272 | m |
| | | Surface Level: | 21.2 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 7.91 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 10.95 | m |
| Length of well screen (Le) | 6 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 10.95 | 3.04 | 1.000 |
| 1 | 10.78 | 2.87 | 0.944 |
| 2 | 10.62 | 2.71 | 0.891 |
| 3 | 10.47 | 2.56 | 0.842 |
| 4 | 10.32 | 2.41 | 0.793 |
| 5 | 10.17 | 2.26 | 0.743 |
| 6 | 10.02 | 2.11 | 0.694 |
| 7 | 9.87 | 1.96 | 0.645 |
| 8 | 9.72 | 1.81 | 0.595 |
| 9 | 9.57 | 1.66 | 0.546 |
| 10 | 9.43 | 1.52 | 0.500 |
| 12 | 9.13 | 1.22 | 0.401 |
| 13 | 8.98 | 1.07 | 0.352 |
| 15 | 8.69 | 0.78 | 0.257 |
| 20 | 8.07 | 0.16 | 0.053 |
| 25 | 7.95 | 0.04 | 0.013 |
| 30 | 7.93 | 0.02 | 0.007 |
| 35 | 7.92 | 0.01 | 0.003 |
| 62 | 7.91 | 0 | 0.000 |




To = 12.5 mins
750 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **3.5E-07** | m/sec |
| | **=** | **0.127** | cm/hour |

# Permeability Testing - Rising or Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 17-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

**Test Location**

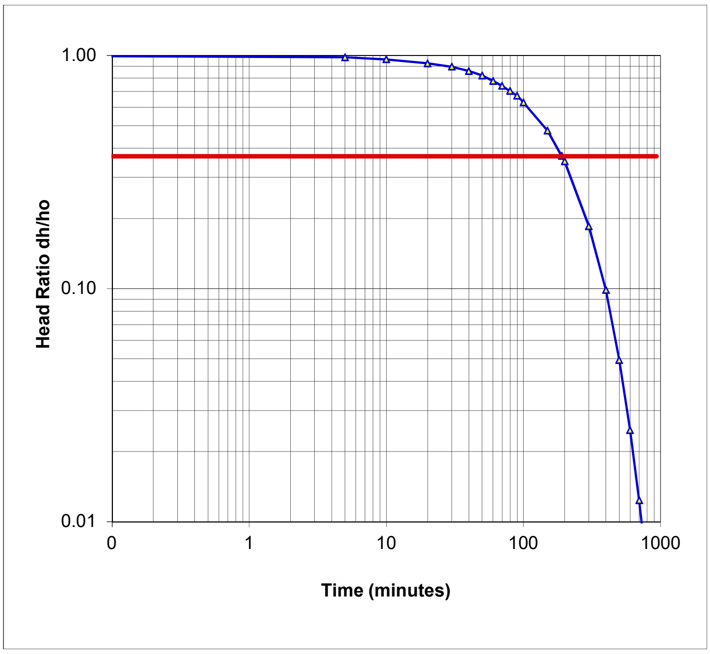
| | | | | |
|---|---|---|---|---|
| | | **Test No.** | BH107A | |
| Description: | Standpipe in borehole | Easting: | 333945 | m |
| Material type: | Sandstone | Northing | 6249270 | m |
| | | Surface Level: | 15.5 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 2.13 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 3.75 | m |
| Length of well screen (Le) | 0.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 3.75 | 1.62 | 1.000 |
| 5 | 3.72 | 1.59 | 0.981 |
| 10 | 3.69 | 1.56 | 0.963 |
| 20 | 3.63 | 1.50 | 0.926 |
| 30 | 3.58 | 1.45 | 0.895 |
| 40 | 3.52 | 1.39 | 0.858 |
| 50 | 3.46 | 1.33 | 0.821 |
| 60 | 3.39 | 1.26 | 0.778 |
| 70 | 3.33 | 1.20 | 0.741 |
| 80 | 3.27 | 1.14 | 0.704 |
| 90 | 3.22 | 1.09 | 0.673 |
| 100 | 3.15 | 1.02 | 0.630 |
| 150 | 2.9 | 0.77 | 0.475 |
| 190.5 | 2.73 | 0.6 | 0.370 |
| 200 | 2.7 | 0.57 | 0.352 |
| 300 | 2.43 | 0.3 | 0.185 |
| 400 | 2.29 | 0.16 | 0.099 |
| 500 | 2.21 | 0.08 | 0.049 |
| 600 | 2.17 | 0.04 | 0.025 |
| 700 | 2.15 | 0.02 | 0.012 |
| 800 | 2.14 | 0.01 | 0.006 |
| 936 | 2.13 | 0 | 0.000 |




To = 190.5 mins
11430 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **1.4E-07** | m/sec |
| | **=** | **0.051** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Rising Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 26-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | AS |

**Test Location**

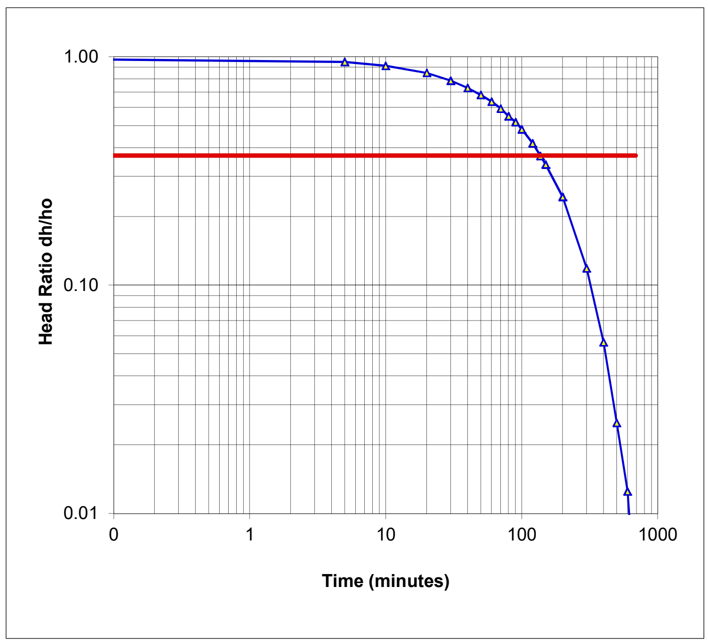
| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | **Test No.** | BH107A | |
| Material type: | Sandstone | Easting: | 333945 | m |
| | | Northing | 6249270 | m |
| | | Surface Level: | 15.5 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 2.2 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 3.8 | m |
| Length of well screen (Le) | 0.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 3.8 | 1.60 | 1.000 |
| 5 | 3.72 | 1.52 | 0.950 |
| 10 | 3.66 | 1.46 | 0.913 |
| 20 | 3.56 | 1.36 | 0.850 |
| 30 | 3.46 | 1.26 | 0.788 |
| 40 | 3.37 | 1.17 | 0.731 |
| 50 | 3.29 | 1.09 | 0.681 |
| 60 | 3.22 | 1.02 | 0.638 |
| 70 | 3.15 | 0.95 | 0.594 |
| 80 | 3.08 | 0.88 | 0.550 |
| 90 | 3.03 | 0.83 | 0.519 |
| 100 | 2.97 | 0.77 | 0.481 |
| 120 | 2.87 | 0.67 | 0.419 |
| 137 | 2.79 | 0.59 | 0.369 |
| 150 | 2.74 | 0.54 | 0.338 |
| 200 | 2.59 | 0.39 | 0.244 |
| 300 | 2.39 | 0.19 | 0.119 |
| 400 | 2.29 | 0.09 | 0.056 |
| 500 | 2.24 | 0.04 | 0.025 |
| 600 | 2.22 | 0.02 | 0.013 |
| 650 | 2.21 | 0.01 | 0.006 |
| 687 | 2.2 | 0 | 0.000 |




To = 137 mins
8220 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **2.0E-07** | m/sec |
| | **=** | **0.071** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Rising or Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 17-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

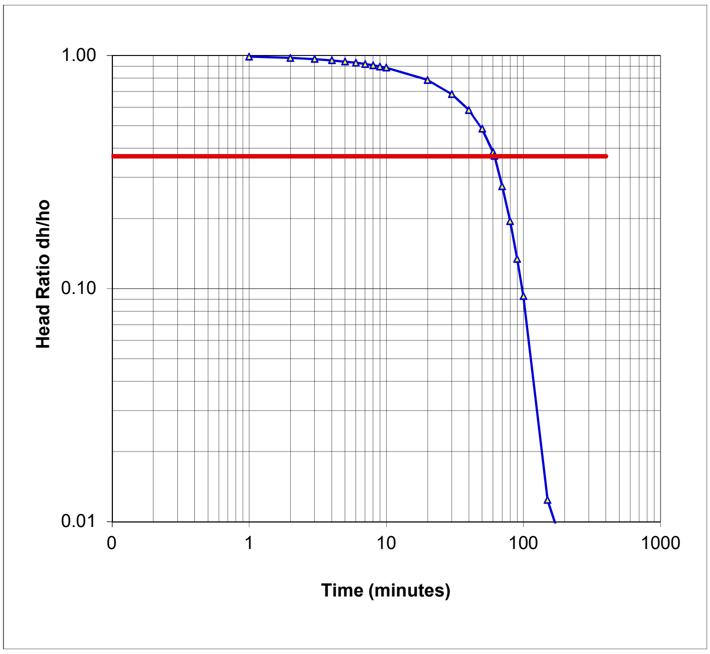
| | | | | |
|---|---|---|---|---|
| **Test Location** | | **Test No.** | BH107B | |
| Description: | Standpipe in borehole | Easting: | 333945 | m |
| Material type: | Sandstone | Northing | 6249272 | m |
| | | Surface Level: | 15.5 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 2.65 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 10.72 | m |
| Length of well screen (Le) | 5.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 10.72 | 8.07 | 1.000 |
| 1 | 10.63 | 7.98 | 0.989 |
| 2 | 10.53 | 7.88 | 0.976 |
| 3 | 10.44 | 7.79 | 0.965 |
| 4 | 10.34 | 7.69 | 0.953 |
| 5 | 10.25 | 7.60 | 0.942 |
| 6 | 10.16 | 7.51 | 0.931 |
| 7 | 10.07 | 7.42 | 0.919 |
| 8 | 9.98 | 7.33 | 0.908 |
| 9 | 9.89 | 7.24 | 0.897 |
| 10 | 9.8 | 7.15 | 0.886 |
| 20 | 8.98 | 6.33 | 0.784 |
| 30 | 8.16 | 5.51 | 0.683 |
| 40 | 7.36 | 4.71 | 0.584 |
| 50 | 6.56 | 3.91 | 0.485 |
| 60 | 5.76 | 3.11 | 0.385 |
| 61.5 | 5.64 | 2.99 | 0.371 |
| 70 | 4.87 | 2.22 | 0.275 |
| 80 | 4.22 | 1.57 | 0.195 |
| 90 | 3.73 | 1.08 | 0.134 |
| 100 | 3.4 | 0.75 | 0.093 |
| 150 | 2.75 | 0.1 | 0.012 |
| 200 | 2.71 | 0.06 | 0.007 |
| 300 | 2.69 | 0.04 | 0.005 |
| 400 | 2.68 | 0.03 | 0.004 |
| 500 | 2.66 | 0.01 | 0.001 |
| 636 | 2.65 | 0 | 0.000 |




To = 61.5 mins
3690 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **7.7E-08** | m/sec |
| | **=** | **0.028** | cm/hour |

## Permeability Testing - Rising Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 26-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | AS |

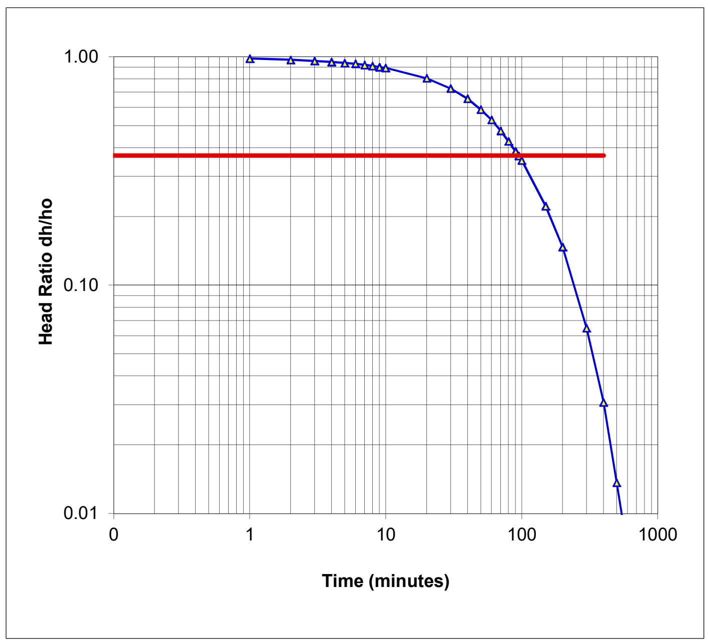
| | | | | |
|---|---|---|---|---|
| **Test Location** | | **Test No.** | BH107B | |
| Description: | Standpipe in borehole | Easting: | 333945 | m |
| Material type: | Sandstone | Northing | 6249272 | m |
| | | Surface Level: | 15.5 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 2.22 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 5.15 | m |
| Length of well screen (Le) | 5.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 5.15 | 2.93 | 1.000 |
| 1 | 5.10 | 2.88 | 0.983 |
| 2 | 5.06 | 2.84 | 0.969 |
| 3 | 5.03 | 2.81 | 0.959 |
| 4 | 5.00 | 2.78 | 0.949 |
| 5 | 4.97 | 2.75 | 0.939 |
| 6 | 4.95 | 2.73 | 0.932 |
| 7 | 4.92 | 2.70 | 0.922 |
| 8 | 4.89 | 2.67 | 0.911 |
| 9 | 4.86 | 2.64 | 0.901 |
| 10 | 4.84 | 2.62 | 0.894 |
| 20 | 4.58 | 2.36 | 0.805 |
| 30 | 4.35 | 2.13 | 0.727 |
| 40 | 4.14 | 1.92 | 0.655 |
| 50 | 3.94 | 1.72 | 0.587 |
| 60 | 3.77 | 1.55 | 0.529 |
| 70 | 3.61 | 1.39 | 0.474 |
| 80 | 3.47 | 1.25 | 0.427 |
| 90 | 3.35 | 1.13 | 0.386 |
| 95 | 3.30 | 1.08 | 0.369 |
| 100 | 3.25 | 1.03 | 0.352 |
| 150 | 2.87 | 0.65 | 0.222 |
| 200 | 2.65 | 0.43 | 0.147 |
| 300 | 2.41 | 0.19 | 0.065 |
| 400 | 2.31 | 0.09 | 0.031 |
| 500 | 2.26 | 0.04 | 0.014 |
| 600 | 2.24 | 0.02 | 0.007 |




To = 95 mins
5700 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **5.0E-08** | m/sec |
| | **=** | **0.018** | cm/hour |

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 5-Jun-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

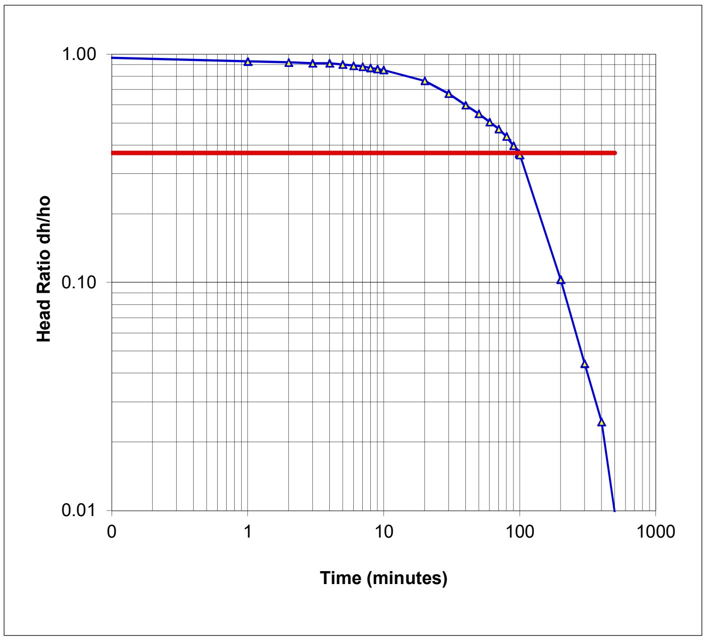
| | | | | |
|---|---|---|---|---|
| **Test Location** | | **Test No.** | BH109B | |
| Description: | Standpipe in borehole | Easting: | 333970 | m |
| Material type: | Sandstone | Northing | 6249311 | m |
| | | Surface Level: | 15.3 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water at end of test | 2.17 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 0.13 | m |
| Length of well screen (Le) | 5.6 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 0.13 | 2.04 | 1.000 |
| 1 | 0.27 | 1.90 | 0.931 |
| 2 | 0.29 | 1.88 | 0.922 |
| 3 | 0.31 | 1.86 | 0.912 |
| 4 | 0.31 | 1.86 | 0.912 |
| 5 | 0.33 | 1.84 | 0.902 |
| 6 | 0.35 | 1.82 | 0.892 |
| 7 | 0.37 | 1.80 | 0.882 |
| 8 | 0.39 | 1.78 | 0.873 |
| 9 | 0.41 | 1.76 | 0.863 |
| 10 | 0.43 | 1.74 | 0.853 |
| 20 | 0.61 | 1.56 | 0.765 |
| 30 | 0.8 | 1.37 | 0.672 |
| 40 | 0.95 | 1.22 | 0.598 |
| 50 | 1.05 | 1.12 | 0.549 |
| 60 | 1.14 | 1.03 | 0.505 |
| 70 | 1.21 | 0.96 | 0.471 |
| 80 | 1.28 | 0.89 | 0.436 |
| 90 | 1.36 | 0.81 | 0.397 |
| 98.5 | 1.42 | 0.75 | 0.368 |
| 100 | 1.43 | 0.74 | 0.363 |
| 200 | 1.96 | 0.21 | 0.103 |
| 300 | 2.08 | 0.09 | 0.044 |
| 400 | 2.12 | 0.05 | 0.025 |
| 500 | 2.15 | 0.02 | 0.010 |
| 600 | 2.17 | 0 | 0.000 |




To = 98.5 mins
5910 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **4.7E-08** | m/sec |
| | **=** | **0.017** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

# Permeability Testing - Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 5-Jun-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

**Test Location**

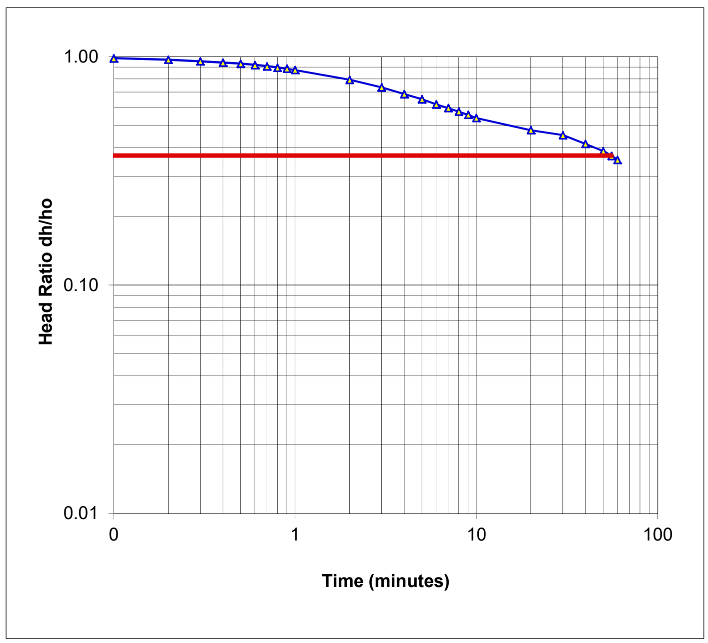
| | | | | |
|---|---|---|---|---|
| | | **Test No.** | BH112A | |
| Description: | Standpipe in borehole | Easting: | 333926 | m |
| Material type: | Sandstone | Northing | 6249325 | m |
| | | Surface Level: | 16.7 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 3.39 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 0.00 | m |
| Length of well screen (Le) | 0.5 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 0.00 | 3.39 | 1.000 |
| 0.10 | 0.05 | 3.34 | 0.985 |
| 0.20 | 0.1 | 3.29 | 0.971 |
| 0.30 | 0.15 | 3.24 | 0.956 |
| 0.40 | 0.19 | 3.20 | 0.944 |
| 0.50 | 0.23 | 3.16 | 0.932 |
| 0.60 | 0.27 | 3.12 | 0.920 |
| 0.70 | 0.31 | 3.08 | 0.909 |
| 0.80 | 0.35 | 3.04 | 0.897 |
| 0.90 | 0.38 | 3.01 | 0.888 |
| 1.00 | 0.42 | 2.97 | 0.876 |
| 2 | 0.7 | 2.69 | 0.794 |
| 3 | 0.9 | 2.49 | 0.735 |
| 4 | 1.06 | 2.33 | 0.687 |
| 5 | 1.18 | 2.21 | 0.652 |
| 6 | 1.29 | 2.1 | 0.619 |
| 7 | 1.37 | 2.02 | 0.596 |
| 8 | 1.44 | 1.95 | 0.575 |
| 9 | 1.5 | 1.89 | 0.558 |
| 10 | 1.56 | 1.83 | 0.540 |
| 20 | 1.77 | 1.62 | 0.478 |
| 30 | 1.85 | 1.54 | 0.454 |
| 40 | 1.98 | 1.41 | 0.416 |
| 50 | 2.08 | 1.31 | 0.386 |
| 55.6 | 2.14 | 1.25 | 0.369 |
| 60 | 2.19 | 1.2 | 0.354 |




To = 55.6 mins
3336 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **4.8E-07** | m/sec |
| | **=** | **0.174** | cm/hour |

# Permeability Testing - Rising or Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 21-May-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

**Test Location**

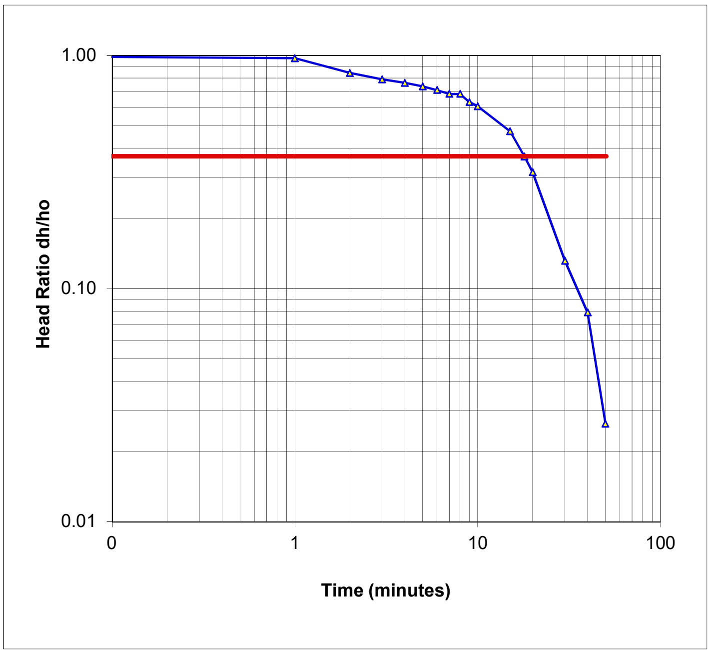
| | | | | |
|---|---|---|---|---|
| Description: | Standpipe in borehole | **Test No.** | BH112B | |
| Material type: | Sandstone | Easting: | 333928 | m |
| | | Northing | 6249324 | m |
| | | Surface Level: | 16.8 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 5.37 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 5.75 | m |
| Length of well screen (Le) | 6 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0 | 5.75 | 0.38 | 1.000 |
| 1 | 5.74 | 0.37 | 0.974 |
| 2 | 5.69 | 0.32 | 0.842 |
| 3 | 5.67 | 0.30 | 0.789 |
| 4 | 5.66 | 0.29 | 0.763 |
| 5 | 5.65 | 0.28 | 0.737 |
| 6 | 5.64 | 0.27 | 0.711 |
| 7 | 5.63 | 0.26 | 0.684 |
| 8 | 5.63 | 0.26 | 0.684 |
| 9 | 5.61 | 0.24 | 0.632 |
| 10 | 5.6 | 0.23 | 0.605 |
| 15 | 5.55 | 0.18 | 0.474 |
| 18 | 5.51 | 0.14 | 0.368 |
| 20 | 5.49 | 0.12 | 0.316 |
| 30 | 5.42 | 0.05 | 0.132 |
| 40 | 5.4 | 0.03 | 0.079 |
| 50 | 5.38 | 0.01 | 0.026 |
| 50.5 | 5.37 | 0 | 0.000 |




To = 18 mins
1080 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

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

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **2.4E-07** | m/sec |
| | **=** | **0.088** | cm/hour |

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au

## Permeability Testing - Falling Head Test Report

| | | | |
|---|---|---|---|
| Client: | Vertical First Pty Ltd | Project No: | 86767.00 |
| Project: | Proposed Commercial Development | Test date: | 5-Jun-20 |
| Location: | 8-10 Lee Street, Haymarket | Tested by: | NB |

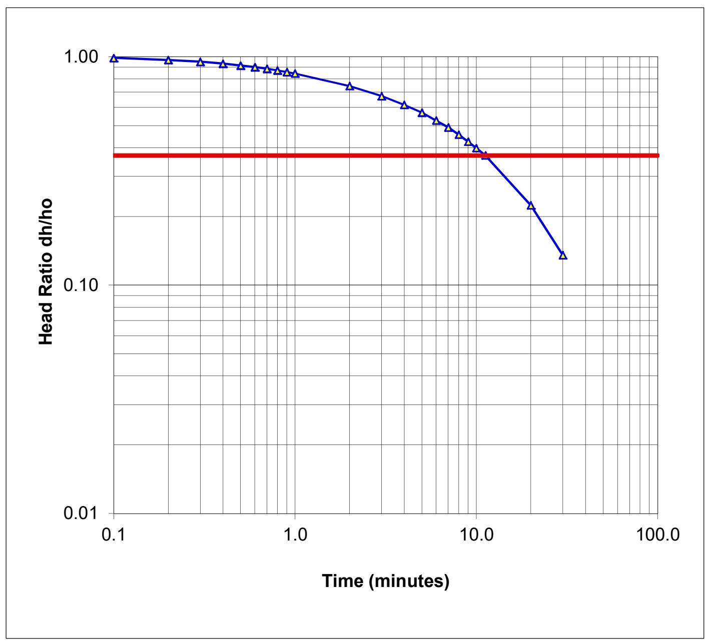
| | | | | |
|---|---|---|---|---|
| **Test Location** | | **Test No.** | BH112B | |
| Description: | Standpipe in borehole | Easting: | 333928 | m |
| Material type: | Sandstone | Northing | 6249324 | m |
| | | Surface Level: | 16.8 | m AHD |

**Details of Well Installation**

| | | | | | |
|---|---|---|---|---|---|
| Well casing diameter (2r) | 50 | mm | Depth to water before test | 5.32 | m |
| Well screen diameter (2R) | 76 | mm | Depth to water at start of test | 0.00 | m |
| Length of well screen (Le) | 6 | m | | | |

**Test Results**

| Time (min) | Depth (m) | Change in Head: δH (m) | δH/Ho |
|---|---|---|---|
| 0.0 | 0.00 | 5.32 | 1.000 |
| 0.1 | 0.06 | 5.26 | 0.989 |
| 0.2 | 0.17 | 5.15 | 0.968 |
| 0.3 | 0.26 | 5.06 | 0.951 |
| 0.4 | 0.36 | 4.96 | 0.932 |
| 0.5 | 0.45 | 4.87 | 0.915 |
| 0.6 | 0.53 | 4.79 | 0.900 |
| 0.7 | 0.61 | 4.71 | 0.885 |
| 0.8 | 0.68 | 4.64 | 0.872 |
| 0.9 | 0.76 | 4.56 | 0.857 |
| 1 | 0.82 | 4.50 | 0.846 |
| 2 | 1.36 | 3.96 | 0.744 |
| 3 | 1.74 | 3.58 | 0.673 |
| 4 | 2.04 | 3.28 | 0.617 |
| 5 | 2.29 | 3.03 | 0.570 |
| 6 | 2.52 | 2.8 | 0.526 |
| 7 | 2.71 | 2.61 | 0.491 |
| 8 | 2.89 | 2.43 | 0.457 |
| 9 | 3.06 | 2.26 | 0.425 |
| 10 | 3.20 | 2.12 | 0.398 |
| 11.2 | 3.35 | 1.97 | 0.370 |
| 20 | 4.13 | 1.19 | 0.224 |
| 30 | 4.6 | 0.72 | 0.135 |




To = 11.2 mins
672 secs

**Theory:** Falling Head Permeability calculated using equation by Hvorslev

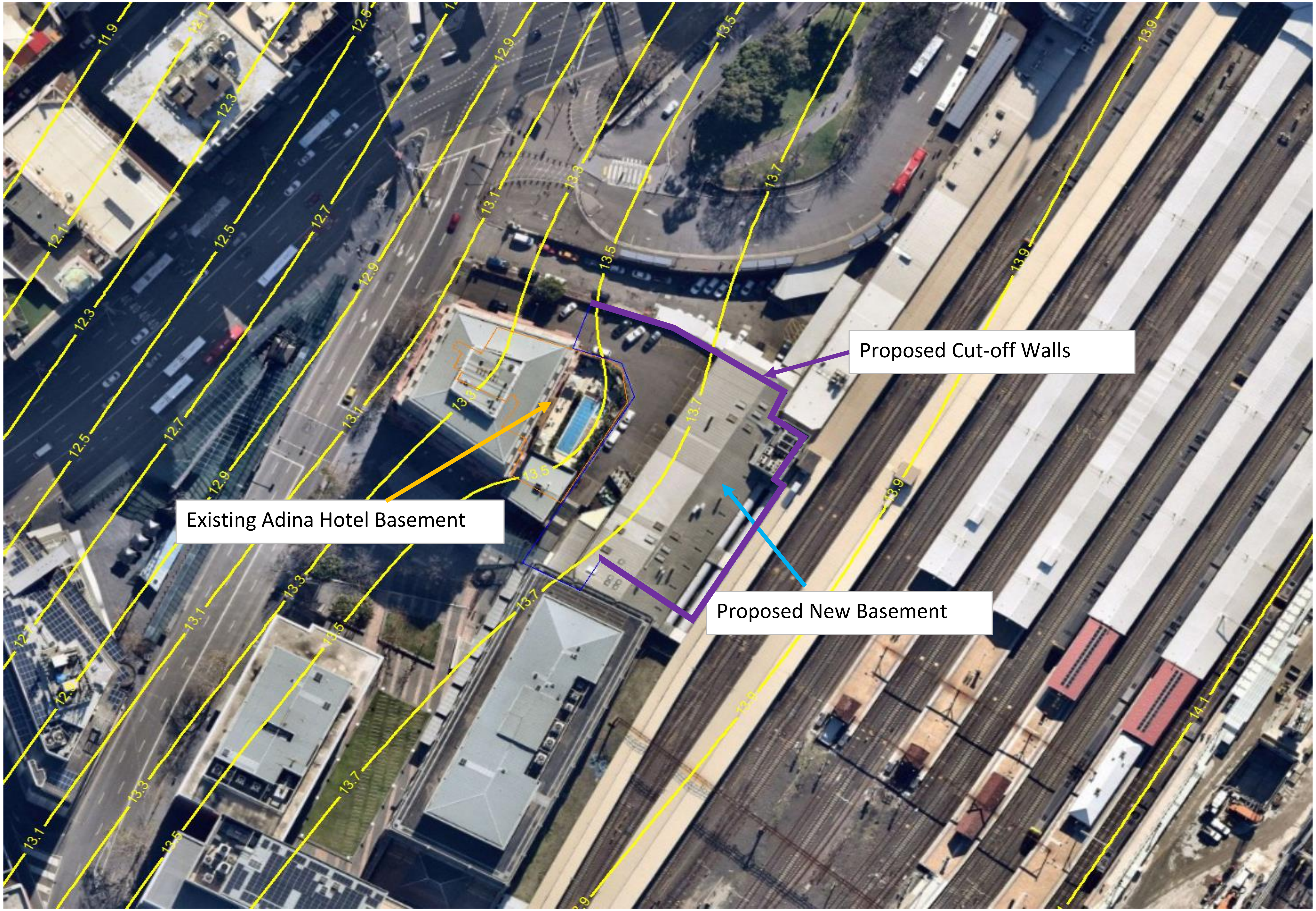
$k = [r^2 \ln(Le/R)]/2Le\ To$

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

| | | | |
|---|---|---|---|
| **Hydraulic Conductivity** | **k =** | **3.9E-07** | m/sec |
| | **=** | **0.141** | cm/hour |

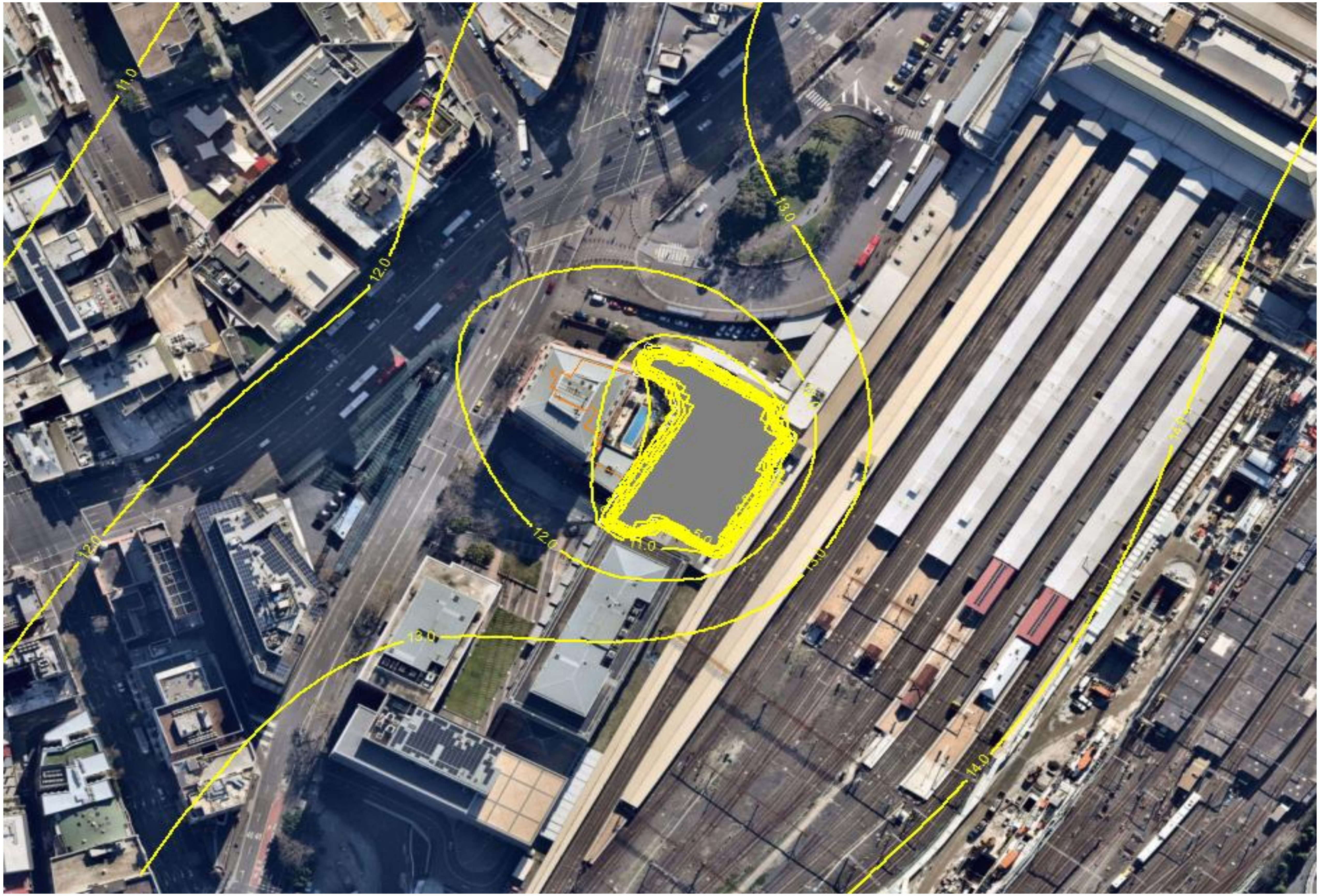
# Appendix E

Modelling Results
Estimated Groundwater Table and Drawdown Contours

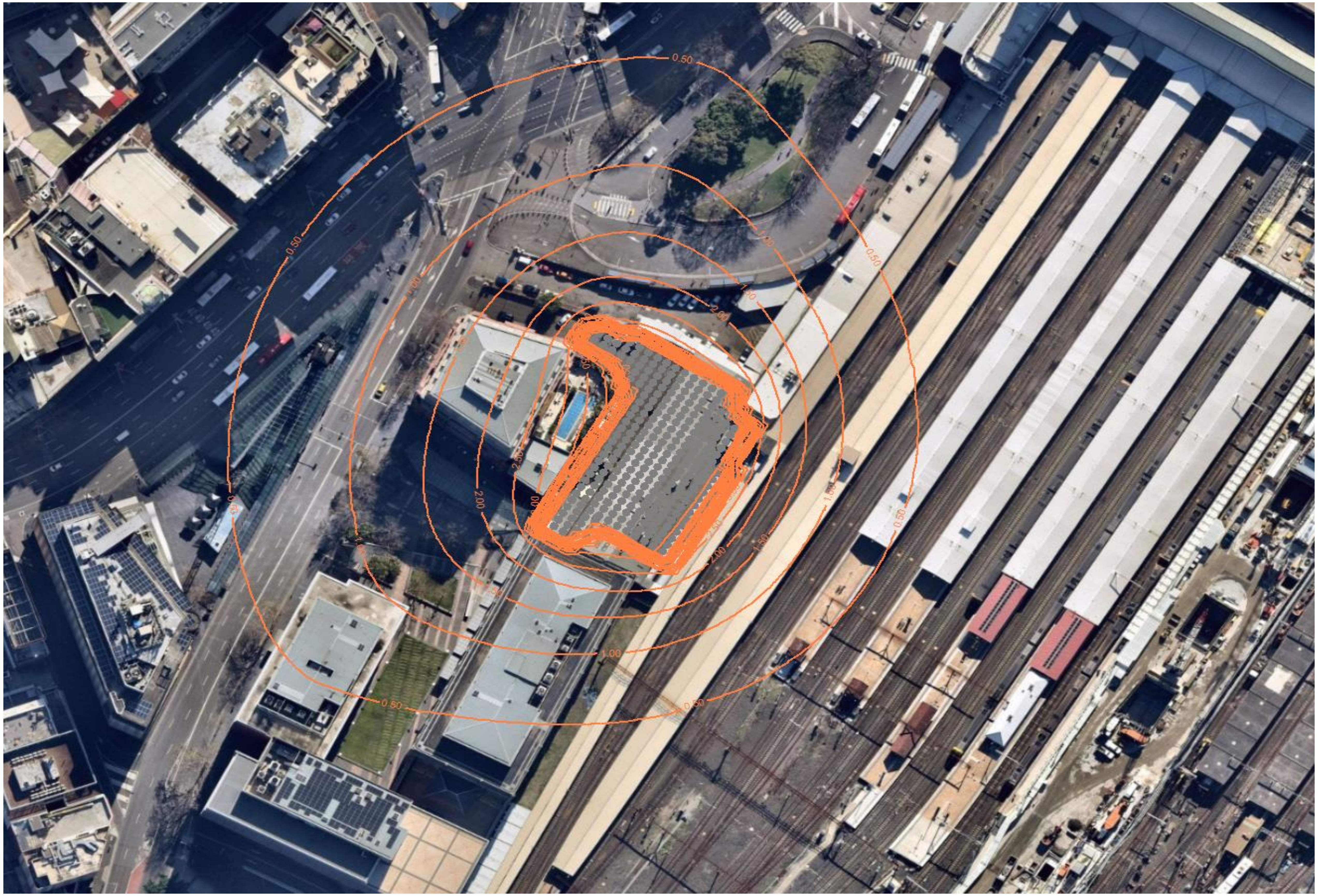



**Douglas Partners**
*Geotechnics / Environment / Groundwater*

| | | | |
|---|---|---|---|
| CLI□□T□ Vertical First □t□Ltd | | TITL□□ □x□□□n□ □ro□nd□ □er □□□e □ro□o□ed Co□ □er□c□□De□e□o□□ en□ □□□□ □ee □□ree□□□ □□□ □r□e□ | □R□□□CT □□□ □□□□□□□□ |
| □FFIC□□ S□d□e□ | DR□□ □ □□□ □□ | | DR□□ I□□ □□□ M□ |
| SC□L□□ □TS | D□T□□ □□□□□□□ | | R□VISI□□□ □ |




| | | | | |
|---|---|---|---|---|
| Douglas Partners<br>Geotechnics / Environment / Groundwater | CLI□□T□ Vertical First □t□Ltd | | TITL□□ □on□ □er□ □ro□nd□ □er □□□□e A□er De□ □er□n□<br>□ro□o□ed Co□ □er□c□□De□e□o□□ en□<br>□□□□ □ee □□ree□□□□□ □r□e□ | □R□□CT □□□ □□□□□□□ |
| | □FFIC□□ S□d□e□ | DR□□ □ □□□ □□ | | DR□□ I□□ □□□ M□ |
| | SC□L□□ □TS | D□T□□ □□□□□□□ | | R□VISI□□□ □ |




Douglas Partners
Geotechnics / Environment / Groundwater

| | | | |
|---|---|---|---|
| CLI□□T□ Vertical First □t□Ltd | | TITL□□ □on□ □er□ Dr□□do□n Con□o□r □ro□o□ed Co□ □er□c□□De□e□o□□en□ □□□□ □ee □□ree□□□ □□□ □r□e□ | □R□□□CT □□□ □□□□□□□□ |
| □FFIC□□ S□d□e□ | DR□□ □ □□□ □□ | | DR□□ I□□ □□□ M□ |
| SC□L□□ □TS | D□T□□ □□□□□□□□ | | R□VISI□□□ □ |