Catholic Education Diocese of Parramatta C/- WINIM Developments Pty Ltd

# Preliminary Geotechnical and Hydrogeological Assessment: WCC Stage 1 - 2 Darcy Road, Westmead NSW

martens consulting engineers

ENVIRONMENTAL

WATER

WASTEWATER

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## Abbreviations

ABC – Allowable bearing capacity

BH – Borehole

CBD – Central Business District

CEDP – Catholic Education Diocese of Parramatta

CFA – Continuous flight auger

DA – Development application

DBYD – Dial Before You Dig

DCP – Dynamic cone penetrometer

DoP – Diocese of Parramatta

DP – Deposited plan

IA – Investigation Area

KN - Kilonewtons

$kN/m^3$ – Kilonewtons per cubic metre

kPa – Kilopascal

LGA – Local government area

MA – Martens & Associates Pty Ltd

mAHD – Metres Australian height datum

mbgl – Metres below ground level

MPa - Megapascal

SSD – State Significant Development

WCC – Westmead Catholic Community

# 1 Introduction

## 1.1 Overview

This report supports a State Significant Development Application for the Westmead Catholic Community (WCC) Site at 2 Darcy Road, Westmead.

The WCC project seeks to meet the needs of the growing population within the region by providing upgraded school facilities for Mother Teresa and Sacred Heart Primary Schools, as well as a new Parish church. WCC is a collaboration between Catholic Education Diocese of Parramatta (CEDP), the Diocese of Parramatta (DoP), the Sisters of Mercy and the Marist Brothers Province of Australia.

As the proposal is for the purposes of alterations and additions to an existing school and has a capital investment value in excess of $20 million, it is a State Significant Development (SSD) for the purposes of the Environmental Planning and Assessment 1979 (the Act). The Parish church is also an SSD under clause 8(2) (a) of State Environmental Planning Policy (State and Regional Development) 2011 as it forms part of the proposal, which comprises a single integrated development with significant functional links between the education and church uses.

## 1.2 The Site

The WCC Site is located within the Parramatta local government area (LGA). It is approximately 2 km to the north-west of the Parramatta CBD and approximately 300 m to the west of Westmead Train Station.

The WCC Site has an area of approximately 12 ha and a frontage of approximately 430 m to Darcy Road. It consists of two lots, which are legally described as: Lot 1 in DP1095407, which is owned by the Trustees of the Roman Catholic Church of Parramatta; and Lot 1 in DP1211982, which is under the ownership of the Trustees of the Marist Brothers.

The WCC Site is bound by:

- Darcy Road to the north followed by the Westmead Health and Education Precinct comprising the Westmead Hospital, Westmead Private Hospital and the Western Sydney University Medical Research Institutes.
- The T1 North Shore & Western / T5 Cumberland train lines to the south.
- The Western Sydney University Westmead Campus to the east.

- Residential land use to the west.

The locational context of the WCC Site is shown in Figure 1.

The Westmead Health and Education Precinct, the WCC Site and the surrounding residential land collectively form part of the recently nominated Westmead Priority Precinct Area.

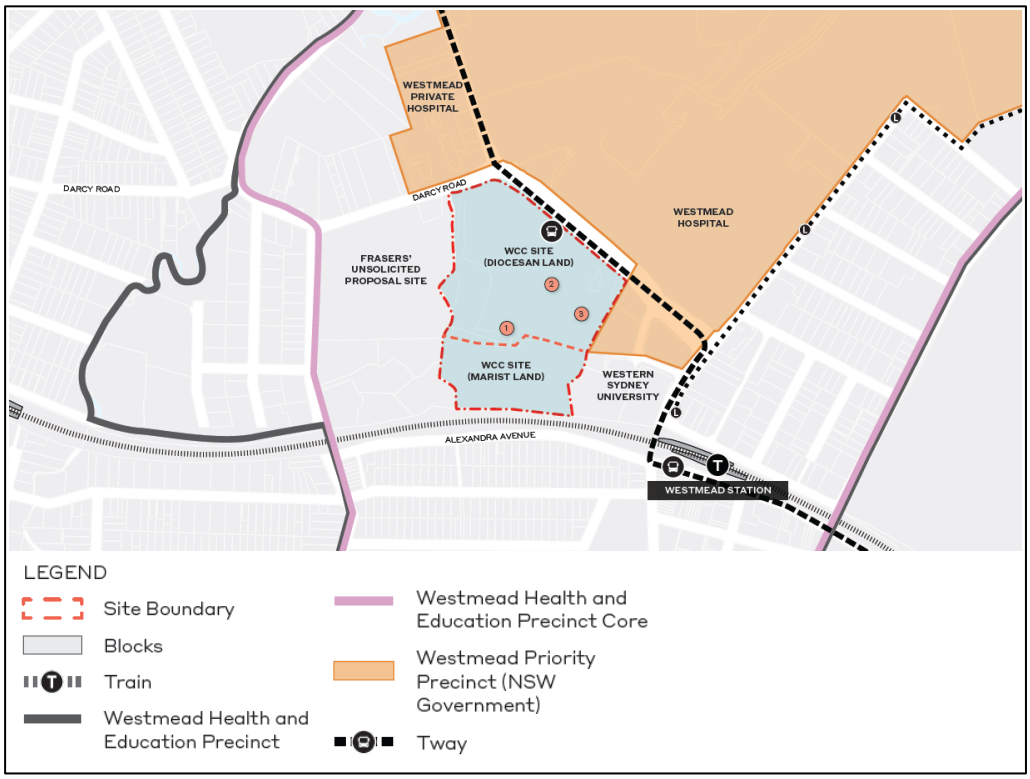


**Figure 1**: Location Plan

## 1.3 Existing Development

The WCC Site currently contains three separate schools:

- The Catherine McAuley Westmead Catholic High School for girls which predominantly occupies the northern part.
- The Parramatta Marist High School for boys which occupies the eastern part.
- The Mother Teresa Primary School occupies part of the Catherine McAuley Westmead High School building in the centre.
- The southern portion contains open sports fields associated with the Parramatta Marist High School.

The existing Brothers' residence is located in the north-eastern corner of the WCC Site. An at-grade car park occupies the western part of the WCC Site, to the north of the sports fields. Collectively, the three schools currently accommodate approximately 2,637 students and 190 staff.

## 1.4 The Proposed Site Development

The SSD application will seek approval for:

- A primary school with capacity for approximately 1,680 students to provide expanded facilities for the existing Mother Teresa Primary School and to replace the existing Sacred Heart Primary School at Ralph Street.
- A new Parish church.
- A Catholic early learning centre (fit-out within an existing building).
- New landscaping.

The area to be redeveloped (the site) is located within the WCC site (Diocesan Land) at 2 Darcy Road, Westmead NSW as shown in Map GE01, Map Set MS02-R01, Attachment A.

# 2 Investigation Area and Scope of Works

The focus of this preliminary geotechnical and hydrogeological assessment is the proposed K-6 school building and church building, to be located within the north western corner of the site [the investigation area (IA)]. The IA is shown in Map GE01, Map Set MS02-R01, Attachment A. The proposed development details and investigation scope are summarised in Table 1.

**Table 1**: Summary of the proposed development and investigation scope.

| Item | Details |
|---|---|
| Proposed Development | The proposed development is to consist of:<br>o A new 6-level K-6 building with a lift. Maximum column loads of 6000 kN are anticipated. The building is to have a ground floor slab at RL 20.5 m above Australian Height Datum (mAHD) (Alleanza Architecture, 2020a). The lift pit is anticipated to extend to a depth of 3 m below the finished ground floor level (RL 17.5 mAHD).<br>o A new single level church building with finished ground floor slab level at RL 19.9 mAHD (Alleanza Architecture, 2020b).<br>o A plinth, supporting a Crucifix, of approximately 14 m height.<br>o Flexible pavements for car park areas and access roads.<br>o Rigid (concrete) pavements around the new buildings. |
| Site Description | At the time of the geotechnical investigation, the IA consisted of:<br>o Grassed sports fields in the north-west with mature trees along the northern site boundary.<br>o Demountable school buildings and artificial turf outdoor play area in the south.<br>o Netball court in the north-east.<br>o Concrete footpaths. |
| Surrounding Land Uses | The surrounding land use is as follows:<br>o Darcy Road to the north of the site followed by Westmead Hospital to the northeast of Darcy Road.<br>o School buildings, netball courts and car park to the east.<br>o Car park and raised walkway over a pond to the south and south-west of the site.<br>o A site access road to the west of the site followed by a small unnamed creek to the west of the access road. The creek was dry at the time of the geotechnical investigation and is considered to be a spatially intermittent creek. |
| Investigation Scope of Work | In accordance with the scope of works outlined in MA quotation P1907547BC01V03, dated 16 December 2019, the field investigation conducted from 9 January 2020 to 18 January 2020 included:<br>o Review of available mapping literature.<br>o Review of DBYD survey plans and clearance of borehole locations of underground services.<br>o A walkover inspection of the site to review local geology, soil exposures, surface hydrology, topography and drainage.<br>o Drilling of 11 augered boreholes to between 4.0 to 7.3 metres below ground level (mbgl) or prior TC-bit refusal on bedrock.<br>o Advancement of three of the boreholes (BH105, BH109 and BH110) using rock coring methods to a maximum depth of 13.0 mbgl. |

| Item | Details |
|---|---|
| | o Dynamic Cone Penetrometer (DCP) tests at the borehole locations to assess the near-surface soil consistency or relative density.<br>o Collection and laboratory testing of 3 samples for Atterberg limits and linear shrinkage.<br>o Point load testing of 6 collected rock core samples.<br>The investigation locations are shown in Map GE02, Map Set MS02-R01, in Attachment A. |

# 3 Site Details and Subsurface Conditions

## 3.1 Site Details

Table 2 summarises the general site details considered relevant to the investigation and proposed development.

**Table 2**: Summary of site details and conditions.

| Element | Description/Detail |
|---|---|
| Topography | The site forms part of the Blacktown landscape characterized by gently undulating rises with local relief up to 30 m and slopes usually greater than 5 % (Hazelton et al, 2010). The site is located on a hill side that originally fell with a gentle gradient towards the north-west.<br>The area occupied by grassed sports field in northern and north-western part of the site has been filled between 1.5 m and 3.6 m above the existing ground levels along Darcy Road to raise ground levels. Embankments along the northern and north-western property boundaries and along the eastern side of the site access road that fall with an approximately 1V: 3H gradient down towards Darcy Road and the site access road. The base of the embankment is supported by a retaining wall typically between 0.5 m and 1.5 m high. The retaining wall appears to be in good condition with no obvious signs of deterioration.<br>An embankment is also present between the access road and the creek. The embankment falls between 1V:2H and 1V:3H towards the creek.<br>A stagnant pond is present approximately 40 m to the southwest of the IA. |
| Site Elevation | Ground levels across the site range between 19.2 mAHD in the north-west to 20.3 mAHD in the south-east [Vince Morgan (Surveyors) Pty Ltd, 2019]. |
| Site Aspect | North-west |
| Typical Site Slope | Less than 5 % across the proposed development area. |
| Site Drainage | Via overland flow towards the north-west and buried stormwater drains located throughout the site. |
| Expected Geology Soil and Landscape | The site is underlain by Ashfield Shale comprising dark-grey to black sideritic claystone, siltstone and fine sandstone-siltstone laminite (Clark & Jones, 1991). The north-east to south-west trending Coastal Lineament fault line is mapped approximately 400 m to the north-west of the site.<br>The site is underlain by Blacktown landscape soils that are generally shallow to moderately deep (greater than 1.0 m) and generally comprise clay associated with the Wianamatta Group, Bringelly and Ashfield Shale (Hazelton et al, 2010). |
| Historical development | The 1943 aerial photographs indicate that the site consisted of pasture with scattered tree cover. An unnamed meandering creek is visible in the western part of the site (Land and Property Information, 2020).<br>By 2003 the site had been developed with school buildings in the southern part of the site. Sports fields and courts are visible in the northern part of the site with trees along the northern site boundary (Google Earth, 2020a). The creek alignment had also been changed to accommodate the development.<br>The 2005 aerial photograph of the site shows the construction of the site access road (Google Earth, 2020b). It appears that the road was constructed by cutting into the north-west part of the school property to the existing ground levels along Darcy Road. |

Regrading of the embankments along the northern and north-western site boundaries and the construction of retaining walls associated with the widening of Darcy Road appears to have taken place between 1 October 2005 and 21 September 2006 (Google Earth 2020c and 2020d).

A school building is present in the east of the site in late-2011 (Google Earth 2020e).

By 2012 some of the school buildings in the southern part of the site have been replaced with an outdoor play area (Google Earth, 2020f).

The site has largely remained unchanged since 2012.

## 3.2 Subsurface Conditions

### *3.2.1* Previous Geotechnical and Environmental Investigations

Jeffrey & Katauskas Ltd (J&K) and Environmental Investigation Services (EIS) undertook a combined geotechnical and preliminary environmental investigation in November 2008 of the area to the south and east of the IA for proposed new school buildings and carpark (J & K, 2008 and EIS, 2008). The key findings of the combined investigation include:

- Fill of variable composition underlies the area investigated to depths ranging from 0.2 m to 2.6 mbgl.
- Natural medium plasticity silty clay is present beneath much of the area and ranges in thickness from 0.8 m to 2.7 m.
- Weathered shale was encountered at depths ranging between 2.2 mbgl to 5.0 mbgl.
- The near surface shale is very low strength, increasing to medium to high strength with depth.
- Groundwater was measured at depths ranging from 2.6 mbgl to 4.4 mbgl.
- Sources of potential soil and groundwater contamination identified by EIS include potentially contaminated imported fill material, demolition of former structures in the central-west and south-east sections of the area investigated, and potential use of pesticides in the southern section of the area investigated

The approximate locations of the J&K boreholes are indicated in Map GE02 Map Set MS01-R01, Attachment A. Copies of the J&K borehole logs are provided in Attachment F.

### 3.2.2 Subsurface Conditions – Church and Crucifix

Based on the former J&K / EIS investigation and MA's investigation results, the following generalised subsurface units are expected to underlie the area of the proposed Church and Crucifix:

Unit A: Fill consisting predominantly of clay with some gravel, sand and silt. The fill material and conditions vary across the area of the proposed building and is considered as "uncontrolled" fill. The fill extends to depths ranging from 2.5 mbgl to 3.8 mbgl, increasing from south-east to north-west. The fill is expected to be site-won excavated material from the construction of the buildings in the eastern part of the site.

Unit B: Alluvium: medium to high plasticity clay with silt and silty clay, with lesser amounts of low to medium plasticity silt. The alluvium is generally soft or firm with some stiff to very stiff layers and is between 0.9 m and 1.8 m thick, likely increasing towards the north-west. The alluvium has an organic odour.

Unit C: Residual Soil: medium to high plasticity clay and clay with silt, stiff to hard. The residual soil profile is in excess of 3.2 m thick.

Unit D1: Highly weathered, very low to low strength shale was encountered in borehole BH103 at a depth of 7.1 mbgl and was proven to 7.3 mbgl. The depth to rock appears to increase towards the north-west. The highly weathered shale is inferred to be Class V shale in accordance with Pells et al (1998).

Unit D2: Medium to high strength shale is expected to be located below depths of between 8.0 mbgl and 9.0 mbgl.

Groundwater inflows were observed at depths ranging from 3.2 mbgl to 4.5 mbgl (RL 16.8 mAHD to 15.2 mAHD).

Encountered conditions are described in more detail on the borehole logs (BH101 to BH103) in Attachment B and associated explanatory notes in Attachment H. For DCP test results refer to Attachment C.

### 3.2.3 Subsurface Conditions – K-6 Building

Based on the former J&K / EIS investigation and MA's investigation results, the following generalised subsurface units are expected to underlie the area of the proposed K-6 School building:

Unit A: Fill consisting predominantly of clay with some gravel, sand and silt. The fill material and conditions vary across the area of

the proposed building and is considered as "uncontrolled" fill. The fill extends to depths ranging from 1.6 mbgl in the east to 3.4 mbgl in the west. The fill is expected to be site-won excavated material from the construction of the buildings in the eastern part of the site.

Unit B: Alluvium: medium to high plasticity clay with silt and silty clay with lesser amounts of low to medium plasticity silt. The alluvium is generally soft to firm with some stiff to very stiff layers and is between 0.4 m and 1.8 m thick increasing westwards towards the creek and over an inferred drainage depression extending northeast – southwest across the area of the proposed building.

Unit C: Residual soil: medium to high plasticity clay and clay with silt, stiff to hard. The residual soil is between 1.5 m and 4 m thick.

Unit D1: Shale and claystone: highly weathered, very low to low strength. The highly weathered shale and claystone is between 2.6 m and 3.9 m thick and inferred to be Class V shale in accordance with Pells et al (1998).

Unit D2: Medium strength shale, thinly laminated, slightly weathered, with high strength layers. The slightly weathered shale was proven to a depth of 13 mbgl. Shearing of the shale is evident from a number of steeply inclined fractures encountered within boreholes BH105, BH109 and BH110 at depths of between 9.0 mbgl and 9.5 mbgl. The shearing is likely associated with the Coastal Lineament fault. The slightly weathered, medium strength shale is inferred to be Class II shale in accordance with Pells et al (1998).

Groundwater inflows were observed at depths ranging from 2.4 mbgl to 7.1 mbgl (RL 17.9 mAHD to 13.2 mAHD).

Encountered conditions are described in more detail on the borehole logs (BH104 to BH111) in Attachment B and associated explanatory notes in Attachment H.

# 4 Hydrogeological Assessment

## 4.1 NSW Department of Primary Industries Bore Search

A review of the NSW Department of Primary Industries Water (DPIW) real time groundwater bore database revealed that there is one groundwater monitoring bore within 500 m of the subject site (BOM, 2020). The borehole, reference number GW108378, is located approximately 415 m north-east of the site along the bank of the Toongabbie Creek. The borehole was drilled for industrial purposes, possibly for the abstraction of potable groundwater. A groundwater depth of 23 mbgl was recorded in this borehole.

## 4.2 Groundwater Observations

A summary of groundwater inflows encountered during the drilling of the boreholes is provided in Table 3.

**Table 3**: Summary of groundwater inflow levels.

| Location | Geology | Groundwater Inflows | |
|---|---|---|---|
| | | Depth (mBGL) | RL (mAHD) |
| BH101 | Alluvium | 4.5 | 15.20 |
| BH102 | Alluvium | 3.2 | 16.80 |
| BH103 | Alluvium | 3.4 | 16.75 |
| BH104 | Fill | 2.9 | 17.5 |
| BH105 | Alluvium | 2.6 | 17.80 |
| BH106 | N/A [2] | NIL [1] | N/A [2] |
| BH106A | Shale | 7.1 | 13.20 |
| BH107 | Claystone | 5.5 | 14.65 |
| BH108 | Alluvium | 2.9 | 17.35 |
| BH109 | Fill | 2.4 | 17.90 |
| BH110 | Fill | 2.7 | 17.70 |
| BH111 | Residual soil (near rock interface) | 3.1 | 17.3 |

**Notes:**

1. Not encountered during auger drilling.
2. Not applicable

A summary of groundwater level readings following completion of borehole drilling is provided in Table 4.

**Table 4**: Summary of standing groundwater levels.

| Location | Date | Groundwater levels | | Geology |
|---|---|---|---|---|
| | | Depth (mBGL) | RL (mAHD) | |
| BH101 | 18.01.2020 | 4.29 | 15.41 | Alluvium |
| BH104 | 14.01.2020 | 2.90 | 17.50 | Fill |
| | 18.01.2020 | 2.90 | 17.50 | |
| BH107 | 13.01.2020 | 4.70 | 15.45 | Claystone |
| BH109 | 13.01.2020 | 2.00 | 18.30 | Fill |
| BH111 | 08.01.2020 | 6.50 | 13.90 | Shale |

A groundwater monitoring well was constructed in BH106A (MW01) with a slotted screen extending from 3.0 mbgl to 7.2 mbgl. A summary of groundwater level measurements is provided in Table 5.

**Table 5**: Summary of groundwater level measurements at MW01.

| Geology | Date | Groundwater Level | |
|---|---|---|---|
| | | Depth (mBGL) | RL (mAHD) |
| Shale | 18.01.2020 | 4.45 | 15.95 |
| | 06.02.2020 | 4.52 | 15.88 |

## 4.3 Conclusions

The groundwater observations indicate the presence of two groundwater bearing zones:

1) A shallow perched groundwater within the fill and alluvium at depths of between 2.0 mbgl and 4.29 mbgl (RL 18.3 mAHD and RL 15.41 mAHD respectively).

2) A deeper groundwater level within the shale and the residual soil close to the rock interface at depths of between 3.1 mbgl and 7.1 mbgl (RL 17.3AHD and 13.2m AHD respectively).

The groundwater is anticipated to be the result of:

- The penetration of surface water run-off into the ground.
- Lateral movement of groundwater from upslope areas to the south and south-east of the IA.
- Surface water seepage through the ground from the pond to the south-west of the IA.

It is anticipated that the groundwater flows across the site towards the north-west. Groundwater levels are expected to reduce towards the north-west. Flow rates are anticipated to be low, increasing following intense or prolonged periods of precipitation.

The excavation for the lift shaft should not intercept the permanent groundwater. The proposed development is anticipated to have no impact on the permanent groundwater level and no drawdown effects are foreseen. Minor perched groundwater seepages may be controlled using sump and pump methods to keep the excavation reasonably dry during construction.

# 5 Salinity and Acid Sulphate Soils Assessment

## 5.1 Documented Salinity Risk Potential

The NSW Office of Environment and Heritage (2020) indicates that the site is located within the Blacktown soil landscape and that the site is located in an area of high salinity potential.

## 5.2 Signs of Potential Saline Soils

No obvious signs of saline conditions were observed:

- Vegetation growth appeared healthy and uninhibited.
- No water marks or salt crystals were observed on the ground surface.
- Site surface drainage appeared generally good.
- No evidence of concentrated surface erosion was observed.

## 5.3 Laboratory Test Results

Laboratory test results for preliminary salinity classification are summarised in Table 6. Laboratory test certificates are provided in Attachment E.

**Table 6**: Salinity test results.

| Sample ID [1] | Material [2] | Soil Type | $EC_{(1:5)}$ (dS/m) | $EC_e$ (dS/m) [3] | Salinity Classification [4] |
|---|---|---|---|---|---|
| 7547/BH101/0.5 | Heavy Clay | Fill | 0.12 | 0.72 | Non-saline |
| 7547/BH101/2.0 | Heavy Clay | Fill | 0.30 | 1.80 | Non-saline |
| 7547/BH101/4.0 | Heavy Clay | Alluvium | 0.27 | 1.62 | Non-saline |
| 7547/BH101/6.0 | Heavy Clay | Residual | 0.24 | 1.44 | Non-saline |
| 7547/BH103/1.0 | Heavy Clay | Fill | 0.24 | 1.44 | Non-saline |
| 7547/BH103/3.0 | Heavy Clay | Alluvium | 0.07 | 0.4 | Non-saline |
| 7547/BH103/5.0 | Heavy Clay | Residual | 0.36 | 2.16 | Slightly saline |
| 7547/BH105/2.0 | Heavy Clay | Residual | 0.44 | 2.64 | Slightly saline |
| 7547/BH105/4.0-4.45 | Heavy Clay | Residual | 0.36 | 2.16 | Slightly saline |
| 7547/BH106a/1.0 | Heavy Clay | Fill | 0.40 | 2.40 | Slightly saline |
| 7547/BH106a/4.0 | Heavy Clay | Residual | 0.35 | 2.10 | Slightly saline |

| Sample ID [1] | Material [2] | Soil Type | $EC_{(1:5)}$ (dS/m) | $EC_e$ (dS/m) [3] | Salinity Classification [4] |
|---|---|---|---|---|---|
| 7547/BH106a/4.0 | Heavy Clay | Residual | 0.38 | 2.28 | Slightly saline |
| 7547/BH106a/6.0 | Heavy Clay | Residual | 0.55 | 3.30 | Slightly saline |
| 7547/BH108/3.5 | Heavy Clay | Alluvium | 0.05 | 0.31 | Non-saline |
| 7547/BH108/5.4 | Heavy Clay | Residual | 0.56 | 3.36 | Slightly saline |
| 7547/BH111/0.5 | Heavy Clay | Fill | 0.09 | 0.52 | Non-saline |
| 7547/BH111/2.5 | Heavy Clay | Residual | 0.18 | 1.08 | Non-saline |
| 7547/BH111/3.5 | Heavy Clay | Residual | 0.15 | 0.90 | Non-saline |

**Notes:**

1. Borehole#/Depth (mbgl).
2. Based on Soil Texture Group in Table 6.1 in DLWC (2002).
3. Based on EC to $EC_e$ multiplication factors from Table 6.1 in DLWC (2002).
4. Based on Table 6.2 of DLWC (2002) where $EC_e$ <2 dS/m = non-saline, $EC_e$ of 2-4 dS/m = slightly saline, $EC_e$ of 4-8 dS/m = moderately saline, $EC_e$ of 8-16 dS/m = very saline and $EC_e$ of >16 dS/m = highly saline.

## 5.4 Conclusions and Recommendations

The alluvium is categorised as non-saline while the fill and residual soil are categorised as non-saline to slightly saline. Saline soil management strategies are considered not to be required.

## 5.5 Acid Sulphate Soils (ASS)

The site is mapped as not impacted by ASS risk (NSW Department of Environment & Heritage, 2020). Considering site elevation, topographic, and geology maps and encountered subsurface conditions, it is expected that the alluvium, residual soil and rock profiles are not associated with ASS. Further site investigations for an ASS assessment or preparation of an ASS management plan (ASSMP) are considered not to be required.

# 6 Geotechnical Assessment

## 6.1 Laboratory Point Load Testing

Laboratory point load strength index test results are summarised in Table 7. Rock core photographs are provided in Attachment D for reference. The laboratory test certificate is provided in Attachment E.

**Table 7**: Point load strength index test results

| Borehole | Sample Depth (mbgl) | Point Load Strength Index $I_{s(50)}$ (MPa) [3] | | UCS [1] (MPa) | Rock Strength [2] |
|---|---|---|---|---|---|
| | | Diametral | Axial | | |
| BH105 | 9.00 – 9.12 | 0.75 | 0.49 | 9.8 | Medium |
| | 11.12 – 11.27 | 0.94 | 1.7 | 34 | High |
| BH109 | 9.12 – 9.27 | 1.1 | 1.1 | 22 | High |
| | 10.37 – 10.49 | 0.73 | 0.66 | 13.2 | Medium |
| BH110 | 9.34 – 9.50 | 0.72 | 0.67 | 13.4 | Medium |
| | 11.8 – 12.00 | 1.1 | 2.0 | 40 | High |

**Notes:**

1. Unconfined Compressive Strength of intact material, assuming UCS = 20 x $I_{s(50)}$.
2. Strength classification based on AS1726 (2017).
3. MPa – Megapascal.

The test results and observations during rock coring confirm that the bedrock at the IA generally consists of medium strength shale below a depth of 9.0 mbgl, with some high strength layers. In addition to this, it is anticipated that some low strength layers of shale may also be present below 9.0 mbgl.

It should be considered that testing was carried out on selective relatively intact rock core samples. Intact core samples of the shale above a depth of 9.0 mbgl could not be collected or tested due to the high degree of fracturing and the highly weathered nature of the rock. The highly fractured nature of the shale above a depth of 9.0 mbgl is likely due to shearing associated with the Coastal Lineament fault mapped approximately 400 m to the north-west of the site. The highly fractured rock increased penetration of groundwater causing the high degree of weathering of the shale to a depth of 9.0 mbgl.

Engineering properties of the rock mass will be impacted by the presence of defects in the rock profile, including weathered, sheared and fractured zones.

## 6.2 Atterberg Limits and Linear Shrinkage Testing

Laboratory Atterberg and linear shrinkage test results are summarised in Table 8. The laboratory test certificate is provided in Attachment E.

**Table 8**: Atterberg Limits and Linear Shrinkage Test Results.

| Sample ID [1] | Material | Atterberg Limits (%) [2] | | | LS (%) [2] | Plasticity Classification |
|---|---|---|---|---|---|---|
| | | LL | PL | PI | | |
| 7547/103/3.0 | Silty CLAY | 39 | 16 | 23 | 10 | Medium |
| 7547/103/4.0 | Clay with silt | 55 | 17 | 38 | 16.5 | High |
| 7547/106A/3.0–4.0 | Clay with silt | 65 | 17 | 48 | 18.5 | High |

**Notes:**

1. Project#/Borehole#/Depth (mBGL).
2. LL = Liquid limit, PL= Plastic limit, PI=Plasticity index, LS = Linear shrinkage

Laboratory test results indicate that the tested soil samples are of medium to high plasticity with a high degree of reactivity, which may result in high ground movement due to soil moisture changes.

## 6.3 Exposure Classification

Exposure classification test results are summarised in Table 9. The laboratory test certificates are provided in Attachment E.

**Table 9**: Exposure classification test results.

| Sample ID [1] | Material | $EC_e$ (dS/m) [2] | pH | Sulphate ($SO_4$) (mg/kg) | Exposure Classification | | |
|---|---|---|---|---|---|---|---|
| | | | | | AS 2159 [3] | AS 2159 [4] | AS 3600 [5] |
| 7547/BH101/0.5 | Clay | 0.12 | 8.4 | <10 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH101/2.0 | Clay | 0.30 | 5.7 | 370 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH101/4.0 | Clay | 0.27 | 8.3 | 270 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH101/6.0 | Clay | 0.24 | 7.6 | 140 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH103/1.0 | Clay | 0.24 | 7.9 | 170 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH103/3.0 | Clay | 0.07 | 6.7 | 64 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH103/5.0 | Clay | 0.36 | 5.9 | 190 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH105/2.0 | Clay | 0.44 | 6.5 | 490 | Non-aggressive | Non-aggressive | A1 |

| Sample ID [1] | Material | $EC_e$ (dS/m) [2] | pH | Sulphate ($SO_4$) (mg/kg) | Exposure Classification | | |
|---|---|---|---|---|---|---|---|
| | | | | | AS 2159 [3] | AS 2159 [4] | AS 3600 [5] |
| 7547/BH105/4.0-4.45 | Clay | 0.36 | 5.5 | 87 | Mild | Non-aggressive | A2 |
| 7547/BH106a/1.0 | Clay | 0.40 | 7.5 | 500 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH106a/4.0 | Clay | 0.35 | 5.1 | 79 | Mild | Non-aggressive | A2 |
| 7547/BH106a/4.0 | Clay | 0.38 | 5.1 | 76 | Mild | Non-aggressive | A2 |
| 7547/BH106a/6.0 | Clay | 0.55 | 5.6 | 160 | Non-aggressive | Mild | A1 |
| 7547/BH108/3.5 | Clay | 0.05 | 6.5 | <10 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH108/5.4 | Clay | 0.56 | 6 | 160 | Non-aggressive | Mild | A1 |
| 7547/BH111/0.5 | Clay | 0.09 | 6.9 | 59 | Non-aggressive | Non-aggressive | A1 |
| 7547/BH111/2.5 | Clay | 0.18 | 5.3 | 20 | Mild | Non-aggressive | A2 |

**Notes:**

1. Project#/Borehole#/Depth (mBGL).
2. From Column 5, Table 6.
3. Exposure classification for concrete piles in soil based on Table 6.4.2(C) of AS 2159-2009.
4. Exposure classification for steel piles in soil based on Table 6.5.2(C) of AS 2159-2009.
5. Exposure classification for buried reinforced concrete based on Tables 4.8.1 and 4.8.2 of AS 3600-2018.

In accordance with AS2159 (2009), an exposure classification of 'mild' should be adopted for buried concrete and steel piles. In accordance with AS3600 (2018), an exposure classification of 'A2' should be adopted for shallow concrete footings.

## 6.4 Earthquake Site Subsoil Class

The site is assessed to be a class '$C_e$ (shallow soil site)' in accordance with AS 1170.4 (2007). An earthquake Hazard Factor (z) of 0.08 may be adopted for this site.

## 6.5 Preliminary Material Properties

Preliminary material properties inferred from observations during borehole drilling, such as auger penetration resistance, DCP test results, rock condition and point load test results as well as engineering judgement are summarised in Table 10.

**Table 10**: Preliminary material properties.

| Layer | $Y_{in\text{-}situ}$ [1] (kN/m³) | UCS [2] (MPa) | $c_u$ [3] (kPa) | c' [4] (kPa) | Ø' [5] (deg) | E' [6] (MPa) | $K_0$ [7] | $K_a$ [8] | $K_p$ [9] |
|---|---|---|---|---|---|---|---|---|---|
| Unit A: Fill: Clay (uncontrolled). | 17 | NA [10] | 50 | 4 | 26 | 8 | 0.56 | 0.39 | 2.56 |
| Unit B: Alluvium: soft to firm, medium to high plasticity clay. | 16 | NA [10] | 10 | 2 | 22 | 2 | 0.63 | 0.46 | 2.2 |
| Unit C: Residual: stiff to hard, medium to high plasticity clay and clay with silt. | 17 | NA [10] | 75 - 200 | 4 - 6 | 26 - 30 | 15 - 60 | 0.56 – 0.50 | 0.39 – 0.33 | 2.56 – 3.00 |
| Unit D1: Highly weathered, very low to low strength, highly fractured, shale (Class V Shale [11]). | 22 | 0.5 | NA [10] | 20 | 28 | 50 | NA [10] | NA [10] | NA [10] |
| Unit D2: Slightly weathered to fresh, medium strength shale (Class II Shale [11]). | 23 | 9 | NA [10] | 150 | 32 | 1000 | NA [10] | NA [10] | NA [10] |

**Notes:**

1. Material in-situ unit weight (kN/m³), based on visual assessment (±10 %).
2. Unconfined Compressive Strength of rock.
3. Undrained shear strength of cohesive soils.
4. Drained cohesion.
5. Effective internal friction angle (±2˚) estimate, assuming drained conditions.
6. Effective elastic modulus (±10 %) estimate.
7. Earth pressure coefficient at rest.
8. Active earth pressure coefficient.
9. Passive earth pressure coefficient.
10. Not applicable.
11. Classification according to Pells et al (1998).

## 6.6 Risk of Slope Instability

No evidence of former land instability could be observed within the site and surrounding land during the site walkover survey. Boreholes have identified potentially sheared zones within the rock indicative of former and now relict of early movements.

The risk of potential slope instability, such as landslide or soil creep, is considered to be very low subject to the recommendations in this report and the adoption of relevant engineering standards and guidelines. A detailed slope risk assessment in accordance with the Australian

Geomechanics Society's Landslide Risk Management Guidelines (2007) was not undertaken.

# 7 Preliminary Pavement Thickness Design

## 7.1 Design Parameters

### *7.1.1* Traffic Loading

A traffic loading of 5 x $10^4$ Equivalent Standard Axles (ESA) was adopted for design of the proposed internal road and carpark areas in accordance with Austroads (2012).

### *7.1.2* California Bearing Ratio (CBR) Value

Based on the near surface soils encountered, a CBR value of between 1% and 3% is to be expected.

The Australian Road Research Board (1989) advises that a minimum CBR value of 3% is to be adopted for preliminary design purposes. In order to adopt a CBR value of 3%, subgrade improvement or replacement with a suitable engineered fill may be required.

CBR testing is recommended to provide reliable information regarding the subgrade conditions across the proposed pavement areas for the detailed design of the site.

## 7.2 Subgrade Preparation

The subgrade is to be trimmed and treated to at least 300 mm depth by either:

- Removal and replacement with approved granular fill under geotechnical engineer's direction;
- Undertake in-situ stabilisation with cement / lime or similar binding agent; or
- Mixing the existing subgrade material with granular material to achieve a minimum 3 % CBR for subgrade.

Disposal of excavated material off site, if required, should be carried out in accordance with NSW EPA (2014) Waste Classification Guidelines.

Density testing of the upper 300 mm of subgrade and placed fill should be carried out at a minimum rate of one test per 500 $m^3$ distributed reasonably evenly throughout full depth and area (refer Table 8.1 of AS3798). Minimum relative density of the subgrade shall be 100 % Maximum Dry Density (MDD) at a standard compactive effort within 2 % of optimum moisture content (OMC).

## 7.3 Preliminary Flexible Pavement Thickness

A flexible pavement is considered to be suitable for the site. Table 11 presents recommended flexible pavement material thicknesses for the proposed internal road.

**Table 11**: Preliminary flexible pavement material thickness design for CBR 3 %.

| Road Type | Total Thickness (mm) [1] | Layer | Thickness (mm) | Materials |
|---|---|---|---|---|
| Private roads | 400 (including pavement surfacing) | Pavement Surfacing | 50 | AC10 |
| | | Base | 150 [1] | DGB20 |
| | | Sub-base | 200 [1] | CSS40 or DGS40 |

**Notes:**

1. Total thickness of granular portion (i.e. base + sub-base) was adopted from Figure 12.2 Austroads (2017).

## 7.4 Preliminary Rigid Pavement Thickness

Rigid pavements may be considered for lightly trafficked roads on the site. Table 12 presents recommended preliminary rigid pavement material thicknesses for the proposed internal road.

**Table 12**: Preliminary rigid pavement material thickness design for CBR 3 %.

| Pavement Composition | Total Thickness (mm) [1] | |
|---|---|---|
| | With concrete shoulders | Without concrete shoulders |
| Continuously reinforced concrete basecourse | 165 | 180 |
| Subbase | 125 | 125 |
| Minimum steel reinforcing fabric size | SL 92 | |
| Min. concrete compressive strength | 32 MPa | |

**Notes:**

1. Total thickness of granular portion (i.e. base + concrete base) was adopted from Figures 12.14 and 12.15 Austroads (2017).

## 7.5 Placement and Testing of Pavement Material

Pavement materials shall be placed in layers (when compacted) not thicker than 200 mm or less than 100 mm. Pavement materials shall be compacted to the following condition:

- Sub-base - Minimum 98 % MDD at modified compactive effort (±2% OMC).

- Base - Minimum 98% MDD at modified compactive effort (±2% OMC).

Compaction testing shall be undertaken by a NATA accredited laboratory in accordance with Council requirements and industry standards. Testing should be carried out at a rate of 1 per 50 linear metres of road, or per 250 $m^2$, whichever is the greater, with a minimum of 2 tests in any one length. Each pavement layer shall be proof rolled under Geotechnical Engineers' supervision. Subsequent pavement layers shall not be placed prior to approval of underlying layer by the Geotechnical Engineer.

# 8 Geotechnical Recommendations

## 8.1 General Recommendations

General geotechnical recommendations for the proposed development are provided in Attachment G. Additional recommendations are provided in the following sections.

## 8.2 Key Geotechnical Constraints

The site is considered suitable for the proposed development. However, the following key geotechnical constraints should to be considered during the detailed design and construction phases:

- The IA is underlain by a layer of fill between 1.6 m and 3.8 m thick. The fill was likely placed under uncontrolled conditions considering the material condition variability and absence of compliance testing data. The fill cannot be relied on as a foundation and is likely to be susceptible to high ground movements (shrinking and/or swelling) due to soil moisture changes and loading. The fill in the north western part of the AI is not suitable for increased loading as this may induce settlement and instability of the embankment and retaining wall.

- The perched groundwater levels at depths of between 2.0 mbgl and 4.29 mbgl (RL 18.3 mAHD and RL 15.41 mAHD respectively) within the fill and alluvium are anticipated to be variable due to the presence of drainage depressions channelling the water into the western and north-western parts of the IA. Groundwater levels are also anticipated to be impacted by the water levels in the creek and pond to the west and south-west.

- The soft to firm alluvium is not considered suitable as a foundation material as it is liable to settlement under increased loading and decomposition of organic material.

- The near-surface fill material is anticipated to give low CBR values in the order of 3%.

- The rock is highly weathered and sheared to a depth of 9.0 mbgl.

## 8.3 Site Classification

The site is classified as a "P" site in accordance with AS 2870 (2011) due to the presence of uncontrolled fill which is considered unsuitable as a foundation. The design should consider the possible impacts of perched ephemeral groundwater, surface water infiltration, surface water

ponding, and nearby vegetation (present and future) on the site classification.

## 8.4 Excavations

The proposed excavation for the K-6 building lift pit will encounter a soil profile comprising a variable thickness of fill overlying alluvium and residual soil of variable thickness and conditions. It is anticipated that the soils can be readily excavated using conventional tracked earthmoving equipment. The excavation will require support for excavation beyond a depth of 1.0 mbgl. This may be in the form of a bored pile wall with shotcrete infill panels, sheet pile walls or temporary I-beams and timber infill panels. Alternately, excavations may be battered to a temporary gradient of 1H: 1V provided there is sufficient space to remain outside of the zone of influence of adjacent structures. The zone of influence is defined as a 45-degee line extending downwards from the base of structures.

## 8.5 Reuse of Site-won Material

Excavated fill material is considered to be suitable for replacement as general fill provided it is free of substances with the potential to cause contamination. The preliminary site investigation undertaken by MA indicates that the site is considered to generally have a low risk of localised or broad scale contamination (MA, 2020). The alluvium is not considered suitable for reuse as it is anticipated to be water logged and contains organic material that is liable to decompose. The residual soil is considered suitable for reuse as a general fill.

Should filling be required to raise subgrade levels, the use of site-won excavated residual soils (unsuitable material and medium to high and high plasticity clay excluded) may be considered, subject to implementing stringent moisture conditioning and compaction controls. The use of medium to high or high plasticity clay will require treatment, as discussed above. Alternatively, suitable granular fill, approved for use by a Geotechnical Engineer, may be adopted.

## 8.6 Temporary Work Platforms

The near surface soils are liable to loss of strength upon wetting and are therefore assessed to be of poorly trafficable. It is recommended that a layer of crushed stone or recycled concrete be placed across the site in areas that are to be trafficked by construction plant to minimise erosion and dust formation. Additionally, it may be necessary to undertake an assessment of the site to establish the suitability of the sub-surface condition should plant with high ground bearing pressures (for instance cranes or large piling rigs) be required.

## 8.7 Allowable Bearing Capacity

Table 13 presents preliminary design parameters that may be adopted for footing design.

**Table 13**: Preliminary footing design parameters.

| Layer [5] | | Piles [1] | |
|---|---|---|---|
| | | UBC [2,4] | USF [3,4] |
| Unit C: | Residual soil: clay stiff to hard. | 450 | 10 |
| Unit D1: | Shale Class V | 2000 | 75 |
| Unit D2: | Shale: Class II | 15000 | 500 |

**Notes:**

1. Assuming bored cast in-situ pile.
2. Ultimate end bearing capacity (kPa) for piles embedded at least 0.5 m or 1 pile diameter, whichever is greater, into the material unit, subject to confirmation on-site by a geotechnical engineer of inferred foundation conditions.
3. Ultimate skin friction (kPa) below 1 m depth for bored pile in compression, assuming intimate contact between pile and foundation material and a pile sidewall roughness of R2.
4. Design needs to consider negative shaft friction due to the depth of fill present beneath the AI. A reduction factor of Øg = 0.4 should be adopted in accordance with AS2159 (2009) to limit settlement to an acceptable level for conventional building structures (< 1% of minimum footing width) considering a limited on-site pile testing regime. Shaft friction should be reduced by 25 % if the concrete is not poured immediately after completion of the pile bore.
5. Units A and B are excluded from this table as these are not considered suitable as foundations.

The ground conditions beneath the AI are assessed to be suitable for conventional bored piles. The piles may need to be cased to prevent collapse of the soft to firm fill and alluvium where groundwater is present.

### *8.7.1* Church and Crucifix

The near-surface soils beneath the area of the proposed church and crucifix are not considered suitable for shallow footings. End bearing piles, founded in residual soil or underlying rock, should be adopted. Preliminary pile design parameters are provided in Table 13.

### *8.7.2* K-6 Building

Due to the expected high column loads (6000 kN), the K-6 building is to be supported by end bearing piles founded in the slightly weathered, medium strength shale (Class II). Preliminary pile design parameters are provided in Table 13.

## 8.8 Site Preparation

In the event that lightly loaded floor slabs are to be raised above existing ground levels, it is recommended that unsuitable material such as the existing fill material is excavated to a depth of 0.3 mbgl. Suitable

engineered fill material should be placed in accordance with AS 3798-2007 to raise the site to the required levels. Prior to placement of the engineered fill, the sub-grade should be proof rolled and any soft spots or unsuitable material removed. Engineered fill should be compacted in layers no greater than 300 mm thick to achieve a density index of 70%. A minimum depth of 0.5 m of engineered fill beneath floor slabs is recommended for a 50 kPa allowable bearing capacity.

## 8.9 Site Drainage

The near-surface soils underlying the AI are prone to loss of strength and swell when wet. Surface water run-off should be diverted away from the proposed building platform, pavements and existing or new retaining walls. Ponding and infiltration of surface water should the prevented to limit the impact of associated soil softening beneath the building footings.

The near-surface soils are considered unsuitable for stormwater infiltration systems. However, the clay soils may be suitable for lining of stormwater detention basins. Further testing should be undertaken for verification.

## 8.10 Exclusion zones

To prevent damage to the existing retaining walls, it is recommended that exclusion zones be set out in the early stages of construction. It is recommended that the exclusion zone should be at least 2 m width from the slope crest on the northern and north-western site boundaries and along the access road to prevent damage to the retaining wall or instability of the fill slopes. No heavy plant, equipment or soil stock piles should be placed within this exclusion zone. The exclusion zones should be maintained and observed for the duration of construction.

## 8.11 Construction Monitoring and Inspections

Construction Monitoring and Inspection recommendations are provided in Table 14.

**Table 14**: Recommended inspection/monitoring requirements during site works.

| Scope of Works | Frequency/Duration | Who to Complete |
|---|---|---|
| Observance and maintenance of exclusion zones in the northern and north-western parts of the site above the embankment and retaining wall. | Throughout the construction phase | Builder |
| Inspect exposed material at subgrade level to verify suitability as subgrade for new pavements and further fill placement. | Prior to placement of engineered fill | MA [1] |

| Scope of Works | Frequency/Duration | Who to Complete |
|---|---|---|
| Inspect exposed material at foundation level to verify suitability as foundation prior to pile construction. | Prior to reinforcement set-up and concrete placement | MA [1] |
| Monitor sedimentation downslope of excavated areas. | During and after rainfall events | Builder |
| Monitor sediment and erosion control structures to assess the adequacy and for removal of built up spoil. | After rainfall events | Builder |
| Monitor groundwater seepage/inflow into the excavation for the proposed lift pit excavation, if encountered, to assess the stability of exposed materials and adequacy of temporary drainage provision. | When encountered | MA [1] |

**Notes:**

[1] MA= Martens and Associates engineer

The contractor will also need to take into consideration:

- The potential presence of high strength shale layers below 9.0 mbgl.
- The depth to medium strength shale decreases towards the west and northwest.
- Presence of water in piles may cause softening of the foundation material, therefore concrete will need to be placed immediately following pile boring using a tremie and adequate cleaning o pile base.
- Pile holes should be cased through the fill and soft alluvium.

## 8.12 Further Geotechnical Investigations

It is recommended that additional geotechnical investigations be undertaken to confirm the ground conditions for detailed design purposes. The geotechnical investigation should include:

I. Boreholes drilled using auger drilling methods to V-bit bit refusal on bedrock followed by rock coring to confirm our assessed conditions and to recover at least 3 m of medium strength rock below design foundation level.

II. In-situ testing including Standard Penetration Tests and DCP's to confirm the preliminary soil strength parameters.

III. Collection and lab testing of at least 2 CBR samples for pavement designs.

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# Attachment A – Geotechnical Investigation Plans


0 40 80 120 160 200 m

1:4000 @ A4

Map Title / Figure:

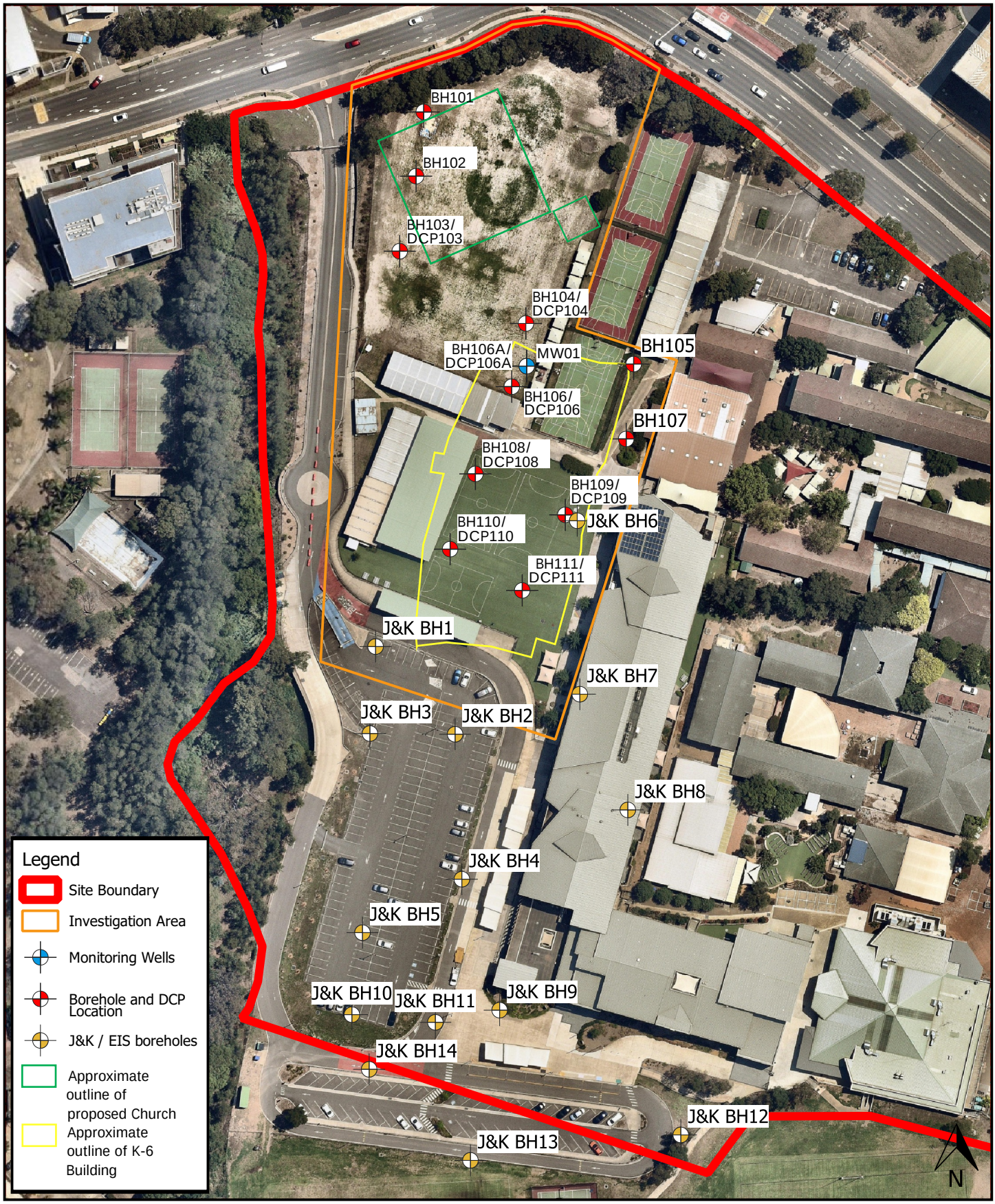
# Site Plan

| | |
|---|---|
| GE01 | Map |
| 2 Darcy Road, Westmead, NSW | Site |
| Preliminary Geotechnical and Hydrogeological Assessment | Project |
| SSD Application | Sub-Project |
| Catholic Education Diocese of Parramatta | Client |
| 13/02/2020 | Date |

martens
Environment | Water | Geotechnics | Civil | Projects



Project No: P1907547 Model: P1907547QGIS02 Projection: MGA Map Set: MS02-R01




0 10 20 30 40 50 m

1:1500 @ A4

Map Title / Figure:

# Geotechnical Investigation Plan

| | |
|---|---|
| GE02 | Map |
| 2 Darcy Raod, Westmead, NSW | Site |
| Preliminary Geotechnical and Hydrogeological Assessment | Project |
| SSD Application | Sub-Project |
| Catholic Diocese of Parramatta | Client |
| 13/02/2020 | Date |

martens
Environment | Water | Geotechnics | Civil | Projects



Project No: P1907547 Model: P1907547QGIS02 Projection: MGA Map Set: MS02-R01

# Attachment B – Test Borehole Logs

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 15/01/2020 | COMPLETED | 15/01/2020 | **REF BH101** |
| PROJECT | Geotechnical Investigation | | LOGGED | SVK | CHECKED | RE | Sheet 1 OF 1 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD ute-mounted hydraulic dril rig | EASTING | 150.983306 | RL SURFACE | 19.7 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 7.20 m depth | NORTHING | -33.803722 | ASPECT | Flat | SLOPE <5% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/T | | | | 19.70 | | | | SP | FILL: SAND; fine to medium grained; pale brown; trace silt and clay; poorly graded; poorly compacted. | D | L | FILL |
| | | | | *0.30* | 0.1/S/1 D 0.10 m | | | | | | | |
| | | | | 19.40 | | | | CL-CI | FILL: CLAY; low to medium plasticity; brown; with gravel; sand and silt; well graded; appears well compacted. | | | |
| | H | | | | 0.5/S/1 D 0.50 m | | | | | | | |
| | | | 1 | | 1/S/1 D 1.00 m | | | | | D | VSt - H | |
| | | | | *1.50* | | | | | | | | |
| | | | | 18.20 | | | | CH | FILL: CLAY; high plasticity; red-brown and brown; with gravel; sand and silt; poorly graded; appears moderately compacted. | | | |
| | L | | 2 | | 2/S/1 D 2.00 m | | | | | | | |
| | H | | | | | | | | | M (<PL) | St - VSt | |
| | M | | 3 | | 3/S/1 D 3.00 m | | | | | | | |
| | H | | | *3.80* | | | | | | | | |
| | | | | 15.90 | | | | CI - CH | CLAY; medium to high plasticity; grey-brown; with silt; trace sand; fine grained well rounded gravel. | | | ALLUVIUM |
| | | | 4 | | 4/S/1 D 4.00 m | | | | | M (<PL) | F | |
| | M | 18/01/20 | | | | | | | | | | |
| | | | 5 | | 5/S/1 D 5.00 m | | | | | M (>>PL) | S | 5.00: Organic Odour |
| | L | | | *5.60* | | | | | | | | |
| | | | | 14.10 | | | | CH | CLAY; high plasticity; grey-brown and grey; with silt; trace ironstone nodules. | | | RESIDUAL SOIL |
| | M | | 6 | | 6/S/1 D 6.00 m | | | | | | St | |
| | | | | *6.60* | | | | | | M (<PL) | | |
| | | | | 13.10 | | | | | From 6.6m - 7.2m inferred hard (inferred extremely weathered rock). | | | 6.60: Inferred extremely weathered rock to 7.0 m. |
| | H | | 7 | | | | | | | | VSt - H | |
| | | | | *7.20* | | | | | | | | |
| | | | | | | | | | Hole Terminated at 7.20 m (Target depth reached) | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS



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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 15/01/2020 | COMPLETED | 15/01/2020 | **REF BH102** |
| PROJECT | Geotechnical Investigation | | LOGGED | SVK | CHECKED | RE | Sheet 1 OF 1 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD ute-mounted hydraulic dril rig | EASTING | 150.983278 | RL SURFACE | 20 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 7.00 m depth | NORTHING | -33.803889 | ASPECT | Flat | SLOPE <5% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | | | | 20.00 | 0.1/S/1 D 0.10 m | | | CL-CI | FILL: Sandy CLAY; low to medium plasticity; brown; with silt; trace gravel; poorly graded; appears to be well compacted. | | VSt | FILL |
| | | | | | 0.3/S/1 D 0.30 m | | | | | | | |
| | | | | | 0.5/S/1 D 0.50 m | | | | | | | |
| | | | | *0.70* | | | | | | | | |
| | H | | | 19.30 | | | | CL | FILL: Gravelly CLAY; low plasticity; brown; with sand; trace silt; poorly graded; appears well compacted. | | | 0.80: V-bit refusal. |
| | | | 1 | | 1/S/1 D 1.00 m | | | | | | | |
| | | | | *1.20* | | | | | | | | |
| | | | | 18.80 | | | | CL | FILL: CLAY; low plasticity; brown; with sand and gravel; trace silt; poorly graded; appears to be moderately compacted. | D | | |
| | L | | 2 | | 2/S/1 D 2.00 m | | | | | | | |
| | | | | *2.50* | | | | | | | | |
| | | | | 17.50 | | | | CI-CH | CLAY; medium to high plasticity; grey; with silt; trace sand and fine well rounded gravel. | | St | ALLUVIUM<br>2.50: Organic colour. |
| AD/T | | | 3 | | 3/S/1 D 3.00 m | | | | | M (>PL) | | |
| | M | 15/01/20 | | | | | | | | | | |
| | | | | | | | | | | M (>>PL) | | |
| | | | 4 | | 4/S/1 D 4.00 m | | | | | | | |
| | | | | *4.30* | | | | | | | | |
| | | | | 15.70 | | | | CI-CH | CLAY; medium to high plasticity; red-brown; with silt; trace ironstone nodules. | M (>PL) | | RESIDUAL SOIL |
| | | | 5 | | 5/S/1 ES 5.00 m | | | | | | VSt | |
| | H | | | | | | | | | M (<PL) | | |
| | | | 6 | | 6/S/1 D 6.00 m | | | | | | | |
| | | | | | | | | | | | H | |
| | | | 7 | *7.00* | 7/S/1 D 7.00 m | | | | Hole Terminated at 7.00 m<br>(Target depth reached) | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS



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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 15/01/2020 | COMPLETED | 15/01/2020 | **REF BH103** |
| PROJECT | Geotechnical Investigation | | LOGGED | SVK | CHECKED | RE | Sheet 1 OF 1 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD ute-mounted hydraulic dril rig | EASTING | 150.983222 | RL SURFACE | 20.15 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 7.30 m depth | NORTHING | -33.804083 | ASPECT | Flat | SLOPE <5% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| | | | | 20.15 | | | | | | | | |
| AD/V | H | | | 0.30 | 0.1/S/1 D 0.10 m | | | CL | FILL: Sandy CLAY; low plasticity; brown; with silt; trace fine to medium gravel; poorly graded; poorly compacted. | | | FILL |
| | | | | 19.85 | | | | | | | | |
| | | | | | 0.5/S/1 D 0.50 m | | | CI-CH | FILL: Gravelly CLAY; medium to high plasticity; brown; with sand and silt; trace fine to medium gravels; poorly graded; appears well compacted. | | VSt | |
| | | | | 0.70 | | | | | | | | |
| | | | | 19.45 | | | | CI-CH | FILL: CLAY; medium to high plasticity; grey-brown; with silt and sand; fine to coarse gravels; poorly graded; appears to be well compacted; from 1.5m appears moderately to poory compacted. | D | | 0.70: V-bit refusal. |
| AD/T | M | | 1 | | 1.0/S/1 D 1.00 m | | | | | | St | |
| | | | 2 | | 2.0/S/1 D 2.00 m | | | | | M | F | |
| | | | | 2.80 | | | | | | | | |
| | | | | 17.35 | | | | CI-CH | Silty CLAY; medium to high plasticity; grey; trace sand; fine to medium gravels. | | | ALLUVIUM |
| AD/V | L | ▽ | 3 | | 3.0/S/1 D 3.00 m | | | | | | S | |
| | | | | 3.90 | | | | | | M (>>PL) | | |
| | | | | 16.25 | | | | | | | | RESIDUAL SOIL |
| | | | 4 | | 4.0/S/1 D 4.00 m | | | CI-CH | CLAY; medium to high plasticity; red-brown and grey; with silt; trace ironstone nodules. | M (>PL) | F | |
| | | | 5 | | 5.0/S/1 D 5.00 m | | | | | | | 5.00: V-bit refusal on ironstone nodules. |
| AD/T | H | | 6 | | 6.0/S/1 D 6.00 m | | | | | M (<PL) | VSt - H | |
| | | | 7 | 7.10 | 7.0/S/1 D 7.00 m | | | | | | | |
| | | | | 13.05 | | | | | SHALE; thinly laminated; highly weathered; inferred very low to low strength; with clay seams. | | | WEATHERED ROCK |
| | | | | 7.30 | | | | | Hole Terminated at 7.30 m (Target depth reached) | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS



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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 14/01/2020 | COMPLETED | 14/01/2020 | **REF BH104** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 1 OF 1 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983655 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 7.00 m depth | NORTHING | -33.804101 | ASPECT | West | SLOPE <3% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | H | | | 20.40 | 0.1/S/1 D 0.10 m | | | SM | FILL: Silty SAND; fine grained; dark grey and brown. | D | VSt - H | FILL |
| | | | | *0.20* | | | | | | | | |
| | H | | | 20.20 | | | | ML | FILL: Sandy SILT; low plasticity; red-brown; fine grained sand. | | | |
| | | | | *0.40* | 0.4/S/1 D 0.40 m | | | ML | FILL: Gravelly Sandy SILT; low plasticity; grey and brown; claystone gravels; fine to medium grained. | | St | 0.40: V-bit refusal. |
| | M | | | 20.00 | | | | | | | | |
| | | | | *0.70* | | | | | | | | |
| | H | | 1 | 19.70 | 1.0/S/1 D 1.00 m | | | CI | FILL: Silty CLAY; medium plasticity; brown and red-brown; trace ironstone,coal and claystone gravels. | M (<<PL) | VSt - H | |
| | M | | | | 1.7-1.9/S/1 D 1.70 m | | | | | | St | |
| | | | 2 | | 2.0/S/1 D 2.00 m | | | | | M (<PL) | | |
| | | | | *2.60* | | | | | | | | |
| | | 14/01/20 | | 17.80 | 2.7-3.0/S/1 D 2.70 m | | | | Brown, grey and red-brown. | | | |
| | | | 3 | | 3.0/S/1 D 3.00 m | | | | | M (=PL) | | 2.90: Water measured at 1 hour after drilling. |
| | | | | *3.40* | | | | | | | | |
| AD/T | L | | | 17.00 | 3.5-3.8/S/1 D 3.50 m | | | CI-CH | Silty CLAY; medium to high plasticity; olive and red-brown. | | F | ALLUVIUM |
| | | | | *3.80* | | | | | | | | |
| | | | | 16.60 | | | | CI-CH | CLAY; medium to high plasticity; grey and orange-red; trace subrounded ironstone gravels. | | | RESIDUAL SOIL |
| | | | 4 | | 4.0/S/1 D 4.00 m | | | | | | | |
| | | | | | 4.80 m | | | | | M (<PL) | | 4.80: Possible extremely weathered rock to 5.8 m. |
| | | | 5 | | 5.0/S/1 D 5.00 m | | | | | | VSt - H | |
| | | | | *5.80* | | | | | | | | |
| | H | | | 14.60 | 6.0/R/1 D 6.00 m | | | | CLAYSTONE; dark grey; distinctly weathered; inferred very low strength to low strength. | | | WEATHERED ROCK |
| | | | 6 | | | | | | | | | |
| | | | | *7.00* | | | | | | | | |
| | | | 7 | | 7.0/S/1 D 7.00 m | | | | Hole Terminated at 7.00 m (Target depth reached) | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS



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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 13/01/2020 | COMPLETED | 13/01/2020 | **REF BH105** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 1 OF 3 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983942 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 11.70 m depth | NORTHING | -33.804402 | ASPECT | Southeast | SLOPE 5% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | H | | 1 | 20.40 | 0.1/S/1 D 0.10 m | | | ML | FILL: Sandy Clayey SILT; low to medium plasticity; red-brown; trace subangular ironstone; plastic wrapping; well compacted. | | VSt - H | FILL |
| | | | | *0.40* | | | | | | | | |
| | H | | | 20.00 | 0.5/S/1 D 0.50 m | | | CI-CH | FILL: Silty CLAY; medium to high plasticity; red-brown and brown; trace brick fragments; well compacted. | | | |
| | | | 1 | | 1.0/S/1 D 1.00 m | | | | | M (<<PL) | St - VSt | |
| | | | | *1.50* | | | | | | | | |
| | | | | 18.90 | | | | | Red-brown and dark grey; poorly compacted. | | | 1.50: Drilling fluids used. |
| | | | 2 | | 2.0/S/1 D 2.00 m | | | | | | | |
| | | | | *2.40* | | | | | | | | |
| AD/T | L | ▽ | | 18.00 | SPT 2.50-2.95 m 3,3,3 N=6 1 2.5-2.95/S/1 D 2.50 m 2.60 m | | | CI-CH | Silty CLAY; medium to high plasticity; brown, grey, red and orange; trace ash and thin roots. | M (<PL) to M (=PL) | F | ALLUVIUM 2.60: Possible water inflow . |
| | | | 3 | | | | | | | | | |
| | | | | *3.50* | | | | | | | | |
| | | | | 16.90 | 3.6-3.8/S/1 D 3.60 m 3.70 m | | | CI-CH | CLAY; medium to high plasticity; red, grey and orange. | | | RESIDUAL SOIL |
| | | | | *3.80* | | | | | | | | |
| | | | | 16.60 | | | | | Grey and orange. | | | |
| | M | | 4 | | SPT 4.00-4.45 m 7,9,14 N=23 2 4.0-4.45/S/1 D 4.00 m 4.20 m | | | | | M (<PL) | VSt | |
| | | | | *4.40* | | | | | | | | |
| | | | | 16.00 | | | | | Trace subangular to subrounded ironstone gravels; grey, orange and red. | | | |
| | H | | | *5.00* | | | | | | M (<<PL) | | 4.80: inferred extremely weathered rock to 5.0 m |
| | | | 5 | 15.40 | | | | | CLAYSTONE; dark grey; highly weathered; inferred very low to low strength. | | | WEATHERED ROCK 5.00: V-bit refusal. |
| | M | | 6 | | | | | | | | | |
| | | | 7 | | | | | | | | | |
| | | | | *7.30* | | | | | | | | |
| | | | | | | | | | Continued as Cored Borehole | | | |

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***Engineering Log - BOREHOLE***

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|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 13/01/2020 | COMPLETED | 13/01/2020 | **REF BH105** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 2 OF 3 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983942 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 11.70 m depth | NORTHING | -33.804402 | ASPECT | Southeast | SLOPE 5% |

| Drilling | | | | | | Field Material Description | | | | Defect Information | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | WATER | TCR | RQD (SCR) | DEPTH (metres) | *DEPTH* RL | GRAPHIC LOG | ROCK / SOIL MATERIAL DESCRIPTION | WEATHERING | INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH) | DEFECT DESCRIPTION & Additional Observations | AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000) |
| | | | | 1 | | | | | | | |
| | | | | 2 | | | | | | | |
| | | | | 3 | | | | | | | |
| | | | | 4 | | | | | | | |
| | | | | 5 | | | | | | | |
| | | | | 6 | | | | | | | |
| | | | | 7 | | | | | | | |
| | | | | | ***7.30*** | | Continuation from non-cored borehole | | | | |
| NMLC | | 75 | 7 (26) | | 13.10 | | SHALE; thinly laminated; grey and brown. | HW | | 7.45-7.94: JT, 65 - 70°, Pl<br>7.49-7.72: JT, 50 - 70°, Pl | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS



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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 13/01/2020 | COMPLETED | 13/01/2020 | **REF BH105** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 3 OF 3 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983942 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 11.70 m depth | NORTHING | -33.804402 | ASPECT | Southeast | SLOPE 5% |

| Drilling | | | | | | Field Material Description | | | | Defect Information | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | WATER | TCR | RQD (SCR) | DEPTH (metres) | *DEPTH* RL | GRAPHIC LOG | ROCK / SOIL MATERIAL DESCRIPTION | WEATHERING | INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH) | DEFECT DESCRIPTION & Additional Observations | AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000) |
| NMLC | | 75 | 7 (26) | 8 | | | SHALE; thinly laminated; grey and brown. | HW | | | |
| | | | | | *8.36* 12.04 | | No Core. | | | | |
| | | | | | *8.70* 11.70 | | SHALE; thinly laminated; dark grey. | SW | | 8.72: DB<br>8.79: BP<br>8.83-8.85: Clay<br>8.90: BP, 0 - 10°, Clay, Pl, RF<br>8.91: BP, 0 - 10°, Clay, Pl, RF<br>8.93: JT, 20 - 30°, Clay, UN, RF<br>8.94: BP, 0 - 10°, Clay, Pl, RF<br>8.96: JT, 20 - 30°, Clay, UN, RF<br>9.00: DB<br>9.11: BP, 0 - 10°, Clay, Pl, RF<br>9.13: BP, 0 - 10°, Clay, Pl, RF<br>9.17: BP, 0 - 10°, Clay, Pl, RF<br>9.27: DB<br>9.28: BP, 0 - 10°, Clay, Pl, RF<br>9.44: JT, 20°, Pl<br>9.47: DB<br>9.72: DB<br>9.92: DB<br>10.00: DB<br>10.04: DB<br>10.21: DB<br>10.44: DB<br><br>10.86: DB<br><br>11.00: DB<br>11.10: BP, 0 - 10°, Clay, Pl, RF<br>11.11: BP, 0 - 10°, Clay, Pl, RF<br>11.28: DB<br><br>11.46: JT, 5 - 10°, CN, Pl<br>11.48: BP, 0 - 10°, Clay, Pl, RF<br>11.49: BP, 0 - 10°, Clay, Pl, RF | |
| | | 100 | 73 (95) | 9<br>10<br>11 | | | | | | | |
| | | | | | *11.70* 8.70 | | Hole Terminated at 11.70 m<br>(Target depth reached) | | | | |
| | | | | 12<br>13<br>14<br>15 | | | | | | | |

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***Engineering Log - BOREHOLE***

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|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 13/01/2020 | COMPLETED | 13/01/2020 | **REF BH106** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 1 OF 1 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD ute-mounted hydraulic dril rig | EASTING | 150.983569 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 1.50 m depth | NORTHING | -33.804438 | ASPECT | South | SLOPE <3% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | M | Not Encountered | | 20.40 | 0.1/S/1 D 0.10 m<br>0.1/S/Dup02 D 0.10 m | | | SM | FILL: Silty SAND; fine grained; dark grey; trace subangular to subrounded igneous and siltstone gravels; appears well compacted. | D | St | FILL |
| | | | | *0.30* | | | | | | | | |
| | | | | 20.10 | | | | ML | FILL: Sandy SILT; low plasticity; brown; fine to medium grained sand; trace ironstone gravels; appears well compacted. | | | |
| | | | | *0.60* | 0.5/S/Dup03 D 0.50 m | | | | | | | |
| AD/T | H | | | 19.80 | | | | CL-CI | FILL: Sandy Silty CLAY; low to medium plasticity; brown; fine to medium grained; trace glass shards; appears well compacted. | M (<<PL) | St - H | 0.60: V-bit refusal. |
| | | | 1 | | 1.0/S/Dup04 D 1.00 m | | | | | | | |
| | | | | *1.50* | | | | | Hole Terminated at 1.50 m | | | 1.50: Borehole terminated. TC-bit refusal on possible concrete. |
| | | | 2 | | | | | | | | | |
| | | | 3 | | | | | | | | | |
| | | | 4 | | | | | | | | | |
| | | | 5 | | | | | | | | | |
| | | | 6 | | | | | | | | | |
| | | | 7 | | | | | | | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 15/01/2020 | COMPLETED | 15/01/2020 | **REF BH106A** |
| PROJECT | Geotechnical Investigation | | LOGGED | SVK | CHECKED | RE | Sheet 1 OF 1 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD ute-mounted hydraulic dril rig | EASTING | 150.983571 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 7.20 m depth | NORTHING | -33.804412 | ASPECT | Flat | SLOPE <5% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | H | | 0 | 20.40 | 0.1/S/1 D 0.10 m | | | SP | FILL: SAND; fine to coarse grained; grey-brown; with silt and clay; poorly graded; appears well compacted. | | L | FILL |
| | | | | *0.30* 20.10 | | | | | | | | |
| | H | | | | 0.5/S/1 D 0.50 m | | | CL-CI | FILL: CLAY; low to medium plasticity; brown; with sand and silt; poorly graded; appears moderately compacted. | D | H | |
| | | | | *0.90* 19.50 | | | | | | | | 0.75: V-bit refusal. |
| | | | 1 | | 1.0/S/1 D 1.00 m | | | CI-CH | FILL: CLAY; medium to high plasticity; red-brown and brown; with silt and sand; trace gravels; poorly graded; appears well compacted. | | | |
| | M | | | | | | | | | M (<PL) | St - VSt | |
| | | | 2 | | 2.0/S/1 D 2.00 m | | | | | | | |
| | | | | *2.40* 18.00 | | | | ML | SILT; low to medium plasticity; grey; with clay; trace sand; trace fine, well rounded gravels. | | | ALLUVIUM |
| | L | | | | | | | | | M (<LL) | F - St | |
| | | | 3 | *3.00* 17.40 | | | | CI-CH | CLAY; medium to high plasticity; red-brown and grey; with silt; trace ironstone nodules. | | | RESIDUAL SOIL |
| AD/T | M | | | | | | | | | | VSt | |
| | | | 4 | | 4.0/S/1 D 4.00 m | | | | | | H | |
| | H | | | | | | | | | M (<PL) | | |
| | | | 5 | | 5.0/S/1 D 5.00 m | | | | | | VSt - H | |
| | M-H | | | *5.80* 14.60 | | | | | SHALE; thinly laminated; extremely to highly weathered; dark grey; inferred very low strength. | | | WEATHERED ROCK |
| | | | 6 | | 6.0/S/1 D 6.00 m | | | | | | | |
| | H | 15/01/20 | 7 | *7.20* | | | | | | | | 7.10: Seepage. |
| | | | | | | | | | Hole Terminated at 7.20 m (Target depth reached) | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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**Engineering Log - BOREHOLE**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 15/01/2020 | COMPLETED | 15/01/2020 | **REF BH106A/ MW01** |
| PROJECT | Geotechnical Investigation | | LOGGED | SVK | CHECKED | RE | Sheet 1 OF 1 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983571 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 7.20 m depth | NORTHING | -33.804412 | ASPECT | Flat | SLOPE <5% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | PIEZOMETER DETAILS ID MW01 Static Water Level |
| AD/V | H | | | 20.40 | 0.1/S/1 D 0.10 m | | | SP | FILL: SAND; fine to coarse grained; grey-brown; with silt and clay; poorly graded; appears well compacted. | | L | Concrete |
| | | | | *0.30* 20.10 | | | | | | | | |
| | H | | | | 0.5/S/1 D 0.50 m | | | CL-CI | FILL: CLAY; low to medium plasticity; brown; with sand and silt; poorly graded; appears moderately compacted. | D | H | |
| | | | | *0.90* 19.50 | | | | | | | | |
| | | | 1 | | 1.0/S/1 D 1.00 m | | | CI-CH | FILL: CLAY; medium to high plasticity; red-brown and brown; with silt and sand; trace gravels; poorly graded; appears well compacted. | | | Cuttings |
| | M | | | | | | | | | M (<PL) | St - VSt | |
| | | | 2 | | 2.0/S/1 D 2.00 m | | | | | | | Casing |
| | | | | *2.40* 18.00 | | | | ML | SILT; low to medium plasticity; grey; with clay; trace sand; trace fine, well rounded gravels. | M (<LL) | F - St | |
| | L | | | | | | | | | | | Bentonite |
| | | | 3 | *3.00* 17.40 | | | | CI-CH | CLAY; medium to high plasticity; red-brown and grey; with silt; trace ironstone nodules. | | VSt | |
| AD/T | M | | | | | | | | | | | |
| | | | 4 | | 4.0/S/1 D 4.00 m | | | | | | H | Screen |
| | H | | | | | | | | | | | |
| | | | 5 | | 5.0/S/1 D 5.00 m | | | | | M (<PL) | VSt - H | Sand |
| | M-H | | | | | | | | | | | |
| | | | | *5.80* 14.60 | | | | | SHALE; thinly laminated; extremely to highly weathered; dark grey; inferred very low strength. | | | |
| | | | 6 | | 6.0/S/1 D 6.00 m | | | | | | | |
| | H | | | | | | | | | | | |
| | | | 7 | | | | | | | | | |
| | | | | *7.20* | | | | | Hole Terminated at 7.20 m (Target depth reached) | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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**Engineering Log - TEST**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 13/01/2020 | COMPLETED | 13/01/2020 | **REF BH107** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 1 OF 1 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983889 | RL SURFACE | 20.15 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 6.30 m depth | NORTHING | -33.804618 | ASPECT | West | SLOPE 5% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | M | | 0 | 20.15<br>*0.20*<br>19.95 | 0.1/S/1 D 0.10 m | | | SM | FILL: Silty SAND; fine to medium grained; brown and grey; trace concrete fragments. | D | | FILL<br>0.00: From 0-0.2m; well compacted.<br>0.20: From 0.2-1.8m; moderately to well compacted. |
| | | | | | 0.5/S/1 D 0.50 m | | | CI-CH | FILL: CLAY; medium to high plasticity; red-brown; trace subangular siltstone gravels; brick fragments; moderately to well compacted. | | | |
| | | | | *0.80*<br>19.35 | | | | | Red and grey. | M (<<PL) | VSt | |
| | | | 1 | | 1.0/S/1 D 1.00 m | | | | | | | |
| | | | | *1.30*<br>18.85 | | | | ML | FILL: Sandy SILT; low plasticity; brown and dark brown; trace glass fragments; rounded quartz gravels. | | | |
| | | | | *1.50*<br>18.65 | 1.5-1.8/S/1 D 1.50 m | | | CI | FILL: Silty CLAY; medium plasticity; grey to brown; trace coal; roots and subrounded ironstone gravels. | | | 1.50: V-bit refusal. Possible residual |
| | | | | *1.80*<br>18.35 | | | | CI-CH | CLAY; medium to high plasticity; grey, red-orange; trace rounded to subangular ironstone gravels. | | H | RESIDUAL SOIL |
| | | | 2 | | 2.0/S/Dup01 D 2.00 m | | | | | | VSt | |
| | | | | | | | | | | M (<PL) | | 2.60: Inferred extremely weathered rock. |
| AD/T | H | | 3 | | 3.0/S/1 D 3.00 m | | | | | | H | |
| | | | | *3.80*<br>16.35 | | | | | CLAYSTONE; grey; highly weathered; inferred very low to low strength. | | | WEATHERED ROCK |
| | | | 4 | | 4.0/R/1 D 4.00 m | | | | | | | |
| | | 13/01/20 | 5 | | 5.0/R/1 D 5.00 m | | | | | | | |
| | | | | *5.20*<br>14.95 | | | | | Red-brown | | | |
| | | | | *5.50*<br>14.65 | | | | | SHALE; dark grey; highly weathered; inferred very low to low strength. | | | |
| | | | 6 | | 6.0/R/1 D 6.00 m | | | | | | | |
| | | | | *6.30* | | | | | Hole Terminated at 6.30 m<br>(Target depth reached) | | | |
| | | | 7 | | | | | | | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS



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**Engineering Log - BOREHOLE**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 09/01/2020 | COMPLETED | 09/01/2020 | **REF BH108** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 1 OF 1 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983455 | RL SURFACE | 20.25 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 7.00 m depth | NORTHING | -33.804653 | ASPECT | Northeast | SLOPE <3% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | M | | | 0.10<br>20.15 | 0.1/S/1 D 0.10 m | | | SP<br>CI | FILL: Silty Gravelly SAND; fine to medium grained; brown; subangular to angular brick fragments; with igneous gravels.<br>FILL: Silty CLAY; medium plasticity; brown and red-brown; with subangular igneous gravels; with fine to medium grained sand. | D<br>M (<<PL) | D<br>VSt | FILL |
| | | | | 0.50<br>19.75 | 0.5/S/1 D 0.50 m<br>0.6-0.9/S/1 D 0.60 m | | | CI-CH | FILL: CLAY; medium to high plasticity; red, red-brown, grey and orange; with silt; and subrounded ironstone gravels. | | | |
| | L | | 1 | | 1.0/S/1 D 1.00 m | | | | | M (<PL) | F - VSt | |
| | M | | 2 | 1.80<br>18.45 | 1.8/R/1 D 1.80 m<br>2.0/S/1 D 2.00 m | | | | With subangular siltstone gravels and cobbles. | | | |
| | L | | | 2.20<br>18.05 | 2.4/S/1 D 2.40 m<br>2.4-2.5/S/1 D 2.40 m | | | CI | FILL: Silty CLAY; medium plasticity; dark grey and brown; trace igneous gravels. | M (<PL) to M (=PL) | | |
| | M | 09/01/20 | 3 | 2.70<br>17.55 | 3.2-3.5/S/1 D 3.20 m<br>3.4/S/1 D 3.40 m<br>3.5/S/1 D 3.50 m | | | CI-CH | Silty CLAY; medium to high plasticity; grey, brown, red-brown and orange. | | St - VSt | ALLUVIUM<br>2.70: Possible alluvium/residual soil. |
| | | | 4 | 3.80<br>16.45 | 4.2-4.4/S/1 D 4.20 m<br>4.5/S/1 D 4.50 m | | | CH | CLAY; high plasticity; red, grey and orange; trace rounded ironstone gravels. | M (<PL) | VSt - H | RESIDUAL SOIL |
| AD/T | H | | 5 | 5.50<br>14.75 | 5.4/S/1 D 5.40 m | | | | SHALE; dark grey and grey; distinctly weathered; inferred very low strength. | | | WEATHERED ROCK<br>5.50: V-bit refusal. |
| | | | 6 | | 6.0-7.0/R/1 D 6.00 m | | | | | | | |
| | | | 7 | 7.00 | | | | | Hole Terminated at 7.00 m<br>(Target depth reached) | | | |

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**Engineering Log - BOREHOLE**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 09/01/2020 | COMPLETED | 09/01/2020 | **REF BH109** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 1 OF 3 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983711 | RL SURFACE | 20.3 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 11.56 m depth | NORTHING | -33.804726 | ASPECT | Northeast | SLOPE <3% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | | | | 20.30 | | | | SP | FILL: Silty Gravelly SAND; fine to medium grained; brown; with subangular to angular brick, igneous and concrete gravel. | D | D | FILL |
| | | | | *0.20* | 0.1/S/1 D 0.10 m | | | | | | | |
| | | | | 20.10 | | | | CI | FILL: Silty CLAY; medium plasticity; grey, brown, red-brown and orange; with subangular igneous gravels; claystone gravels. | M (<<PL) | | |
| | | | | | 0.5/S/1 D 0.50 m | | | | | | | |
| | | | 1 | | 1.0/S/1 D 1.00 m | | | | | | VSt | |
| | L | | | | | | | | | M (<PL) | | |
| | | 09/01/20 | | *1.70* | | | | | | | | |
| | | | | 18.60 | | | | CI-CH | FILL: CLAY; medium to high plasticity; dark grey; trace angular to subangular shale gravels. | | | |
| | | | 2 | | 2.0/S/1 D 2.00 m | | | | | M (=PL) | F - St | |
| | | 10/01/2020 | | *2.40* | | | | | | | | |
| | | | | 17.90 | | | | CH | CLAY; high plasticity; grey, red and orange. | | | RESIDUAL SOIL |
| | | | | | SPT 2.50-2.95 m<br>3,4,6<br>N=10 | | | | | | | 2.50: Water was observed on side of SPT. Inferred perched in fill over residual soil. |
| | | | | | 2.5-2.95/S/1 D 2.50 m<br>2.60 m | | | | | | | |
| | | | 3 | | | | | | | | | |
| | M | | | | | | | | | M (<PL) | St | |
| | H | | | *4.00* | | | | | | | H | 3.90: Inferred extremely weathered rock. |
| AD/T | | | 4 | 16.30 | | | | | SHALE/CLAYSTONE; grey; highly weathered; inferred very low strength. | | | WEATHERED ROCK<br>4.00: V-bit refusal. |
| | M | | | | 4.5-4.8/R/1 D<br>4.50-4.80 m | | | | | | | |
| | | | 5 | | | | | | | | | |
| | H | | | | | | | | | | | |
| | | | 6 | *6.00* | | | | | Continued as Cored Borehole | | | |
| | | | 7 | | | | | | | | | |

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**Engineering Log - BOREHOLE**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 09/01/2020 | COMPLETED | 09/01/2020 | **REF BH109** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 2 OF 3 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983711 | RL SURFACE | 20.3 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 11.56 m depth | NORTHING | -33.804726 | ASPECT | Northeast | SLOPE <3% |

| Drilling | | | | | | Field Material Description | | | | Defect Information | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | WATER | TCR | RQD (SCR) | DEPTH (metres) | *DEPTH* RL | GRAPHIC LOG | ROCK / SOIL MATERIAL DESCRIPTION | WEATHERING | INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH) | DEFECT DESCRIPTION & Additional Observations | AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000) |
| | | | | 1 | | | | | | | |
| | | | | 2 | | | | | | | |
| | | | | 3 | | | | | | | |
| | | | | 4 | | | | | | | |
| | | | | 5 | | | | | | | |
| | | | | 6 | *6.00* | | Continuation from non-cored borehole | | | | |
| | | 100 | 12 (26) | 7 | 14.30 | | SHALE; thinly laminated; brown and dark grey; fractures 0-10mm spacing. | HW | | 6.00-6.95: SZ, Possible sheared zone.<br>6.11-6.13: DS, 20mm<br>6.13: DS, 5mm<br>6.14-7.70: JTSet >18, 20 - 25°, Pl, Sm, Spacing 10mm-400mm<br>6.24: DS, 10mm<br>6.27-6.31: DS, 40mm<br>6.49: DS, 2mm<br>6.58: DS, 2mm<br>6.61: DS, 2mm<br>6.64: DS, 1mm<br>6.78-6.94: JTSet 2, 65 - 70°, Pl, Ro<br>7.30-7.65: JTSet 2, 60 - 70°, Pl, Ro | |

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***Engineering Log - BOREHOLE***

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|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 09/01/2020 | COMPLETED | 09/01/2020 | **REF BH109** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 3 OF 3 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983711 | RL SURFACE | 20.3 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 11.56 m depth | NORTHING | -33.804726 | ASPECT | Northeast | SLOPE <3% |

| Drilling | | | | | | Field Material Description | | | | Defect Information | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | WATER | TCR | RQD (SCR) | DEPTH (metres) | *DEPTH* RL | GRAPHIC LOG | ROCK / SOIL MATERIAL DESCRIPTION | WEATHERING | INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH) | DEFECT DESCRIPTION & Additional Observations | AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000) |
| | | | | | *7.85* 12.45 | | SHALE; thinly laminated; dark grey. | HW / SW | | 7.63: DS, 10mm<br>7.74: DS, 5mm<br>7.78-7.82: DS, 40mm<br>7.88: DS, 2mm<br>8.00: DB<br>8.00-8.05: DS, 50mm<br>8.05-8.15: JT, 70 - 80°, UN, RF<br>8.12: DS, 5mm<br>8.15: DS, 2mm<br>8.19: BP, 0 - 10°, Pl, RF, Tight clay lined<br>8.20-8.22: FZ, 10 - 20°, Pl, RF, 95 mm aperture, clay filled.<br>8.22-8.40: FZ, 70 - 80°, Pl, RF, tight, clean<br>8.23: BP, 0 - 10°, Pl, RF, Tight clay lined<br>8.26: BP, 0 - 10°, Pl, RF, Tight clay lined<br>8.36: BP, 0 - 10°, Pl, RF, Tight clay lined<br>8.50: DB<br>8.51-8.53: FZ, 60 - 70°, Pl, RF, Tight, clay lined<br>8.53-8.54: DS, 10mm<br>8.54: FZ, 20°, Pl, RF, Tight, clay lined<br>8.57: FZ, 20°, Pl, RF, Tight, clay lined<br>8.60-8.74: FZ, 90°, Pl, RF, Tight, clay lined<br>8.61: FZ, 10 - 20°, Pl, RF, Tight, clean<br>8.74: FZ, 30 - 40°, Pl, RF, Tight, clean<br>8.80: DB<br>8.85: DB<br>8.87: DB<br>8.92-9.70: JT, 10 - 50°, Pl, RF, 80 mm to 300 mm spacing.<br>9.00: DB<br>9.12: DB<br>9.70: DB<br>9.86: DB<br>9.97: DB<br>10.00: DB<br>10.06: FZ, 50°, Pl, RF, Tight, clean<br>10.19: DB<br>10.38: DB<br>10.49: DB<br>10.62-10.74: FZ, 60 - 90°, Pl, RF, Tight, clean<br>10.66: DB<br>10.74: DB<br>10.86-10.96: JT, 70 - 80°, UN, RF<br>10.96: DB<br>11.00: DB<br>11.06: JT, 40 - 50°, Pl, RF<br>11.16: DB<br>11.26: DB<br>11.27: FZ, 70 - 80°, Pl, RF, Tight, clean<br>11.33: DB<br>11.40: DB<br>11.53: DB | |
| | | 100 | 12 (26) | 8 | | | | | | | |
| | | 100 | 85 (95) | 9 | | | | | | | |
| | | | | 10 | | | | | | | |
| | | | | 11 | *11.56* 8.74 | | Hole Terminated at 11.56 m<br>(Target depth reached) | | | | |
| | | | | 12 | | | | | | | |
| | | | | 13 | | | | | | | |
| | | | | 14 | | | | | | | |
| | | | | 15 | | | | | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS



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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 08/01/2020 | COMPLETED | 08/01/2020 | **REF BH110** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 1 OF 3 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.98335 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 13.00 m depth | NORTHING | -33.804923 | ASPECT | Southeast | SLOPE <2% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | H | | | 20.40 | 0.1/S/1 D 0.10 m | | | SP | FILL: Silty Gravelly SAND; fine to medium grained; brown; subangular to angular gravels consisting of brick, concrete and igneous rock. | D | VD | FILL |
| | | | | *0.60* | 0.5/S/1 D 0.50 m | | | | | | | |
| | | | | 19.80 | | | | CI | FILL: Silty CLAY; medium plasticity; grey, brown, orange and red; with subangular sandstone, shale and igneous granules; trace coal. | | VSt | |
| | | | 1 | | 1.0/S/1 D 1.00 m | | | | | | | |
| | M | | | | 1.2-1.5/S/1 D 1.20 m | | | | | M (<<PL) | St | |
| | | | | | 1.5/S/1 D 1.50 m | | | | | | | |
| | | | 2 | | 2.0/S/1 D 2.00 m | | | | | | VSt | |
| | | | | *2.35* | 2.3/S/1 D 2.30 m | | | | | | | |
| AD/T | H | | | *2.50* | 2.4/S/1 D 2.40 m | | | | FILL: SANDSTONE; Cobble/Boulder. | | | 2.35: V-bit refusal. |
| | | | | 17.90 | SPT 2.50-2.95 m<br>6,4,5<br>N=9 | | | CI | FILL: Silty CLAY; medium plasticity; grey and brown; with subrounded to subangular concrete and igneous fragments/granules. | | | |
| | M | ▽ | | | 2.5/S/1 D 2.50 m<br>2.5-2.95/S/1 D 2.50 m | | | | | M (<PL) | St | 2.70: Water measured |
| | | | 3 | *3.20* | | | | | | | | |
| AD/V | | | | 17.20 | | | | CI-CH | Silty CLAY; medium to high plasticity; grey and orange; trace roots (1mm) | | | ALLUVIUM |
| | | | | | | | | | | | | |
| | | | 4 | | SPT 4.00-4.45 m<br>2,3,3<br>N=6 | | | | | M (=PL) | F | |
| | L | | | | 4.0-4.45/s/1 D 4.00 m<br>4.4-4.45/S/1 D 4.40 m | | | | | | | |
| | | | | | 4.8/S/1 D 4.80 m | | | | | | | |
| | | | 5 | *5.00* | | | | | | | | |
| | | | | 15.40 | | | | CI-CH | CLAY; medium to high plasticity; grey, orange and red; trace ironstone rich layers / ironstone fragments. | | | RESIDUAL SOIL |
| | | | | | SPT 5.50-5.95 m<br>3,12,18<br>N=30 | | | | | | | |
| | M | | | | 5.5-5.95/S/1 D 5.50 m | | | | | M (<PL) | VSt - H | |
| | | | 6 | | | | | | | | | |
| | H | | | | 6.5/S/1 D 6.50 m | | | | | M (<<PL) | H | 6.50: Inferred extremely weathered rock |
| | | | | *6.70* | | | | | | | | |
| AD/T | | | | 13.70 | | | | | SHALE; dark brown and dark grey; distinctly weathered; inferred low strength. | | | WEATHERED ROCK<br>6.70: V-bit refusal. |
| | M | | 7 | | | | | | | | | |
| | | | | *7.50* | | | | | | | | |
| | | | | | | | | | Continued as Cored Borehole | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS



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**Engineering Log - BOREHOLE**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | COMMENCED | 08/01/2020 | COMPLETED | 08/01/2020 | **REF BH110** | |
| PROJECT | Geotechnical Investigation | LOGGED | DI | CHECKED | RE | Sheet 2 OF 3 | |
| SITE | 2 Darcy Rd, Westmead, NSW | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 | |
| EQUIPMENT | 4WD truck-mounted hydraulic drill rig | EASTING | 150.98335 | RL SURFACE | 20.4 m | DATUM | AHD |
| EXCAVATION DIMENSIONS | Ø100 mm x 13.00 m depth | NORTHING | -33.804923 | ASPECT | Southeast | SLOPE | <2% |

| Drilling | | | | | | Field Material Description | | | | Defect Information | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | WATER | TCR | RQD (SCR) | DEPTH (metres) | *DEPTH* RL | GRAPHIC LOG | ROCK / SOIL MATERIAL DESCRIPTION | WEATHERING | INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH) | DEFECT DESCRIPTION & Additional Observations | AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000) |
| | | | | 1 | | | | | | | |
| | | | | 2 | | | | | | | |
| | | | | 3 | | | | | | | |
| | | | | 4 | | | | | | | |
| | | | | 5 | | | | | | | |
| | | | | 6 | | | | | | | |
| | | | | 7 | | | | | | | |
| | | | | | ***7.50*** | | Continuation from non-cored borehole | | | | |
| | | 100 | 0 (30) | | 12.90 | | SHALE; thinly laminated; brown. | HW | | 7.50-8.38: FZ, Highly fractured, fractures generally 5 - 20 mm spacings. | |

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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 08/01/2020 | COMPLETED | 08/01/2020 | **REF BH110** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI | CHECKED | RE | Sheet 3 OF 3 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.98335 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 13.00 m depth | NORTHING | -33.804923 | ASPECT | Southeast | SLOPE <2% |

| Drilling | | | | | | Field Material Description | | | | Defect Information | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | WATER | TCR | RQD (SCR) | DEPTH (metres) | *DEPTH* RL | GRAPHIC LOG | ROCK / SOIL MATERIAL DESCRIPTION | WEATHERING | INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH) | DEFECT DESCRIPTION & Additional Observations | AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000) |
| NMLC | | 100 | 0 (30) | 8 | | | SHALE; thinly laminated; brown. | HW | | | |
| | | | | | *8.38* 12.02 | | NO CORE. | | | | |
| | | 0 | 0 (0) | 9 | *9.20* | | | | | | |
| | | 87 | 83 (85) | 10 | *9.35* 11.05 | | SHALE; thinly laminated; dark grey. | HW SW | | 9.20-9.35: FZ, Highly fractured, fractures generally 5 - 20 mm spacings.<br>9.51: DB<br>9.55-9.56: FZ, 40 - 50°, Clay VNR, Pl, RF<br>9.66: DB<br>9.70: BP, 0°, Clay VNR, Pl, RF<br>9.71: BP, 0°, Clay VNR, Pl, RF<br>9.81: DB<br>9.91: DB<br>10.00: DB<br>10.11-10.15: JTset 2, 40 - 50°, Clay VNR, Pl, RF<br>10.12: DB<br>10.23: DB<br>10.30: DB<br>10.35: DB<br>10.49: DB<br>10.57: DB | |
| | | 100 | 100 (100) | 11 | *10.60* 9.80 | | LAMINITE: thinly laminated to thinly bedded; grey and dark grey (interbedded shale, siltstone and fine grained sandstone) | | | 11.78: DB<br>11.80: DB<br>12.00: DB<br>12.04: DB<br>12.11: DB<br>12.32: DB<br>12.59: DB<br>12.83: DB<br>12.91: BP, 0°, Clay VNR, Pl, RF | |
| | | | | 12 | | | | | | | |
| | | | | 13 | *13.00* 7.40 | | Hole Terminated at 13.00 m<br>(Target depth reached) | | | | |
| | | | | 14 | | | | | | | |
| | | | | 15 | | | | | | | |

EXCAVATION LOG TO BE READ IN CONJUCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS



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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 08/01/2020 | COMPLETED | 08/01/2010 | **REF BH111** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI / SVK | CHECKED | RE | Sheet 1 OF 2 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983632 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 9.20 m depth | NORTHING | -33.805028 | ASPECT | Flat | SLOPE <5% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | DEPTH RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/V | | | | 20.40 | | | | | | | | |
| | | | | *0.20* | 0.1/S/1 D 0.10 m | | | SP | FILL: Gravelly Clayey SAND; medium grained; brown; with igneous gravels. | D | D | FILL |
| | | | | 20.20 | 0.20 m | | | CH | FILL: CLAY; high plasticity; grey and red; trace igneous gravels. | | | |
| | | | | *0.40* | | | | | | | | |
| | | | | 20.00 | 0.5/S/1 D 0.50 m | | | CI-CH | FILL: Silty CLAY; medium to high plasticity; brown, grey, red and orange; trace shale; with subangular igneous and brick fragments. | M (<<PL) | VSt | |
| | L | | | | | | | | | | | |
| | | | | | | | | | | | St | |
| | | | 1 | | 1.0/S/1 D 1.00 m | | | | | M (<PL) | | |
| | | | | *1.20* | | | | | | | | |
| | | | | 19.20 | | | | CL | FILL: Silty CLAY; low plasticity; grey and brown; trace ironstone and shale gravels. | M (=PL) | S - F | |
| | | | | *1.60* | 1.5/S/1 D 1.50 m | | | | | | | |
| | | | | 18.80 | | | | CL-CI | Silty CLAY; low to medium plasticity; red-brown; trace ironstone gravels. | | | RESIDUAL SOIL |
| | L-M | | 2 | | 2.0/S/1 D 2.00 m | | | | | | St | |
| | | | | *2.30* | 2.2-2.5/S/1 D 2.20 m | | | | | | | |
| | | | | 18.10 | 2.40 m | | | CI-CH | CLAY; medium to high plasticity; red, grey and yellow-orange; with silt. | M (<PL) | | |
| | M | | | *2.60* | 2.5/S/1 D 2.50 m | | | | | | | |
| | | | | 17.80 | | | | | Tree roots (20mm to 30mm diameter). | | | |
| | M-H | | 3 | | | | | | | | VSt - H | 3.10: Water found on auger; slight seepage. |
| | | | | *3.40* | | | | | | | | |
| | | | | 17.00 | 3.5/R/1 D 3.50 m | | | | CLAYSTONE; grey; inferred very low strength; highly weathered; (possible siltstone/claystone). | | | WEATHERED ROCK |
| | H | | | *3.80* | | | | | | | | |
| AD/T | | Not Encountered | | 16.60 | | | | | Inferred very low to low strength. | | | 3.80: V-bit refusal. |
| | | | 4 | | | | | | | | | |
| | M | | | | 4.5/R/1 D 4.50 m | | | | | | | |
| | | | 5 | | | | | | | | | |
| | | | | *5.20* | | | | | | | | |
| | | | | 15.20 | | | | | CLAYSTONE/SHALE; grey and dark grey; inferred low strength; extremely weathered to highly weathered. | | | |
| | | | | | 5.5/R/1 D 5.50 m | | | | | | | |
| | | | 6 | | | | | | | | | |
| | H | | | *6.50* | | | | | | | | |
| | | 08/01/20 | | 13.90 | | | | | SHALE; dark grey; inferred very low strength; highly weathered. | | | |
| | | | 7 | | | | | | | | | |

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***Engineering Log - BOREHOLE***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CLIENT | Catholic Education Diocese of Parramatta | | COMMENCED | 08/01/2020 | COMPLETED | 08/01/2010 | **REF BH111** |
| PROJECT | Geotechnical Investigation | | LOGGED | DI / SVK | CHECKED | RE | Sheet 2 OF 2 |
| SITE | 2 Darcy Rd, Westmead, NSW | | GEOLOGY | Ashfield Shale | VEGETATION | Grass | PROJECT NO. P1907547 |
| EQUIPMENT | | 4WD truck-mounted hydraulic drill rig | EASTING | 150.983632 | RL SURFACE | 20.4 m | DATUM AHD |
| EXCAVATION DIMENSIONS | | Ø100 mm x 9.20 m depth | NORTHING | -33.805028 | ASPECT | Flat | SLOPE <5% |

| Drilling | | | | | Sampling | | Field Material Description | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METHOD | PENETRATION RESISTANCE | WATER | DEPTH (metres) | *DEPTH* RL | SAMPLE OR FIELD TEST | RECOVERED | GRAPHIC LOG | USCS / ASCS CLASSIFICATION | SOIL/ROCK MATERIAL DESCRIPTION | MOISTURE CONDITION | CONSISTENCY DENSITY | STRUCTURE AND ADDITIONAL OBSERVATIONS |
| AD/T | H | Not Encountered | 8 | | | | | | SHALE; dark grey; inferred very low strength; highly weathered. | | | |
| | | | | | 8.5-90/R/1 D 8.50 m | | | | | | | |
| | | | 9 | *9.20* | | | | | | | | |
| | | | | | | | | | Hole Terminated at 9.20 m<br>(Target depth reached) | | | 9.20: TC-bit refusal on inferred low to medium strength shale. |
| | | | 10 | | | | | | | | | |
| | | | 11 | | | | | | | | | |
| | | | 12 | | | | | | | | | |
| | | | 13 | | | | | | | | | |
| | | | 14 | | | | | | | | | |
| | | | 15 | | | | | | | | | |

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***Engineering Log - BOREHOLE***

# Attachment C – DCP 'N' Counts

# Dynamic Cone Penetrometer Test Log Summary

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| | | | |
|---|---|---|---|
| **Site** | 2 Darcy Road, Westmead NSW | **DCP Group Reference** | P1907096JS01 |
| **Client** | Catholic Education Diocese of Parramatta C/- WINIM Developments Pty Ltd | **Log Date** | 13.01.2020 - 18.01.2020 |
| **Logged by** | DI & SvK | | |
| **Checked by** | RE | | |
| **Comments** | DCP tests commenced at 50 mm below ground level. | | |

**TEST DATA**

| Depth Interval (m) | DCP102 | DCP103 | DCP104 | DCP105 | DCP106 | DCP106A | DCP107 | |
|---|---|---|---|---|---|---|---|---|
| **0.15** | 19 | - | 12 | 13 | 17 | 21 | 16 | |
| **0.30** | 38 for 140 mm | - | 32 | 23 | Terminated due to high N count at 0.2 m (30 for 50 mm). | Terminated due to high N count at 0.23 m (30 for 80 mm). | 24 | |
| **0.45** | Terminated due to double bouncing at 0.44 m. | - | Terminated due to high N count at 0.35 m | 16 | | | 27 | |
| **0.60** | | - | | 17 | | | 28 | |
| **0.75** | | - | | 29 | | | 21 | |
| **0.90** | | - | | 26 | | | 21 | |
| **1.05** | | - | | 15 | | | 15 | |
| **1.20** | | - | | 15 | | | 16 | |
| **1.35** | | - | | 14 | | | 13 | |
| **1.50** | | - | | 10 | | | 17 | |
| **1.65** | | - | | 11 | | | 25 | |
| **1.80** | | - | | 10 | | | 18 | |
| **1.95** | | - | | 11 | | | 15 | |
| **2.10** | | - | | 11 | | | 13 | |
| **2.25** | | - | | 16 | | | 10 | |
| **2.40** | | 1 | | 16 | | | 12 | |
| **2.55** | | 1 | | 9 | | | 13 | |
| **2.70** | | 2 | | Terminated at target depth | | | 16 | |
| **2.85** | | 4 | | | | | 18 | |
| **3.00** | | 5 | | | | | 20 | |
| **3.15** | | 4 | | | | | 28 | |
| **3.30** | | 6 | | | | | 35 | |
| **3.45** | | 8 | | | | | Terminated due to high N count at 3.35 m. | |
| **3.60** | | 9 | | | | | | |
| **3.75** | | 11 | | | | | | |
| **3.90** | | 12 | | | | | | |
| **4.05** | | 17 | | | | | | |
| **4.20** | | 16 | | | | | | |
| **4.35** | | 17 | | | | | | |
| **4.50** | | 18 | | | | | | |
| **4.65** | | 19 | | | | | | |
| **4.80** | | 28 | | | | | | |
| **4.95** | | 24 | | | | | | |
| **5.10** | | 32 | | | | | | |
| | | Terminated due to high N count at 5.1 m. | | | | | | |

# Dynamic Cone Penetrometer Test Log Summary

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| | | | |
|---|---|---|---|
| **Site** | 2 Darcy Road, Westmead NSW | **DCP Group Reference** | P1907096JS01 |
| **Client** | Catholic Education Diocese of Parramatta C/- WINIM Developments Pty Ltd | **Log Date** | 13.01.2020 - 18.01.2020 |
| **Logged by** | DI & SvK | | |
| **Checked by** | RE | | |
| **Comments** | DCP tests commenced 50 mm below ground level. | | |

**TEST DATA**

| Depth Interval (m) | DCP108 | DCP109 | DCP110 | DCP111 | | | | |
|---|---|---|---|---|---|---|---|---|
| **0.15** | - | - | 36 | - | | | | |
| **0.30** | 22 | 12 | 35 | 11 | | | | |
| **0.45** | 14 | 12 | 15 | 15 | | | | |
| **0.60** | 9 | 12 | 9 | 12 | | | | |
| **0.75** | 7 | 13 | 9 | 7 | | | | |
| **0.90** | 4 | 9 | 9 | 4 | | | | |
| **1.05** | 5 | 8 | 6 | 5 | | | | |
| **1.20** | 5 | 7 | 6 | 2 | | | | |
| **1.35** | 3 | 7 | 6 | 2 | | | | |
| **1.50** | 5 | 8 | 4 | 1 | | | | |
| **1.65** | 12 | 9 | 6 | 7 | | | | |
| **1.80** | 12 | 4 | 5 | 6 | | | | |
| **1.95** | 11 | 5 | 6 | 8 | | | | |
| **2.10** | 7 | 6 | 7 | 11 | | | | |
| **2.25** | 4 | 7 | 8 | 10 | | | | |
| **2.40** | 6 | 10 | 31 for 100 mm. | 9 | | | | |
| **2.55** | 15 | 12 | Terminated due to double bouncing at 2.35m. | 11 | | | | |
| **2.70** | Terminated at target depth | Terminated due to double bouncing at 2.6m. | | 17 | | | | |
| **2.85** | | | | 27 | | | | |
| **3.00** | | | | 32 | | | | |
| **3.15** | | | | 42 | | | | |
| **3.30** | | | | Terminated due to high N count at 3.2m. | | | | |
| **3.45** | | | | | | | | |
| **3.60** | | | | | | | | |
| **3.75** | | | | | | | | |
| **3.90** | | | | | | | | |
| **4.05** | | | | | | | | |
| **4.20** | | | | | | | | |
| **4.35** | | | | | | | | |
| **4.50** | | | | | | | | |
| **4.65** | | | | | | | | |
| **4.80** | | | | | | | | |
| **4.95** | | | | | | | | |
| **5.10** | | | | | | | | |

# Attachment D – Rock Core Photographs


| | | | |
|---|---|---|---|
| **Martens & Associates Pty Ltd** ABN 85 070 240 890 | | **Environment \| Water \| Wastewater \| Geotechnical \| Civil \| Management** | |
| Drawn: | SvK | **PHOTO OF ROCK CORE (BH105 Box 1 of 1)**<br>**WCC Stage 1 - 2 Darcy Road, Westmead NSW** | Drawing:<br>**FIGURE 2** |
| Approved: | RE | | |
| Date: | 21.02.2020 | | |
| Scale: | NA | | File No: P1907547JR02V02 |


| | | | |
|---|---|---|---|
| **Martens & Associates Pty Ltd** ABN 85 070 240 890 | | **Environment \| Water \| Wastewater \| Geotechnical \| Civil \| Management** | |
| Drawn: | SvK | **PHOTO OF ROCK CORE (BH109 Box 1 of 2)**<br>**WCC Stage 1 - 2 Darcy Road, Westmead NSW** | Drawing:<br>**FIGURE 3** |
| Approved: | RE | | |
| Date: | 21.02.2020 | | |
| Scale: | NA | | File No: P1907547JR02V02 |


| | | | |
|---|---|---|---|
| **Martens & Associates Pty Ltd** ABN 85 070 240 890 | | **Environment \| Water \| Wastewater \| Geotechnical \| Civil \| Management** | |
| Drawn: | SvK | **PHOTO OF ROCK CORE (BH109 Box 2 of 2)**<br>**WCC Stage 1 - 2 Darcy Road, Westmead NSW** | Drawing:<br>**FIGURE 4** |
| Approved: | RE | | |
| Date: | 21.02.2020 | | |
| Scale: | NA | | File No: P1907547JR02V02 |


| | | | |
|---|---|---|---|
| **Martens & Associates Pty Ltd** ABN 85 070 240 890 | | **Environment \| Water \| Wastewater \| Geotechnical \| Civil \| Management** | |
| Drawn: | SvK | **PHOTO OF ROCK CORE (BH110 Box 1 of 2)**<br>**WCC Stage 1 - 2 Darcy Road, Westmead NSW** | Drawing:<br>**FIGURE 5** |
| Approved: | RE | | |
| Date: | 21.02.2020 | | File No: P1907547JR02V02 |
| Scale: | NA | | |


| | | | |
|---|---|---|---|
| **Martens & Associates Pty Ltd** ABN 85 070 240 890 | | **Environment \| Water \| Wastewater \| Geotechnical \| Civil \| Management** | |
| Drawn: | SvK | **PHOTO OF ROCK CORE (BH110 Box 2 of 2)**<br>**WCC Stage 1 - 2 Darcy Road, Westmead NSW** | Drawing:<br>**FIGURE 6** |
| Approved: | RE | | |
| Date: | 21.02.2020 | | |
| Scale: | NA | | File No: P1907547JR02V02 |

# Attachment E – Laboratory Analytical Certificates

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
**ABN:** 25 131 532 020
**Sydney:** 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
**Ph:** (02) 9674 7711 **| Fax:** (02) 9674 7755 **| Email:** info@resourcelab.com.au

# Test Report

**Customer:** Martens & Associates Pty Ltd
**Project:** P1907547
**Location:** 2 Darcy Road, Westmead, NSW

**Job number:** 20-0002
**Report number:** 2
**Page:** 1 of 1

## Soil Index Properties

**Sampling method:** Tested as received

**Test method(s):** AS 1289.1.1, 2.1.1, 3.1.1, 3.2.1, 3.3.1 .3.4.1

| | Results | | | | |
|---|---|---|---|---|---|
| **Laboratory sample no.** | 20732 | 20733 | 20739 | | |
| **Customer sample no.** | 7547/BH103/ 3.0m | 7547/BH106/ 3.0-4.0m | 7547/BH119/ 0.2-0.5m | | |
| **Date sampled** | 08-18/01/2020 | 08-18/01/2020 | 18/01/2020 | | |
| Material description | silty CLAY, trace of gravel, dark brown/dark grey | silty CLAY, red/grey | silty CLAY, trace of gravel, yellow-brown/red/grey | | |
| Liquid limit (%) | 39 | 65 | 74 | | |
| Plastic limit (%) | 16 | 17 | 23 | | |
| Plasticity index (%) | 23 | 48 | 51 | | |
| Linear shrinkage (%) | 10.0 | 18.5 | 13.5 | | |
| Cracking / Curling / Crumbling | Cracking and curling | Cracking and curling | Curling | | |
| Sample history | Air dried | Air dried | Air dried | | |
| Preparation | Dry sieved | Dry sieved | Dry sieved | | |

**Approved Signatory:** E. Maldonado **Date:** 31/01/2020

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
**ABN:** 25 131 532 020
**Sydney:** 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
**Ph:** (02) 9674 7711 **| Fax:** (02) 9674 7755 **| Email:** info@resourcelab.com.au

# Test Report

**Customer:** Martens & Associates Pty Ltd
**Project:** P1907547
**Location:** 2 Darcy Road, Westmead, NSW

**Job number:** 20-0002
**Report number:** 4
**Page:** 1 of 1

## Soil Index Properties

**Sampling method:** Tested as received

**Test method(s):** AS 1289.1.1, 2.1.1, 3.1.2, 3.2.1, 3.3.1 .3.4.1

| | Results | | | | |
|---|---|---|---|---|---|
| **Laboratory sample no.** | 20743 | | | | |
| **Customer sample no.** | 7547/BH103/4.0m | | | | |
| **Date sampled** | 08-18/01/2020 | | | | |
| Material description | silty CLAY, trace of gravel, brown/ grey/yellow-brown | | | | |
| Liquid limit (%) | 55 | | | | |
| Plastic limit (%) | 17 | | | | |
| Plasticity index (%) | 38 | | | | |
| Linear shrinkage (%) | 16.5 | | | | |
| Cracking / Curling / Crumbling | Curling | | | | |
| Sample history | Air dried | | | | |
| Preparation | Dry sieved | | | | |

**Approved Signatory:** C. Greely **Date:** 03/02/2020

NATA ACCREDITED FOR TECHNICAL COMPETENCE

Accredited for compliance with ISO/IEC 17025 - Testing.

NATA Accredited Laboratory Number: **17062**

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
ABN: 25 131 532 020
Sydney: 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
Ph: (02) 9674 7711 | Fax: (02) 9674 7755 | Email: info@resourcelab.com.au

# Test Report

**Customer:** Martens & Associates Pty Ltd
**Project:** P1907547
**Location:** 2 Darcy Road, Westmead, NSW

**Job number:** 20-0002
**Report number:** 3


## Point Load Strength Index

**Sampling method:** Tested as received
**Test method(s):** AS 4133.4.1 Clause 3.2, 3.3

| | Results | | | | |
|---|---|---|---|---|---|
| **Laboratory sample no.** | 20744 | 20745 | 20746 | 20747 | 20748 |
| **Customer sample no.** | 7547/BH105/ 9.00-9.12m | 7547/BH105/ 11.12-11.27m | 7547/BH109/ 9.12-9.27m | 7547/BH109/ 10.37-10.49m | 7547/BH110/ 9.34-9.50m |
| **Sample depth** | 9.00-9.12m | 11.12-11.27m | 9.12-9.27m | 10.37-10.49m | 9.34-9.50m |
| **Date sampled** | 08-18/01/2020 | 08-18/01/2020 | 08-18/01/2020 | 08-18/01/2020 | 08-18/01/2020 |
| **Date tested** | 30/01/2020 | 30/01/2020 | 30/01/2020 | 30/01/2020 | 30/01/2020 |
| Lithological description | SHALE | LAMINITE | SHALE | SHALE | SHALE |
| **Diametral** | | | | | |
| Moisture content condition | Moist | Moist | Moist | Moist | Moist |
| Nature of weakness planes | Laminated | Laminated | Laminated | Laminated | Laminated |
| Specimen size | | | | | |
| Length (mm) | 110.0 | 150.0 | 165.0 | 115.0 | 157.0 |
| Diameter (mm) | 51.5 | 51.5 | 51.6 | 51.6 | 51.5 |
| $I_s$ (MPa) | **0.74** | **0.93** | **1.1** | **0.72** | **0.71** |
| $I_{s(50)}$ (MPa) | **0.75** | **0.94** | **1.1** | **0.73** | **0.72** |
| Failure mode | Parallel to Laminae | Parallel to Laminae | Parallel to Laminae | Parallel to Laminae | Parallel to Laminae |
| **Axial** | | | | | |
| Moisture content condition | Moist | Moist | Moist | Moist | Moist |
| Nature of weakness planes | Laminated | Laminated | Laminated | Laminated | Laminated |
| Specimen size | | | | | |
| Height (mm) | 39.2 | 43.6 | 41.2 | 43.0 | 43.1 |
| Diameter (mm) | 51.5 | 51.5 | 51.6 | 51.6 | 51.5 |
| $I_s$ (MPa) | **0.49** | **1.7** | **1.0** | **0.64** | **0.65** |
| $I_{s(50)}$ (MPa) | **0.49** | **1.7** | **1.1** | **0.66** | **0.67** |
| Failure mode | Perpendicular to Laminae | Perpendicular to Laminae | Perpendicular to Laminae | Perpendicular to Laminae | Perpendicular to Laminae |

**Notes:**

**Approved Signatory:** C. Greely **Date:** 03/02/2020

resource laboratories
AGGREGATE, ROCK, AND SOIL TESTING
ABN: 25 131 532 020
**Sydney:** 12/1 Boden Road Seven Hills NSW 2147 | PO Box 45 Pendle Hill NSW 2145
**Ph:** (02) 9674 7711 | **Fax:** (02) 9674 7755 | **Email:** info@resourcelab.com.au

# Test Report

**Customer:** Martens & Associates Pty Ltd
**Project:** P1907547
**Location:** 2 Darcy Road, Westmead, NSW

**Job number:** 20-0002
**Report number:** 3


## Point Load Strength Index

**Sampling method:** Tested as received
**Test method(s):** AS 4133.4.1 Clause 3.2, 3.3

| | Results | | | | |
|---|---|---|---|---|---|
| **Laboratory sample no.** | 20749 | 20750 | 20751 | | |
| **Customer sample no.** | 7547/BH110/ 11.80-12.00m | 7547/BH115/ 3.28-3.40m | 7547/BH115/ 6.25-6.37m | | |
| **Sample depth** | 11.80-12.00m | 3.28-3.40m | 6.25-6.37m | | |
| **Date sampled** | 08-18/01/2020 | 08-18/01/2020 | 08-18/01/2020 | | |
| **Date tested** | 30/01/2020 | 30/01/2020 | 30/01/2020 | | |
| Lithological description | LAMINITE | SHALE | LAMINITE | | |
| **Diametral** | | | | | |
| Moisture content condition | Moist | Moist | Moist | | |
| Nature of weakness planes | Laminated | Laminated | Laminated | | |
| Specimen size | | | | | |
| Length (mm) | 187.0 | 59.0 | 125.0 | | |
| Diameter (mm) | 51.6 | 50.5 | 50.2 | | |
| $I_s$ (MPa) | **1.1** | **0.098** | **1.1** | | |
| $I_{s(50)}$ (MPa) | **1.1** | **0.098** | **1.1** | | |
| Failure mode | Parallel to Laminae | Parallel to Laminae | Parallel to Laminae | | |
| **Axial** | | | | | |
| Moisture content condition | Moist | Moist | Moist | | |
| Nature of weakness planes | Laminated | Laminated | Laminated | | |
| Specimen size | | | | | |
| Height (mm) | 39.4 | 31.8 | 33.8 | | |
| Diameter (mm) | 51.6 | 50.5 | 50.2 | | |
| $I_s$ (MPa) | **2.0** | **0.15** | **1.4** | | |
| $I_{s(50)}$ (MPa) | **2.0** | **0.14** | **1.3** | | |
| Failure mode | Perpendicular to Laminae | Perpendicular to Laminae | Perpendicular to Laminae | | |

**Notes:**

**Approved Signatory:** C. Greely **Date:** 03/02/2020

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

# CERTIFICATE OF ANALYSIS 234892-A

## Client Details

| | |
|---|---|
| **Client** | Martens & Associates Pty Ltd |
| **Attention** | Jeff Fulton, Robert Mehaffey, William Xu |
| **Address** | Suite 201, 20 George St, Hornsby, NSW, 2077 |

## Sample Details

| | |
|---|---|
| **Your Reference** | **P1907547COC03V01** |
| **Number of Samples** | 88 Soil |
| **Date samples received** | 20/01/2020 |
| **Date completed instructions received** | 20/01/2020 |

## Analysis Details

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

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

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

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

## Report Details

| | |
|---|---|
| **Date results requested by** | 28/01/2020 |
| **Date of Issue** | 28/01/2020 |

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

**Results Approved By**
Priya Samarawickrama, Senior Chemist

**Authorised By**

Nancy Zhang, Laboratory Manager

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 234892-A-2 | 234892-A-4 | 234892-A-5 | 234892-A-6 | 234892-A-13 |
| Your Reference | UNITS | BH101/0.5 | BH101/2.0 | BH101/4.0 | BH101/6.0 | BH103/1.0 |
| Date Sampled | | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| Date analysed | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| pH 1:5 soil:water | pH Units | 8.4 | 5.7 | 8.3 | 7.6 | 7.9 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 120 | 300 | 270 | 240 | 240 |
| Sulphate, SO4 1:5 soil:water | mg/kg | <10 | 370 | 270 | 140 | 170 |

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 234892-A-14 | 234892-A-15 | 234892-A-24 | 234892-A-25 | 234892-A-28 |
| Your Reference | UNITS | BH103/3.0 | BH103/5.0 | BH105/2.0 | BH105/4.0-4.45 | BH106a/1.0 |
| Date Sampled | | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| Date analysed | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| pH 1:5 soil:water | pH Units | 6.7 | 5.9 | 6.5 | 5.5 | 7.5 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 66 | 360 | 440 | 360 | 400 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 64 | 190 | 490 | 87 | 500 |

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 234892-A-30 | 234892-A-31 | 234892-A-43 | 234892-A-44 | 234892-A-50 |
| Your Reference | UNITS | BH106a/4.0 | BH106a/6.0 | BH108/3.5 | BH108/5.4 | BH111/0.5 |
| Date Sampled | | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| Date analysed | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| pH 1:5 soil:water | pH Units | 5.1 | 5.6 | 6.5 | 6.0 | 6.9 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 350 | 550 | 52 | 560 | 87 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 79 | 160 | <10 | 160 | 59 |

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 234892-A-53 | 234892-A-56 | 234892-A-57 | 234892-A-58 | 234892-A-65 |
| Your Reference | UNITS | BH111/2.5 | BH112/1.0 | BH112/1.5 | BH112/2.5 | BH114/1.0 |
| Date Sampled | | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| Date analysed | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| pH 1:5 soil:water | pH Units | 5.3 | 5.3 | 5.6 | 5.3 | 6.6 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 180 | 98 | 97 | 230 | 120 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 20 | 76 | 80 | 150 | 120 |

| Misc Inorg - Soil | | | | | |
|---|---|---|---|---|---|
| Our Reference | | 234892-A-68 | 234892-A-69 | 234892-A-73 | 234892-A-87 |
| Your Reference | UNITS | BH115/0.5 | BH115/1.0 | BH118/0.1 | BH111/3.5 |
| Date Sampled | | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 | 08/01/2020 - 18/01/2020 |
| Type of sample | | Soil | Soil | Soil | Soil |
| Date prepared | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| Date analysed | - | 23/01/2020 | 23/01/2020 | 23/01/2020 | 23/01/2020 |
| pH 1:5 soil:water | pH Units | 5.0 | 4.8 | 6.4 | 7.3 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 290 | 180 | 57 | 150 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 160 | 24 | 21 | 39 |

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

| QUALITY CONTROL: Misc Inorg - Soil | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-1 | 234892-A-4 |
| Date prepared | - | | | 23/01/2020 | 2 | 23/01/2020 | 23/01/2020 | | 23/01/2020 | 23/01/2020 |
| Date analysed | - | | | 23/01/2020 | 2 | 23/01/2020 | 23/01/2020 | | 23/01/2020 | 23/01/2020 |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 2 | 8.4 | 8.3 | 1 | 102 | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | <1 | 2 | 120 | 120 | 0 | 109 | [NT] |
| Sulphate, SO4 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | 2 | <10 | <10 | 0 | 94 | # |

| QUALITY CONTROL: Misc Inorg - Soil | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-2 | 234892-A-69 |
| Date prepared | - | | | [NT] | 30 | 23/01/2020 | 23/01/2020 | | 23/01/2020 | 23/01/2020 |
| Date analysed | - | | | [NT] | 30 | 23/01/2020 | 23/01/2020 | | 23/01/2020 | 23/01/2020 |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 30 | 5.1 | 5.1 | 0 | [NT] | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | [NT] | 30 | 350 | 380 | 8 | [NT] | [NT] |
| Sulphate, SO4 1:5 soil:water | mg/kg | 10 | Inorg-081 | [NT] | 30 | 79 | 76 | 4 | 101 | 117 |

## Result Definitions

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

## Quality Control Definitions

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

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

## Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

## Report Comments

MISC_INORG:

# Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

# Attachment F – J&K / EIS Borehole Logs

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

**Borehole No. 1** 1/1

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.0m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N = 20 8,11,9 | 0 | | | FILL: Silty clay, medium plasticity, light grey and brown, with shale gravel. | MC≈PL | | | GRASS COVER<br>APPEARS WELL COMPACTED |
| | | | | | N = 11 6,5,6 | 1 | | | | | | | |
| ▼ ON COMPLETION & AFTER 6 HRS | | | | | | 2 | | CL | SILTY CLAY: medium plasticity, brown, with a trace of ironstone gravel. | MC≈PL | H | >600<br>>600<br>>600 | |
| | | | | | N = 4 2,2,2 | 3 | | | SILTY CLAY: medium plasticity, grey and light brown, with a trace of organic material and ironstone gravel. | MC>PL | St | 150<br>200<br>160 | |
| | | | | | N = 23 7,8,15 | 4 | | CL-CH | SILTY CLAY: medium to high plasticity, grey and brown, with a trace of ironstone gravel. | MC≈PL | VSt | 350<br>380<br>320 | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | END OF BOREHOLE AT 6.0m | | | | |
| | | | | | | 7 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **2** 1/1

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.0m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | | | | - | FILL: Gravelly silty sand, fine to medium grained, light brown, igneous gravel with brick fragments. | D | - | - | APPEARS MODERATELY COMPACTED |
| | | | | | N = 6 4,4,2 | | | | FILL: Silty clay, medium plasticity, grey and light brown, with a trace of gravel and organic material. | MC>PL | | | |
| | | | | | | 1 | | | | | | | |
| | | | | | N = 8 2,3,5 | | | | | | | | |
| | | | | | | 2 | | CL-CH | SILTY CLAY: medium to high plasticity, orange brown and grey, with a trace of ironstone gravel. | MC≈PL | (St-VSt) | - | RESIDUAL |
| | | | | | N = 18 5,6,12 | 3 | | | | | VSt | 200 300 270 | |
| | | | | | | | | | | | | | |
| ▼ ON COMPLETION & AFTER 6.5 HRS | | | | | | 4 | | - | SHALE: grey. | DW | VL-L | - | LOW 'TC' BIT RESISTANCE |
| | | | | | | 5 | | | | | L-M | | LOW TO MODERATE RESISTANCE |
| | | | | | | 6 | | | END OF BOREHOLE AT 6.0m | | | | |
| | | | | | | 7 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **3** 1/2

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 19.4m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** M.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION OF AUGERING | | | | | SPT 20/50mm REFUSAL | 0 | | | ASPHALTIC CONCRETE: 120mm.t | | | | |
| | | | | | | | | - | FILL: Gravelly sand, fine to medium grained, brown and grey, with brick fragments. | D-M | - | - | APPEARS WELL COMPACTED |
| | | | | | | 1 | | | FILL: Sandy clay, medium plasticity, brown, grey and dark grey, with a trace of shale and igneous gravel and brick fragments. | MC≈PL | | | APPEARS POORLY COMPACTED |
| ▼ ON COMPLETION OF CORING & AFTER 2 HRS | | | | | N = 6 2,3,3 | 2 | | | | | | | |
| | | | | | | 3 | | CL | SILTY CLAY: medium plasticity, red brown mottled orange and grey, with fine to medium grained ironstone gravel. | MC > PL | VSt-H | - | |
| | | | | | N = 26 6,10,13 | | | | | | | 350 300 | |
| | | | | | | 4 | | | as above, but grey. | MC < PL | H | | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | N = 36 5,11,25 | | | | | | | >600 >600 >600 | |
| | | | | | | 5 | | - | SHALE: grey and orange brown. | XW-DW | EL-VL | - | |
| | | | | | | 6 | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 7 | | | | | | | |


Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
Job No: 22466ZH BH3 START CORING AT 5.82m
5
5.82m
CORE LOSS 0.18m
6
7
8
9
10
END AT 10.65m

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 3 2/2

# CORED BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Core Size:** NMLC **R.L. Surface:** ≈ 19.4m

**Date:** 15-11-08 **Inclination:** VERTICAL **Datum:** AHD

**Drill Type:** JK300 **Bearing:** - **Logged/Checked by:** M.P./

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_S(50)$ (EL VL L M H VH EH) | DEFECT DETAILS: DEFECT SPACING (mm) (500 300 100 50 30 10) | DEFECT DETAILS: DESCRIPTION (Specific / General) |
|---|---|---|---|---|---|---|---|---|---|
| | | 5 | | START CORING AT 5.82m | | | | | |
| | | | | CORE LOSS 0.18m | | | | | |
| FULL RETURN | | 6 | | SHALE: dark grey, with laminae bedded at 0-2°. | XW | EL | | | |
| | | | | | DW | VL | | | - Cr, 230mm.t<br>- XWS, 160mm.t |
| | | 7 | | | | | | | - Cr, 460mm.t |
| | | | | | | | | | - XWS, 20mm.t |
| | | | | | | | | | - Cr, 160mm.t |
| | | 8 | | | | | | | - Cr, 80mm.t |
| | | | | | | | | | - Cr, 420mm.t |
| | | | | | FR | M-H | × | | |
| | | 9 | | | | | × | | - J, 15°, P, S, IS |
| | | | | | | | × | | |
| | | 10 | | | | | × | | - J, 30°, Un, S |
| | | | | | | | × | | - CS, 0°, 5mm.t |
| | | | | END OF BOREHOLE AT 10.65m | | | | | |
| | | 11 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **4** 1/1

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.8m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLET -ION | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | | | | - | FILL: Gravelly silty sand, fine to medium grained, grey, with igneous gravel. | M | - | - | |
| | | | ■ | | N = 10 4,5,5 | | | | FILL: Silty clay, medium plasticity, grey and brown, with a trace of shale, igneous and ironstone gravel. | MC≈PL | | | APPEARS MODERATELY TO WELL COMPACTED |
| | | | | | | 1 | | | | | | | |
| | | | | | | | | | END OF BOREHOLE AT 1.5m | | | | |
| | | | | | | 2 | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **5** 1/2

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK300 **R.L. Surface:** ≈ 20.5m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** M.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION OF AUGERING | | | | | N = 11 11,6,5 | 0 | | | FILL: Sandy silty clay, medium plasticity, brown, with brick and tile fragments and metal and plastic inclusions. | MC < PL | | | GRASS COVER<br>APPEARS MODERATELY COMPACTED |
| ▼ ON COMPLETION OF CORING & AFTER 3 HRS | | | | | N = 4 2,2,2 | 1 | | | FILL: Silty clay, medium plasticity, grey mottled red and orange brown, with fine to medium grained ironstone gravel. | MC > PL | | 270<br>330<br>270 | APPEARS POORLY COMPACTED |
| | | | | | N = 18 5,8,10 | 2 | | CL | SILTY CLAY: medium plasticity, brown mottled red brown, with a trace of ash. | MC > PL | VSt -H | - | RESIDUAL |
| | | | | | | 3 | | | | | | 370<br>530<br>520 | |
| | | | | | N = 31 5,12,19 | 4 | | | SILTY CLAY: medium plasticity, grey, with fine to medium grained ironstone gravel. | MC < PL | H | >600<br>>600<br>>600 | |
| | | | | | | 5 | | - | SHALE: grey and brown, with iron indurated bands. | XW | EL | | |
| | | | | | | | | | | DW | VL-L | | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | 6 | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 7 | | | | | | | |


Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
Job No: 22466ZH · BH5 START CORING AT 5·96m
C.L 0.04
6
7
8
END OF BH AT 8·96m

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

# CORED BOREHOLE LOG

Borehole No. **5** 2/2

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA
**Project:** PROPOSED NEW BUILDINGS AND CARPARK
**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Core Size:** NMLC **R.L. Surface:** ≈ 20.5m
**Date:** 15-11-08 **Inclination:** VERTICAL **Datum:** AHD
**Drill Type:** JK300 **Bearing:** - **Logged/Checked by:** M.P./

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH | DEFECT SPACING (mm) 500 300 100 50 30 10 | DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 5 | | START CORING AT 5.96m | | | | | |
| FULL RET-URN | | 6 | | CORE LOSS 0.04m<br>SHALE: dark grey, with occasional brown bands, bedded at 0-2°. | DW | L-M | | | - Cr, 310mm.t<br>MULTIPLE XWS UP TO 10mm.t<br>CS, 0°, 25mm.t<br>- Cr, 50mm.t<br>- CS, 2mm.t<br>- Cr, 180mm.t<br>- J, 40°, P, S<br>- Cr, 350mm.t |
| | | 7 | | | | | | | |
| | | 8 | | | SW | H | | | - XWS, 130mm.t<br>- Cr, 110mm.t<br>- J, 45°, P, S, IS<br>- Be, 0°, P, S, IS<br>- XWS, 20mm.t<br>- XWS, 20mm.t<br>- CS, 0°, 5mm.t<br>- CS, 0°, 2mm.t<br>- CS, 0°, 2mm.t<br>- Be, 0°, P, S, IS<br>- CS, 0°, 2mm.t<br>- Cr, 30mm.t<br>- XWS, 2mm.t<br>- Be, 0-5°, Un, S, IS |
| | | 9 | | END OF BOREHOLE AT 8.95m | | | | | 50mm DIA. PVC STANDPIPE INSTALLED TO 9m DEPTH, MACHINE SLOTTED FROM 3m TO 9M DEPTH, BACKFILLED WITH 2mm SAND FROM 1m TO 9m AND BENTONITE COLLAR FROM 0m TO 1m. FINISHED WITH GATIC COVER SET IN CONCRETE |
| | | 10 | | | | | | | |
| | | 11 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **6** 1/2

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK300 **R.L. Surface:** ≈ 20.5m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** M.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION OF AUGERING | | | | | N = 17 5,6,11 | 0 | | | FILL: Sandy gravel, fine to medium grained, grey, igneous. | M | | | |
| | | | | | | 1 | | | FILL: Clayey gravel, fine to coarse grained, brown, with concrete, shale and sand. | | | | APPEARS WELL COMPACTED |
| | | | | | N = 3 2,2,1 | | | | FILL: Sandy gravelly clay, medium plasticity, brown and grey. | MC≈PL | | | APPEARS POORLY COMPACTED |
| ▼ ON COMPLETION & AFTER 1 HR | | | | | | 2 | | CL | SILTY CLAY: medium plasticity, grey mottled orange brown. | MC > PL | VSt -H | - | RESIDUAL |
| | | | | | N = 11 3,4,7 | 3 | | | | | | 300 240 570 340 | |
| | | | | | | 4 | | - | SHALE: grey. | XW | EL | - | VERY LOW 'TC' BIT RESISTANCE |
| | | | | | | | | | | DW | M | | MODERATE RESISTANCE |
| | | | | | | 5 | | | | | VL | | VERY LOW RESISTANCE |
| | | | | | | | | | | | | | LOW TO MODERATE RESISTANCE |
| | | | | | | 6 | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 7 | | | | | | | |


Jeffery and Katauskas Pty Ltd
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
Job No: 22466ZH BH6 START CORING AT 5.84m
6
7
8
9
C.L.
0.06
END AT 9.62m

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **6** 2/2

# CORED BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Core Size:** NMLC **R.L. Surface:** ≈ 20.5m

**Date:** 15-11-08 **Inclination:** VERTICAL **Datum:** AHD

**Drill Type:** JK300 **Bearing:** - **Logged/Checked by:** M.P./

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH | DEFECT SPACING (mm) 500 300 100 50 30 10 | DEFECT DETAILS: DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 5 | | START CORING AT 5.84m | | | | | |
| | | 6 | | SHALE: dark brown and grey. | XW | EL | | | |
| | | 7 | | | DW | L | | | - Cr, 150mm.t |
| FULL RET -URN | | | | CORE LOSS 0.06m | DW | L-M | | | - CS, 25mm.t<br>- 6xBe, 0-5°, P, S, IS<br>- Cr, 15mm.t |
| | | | | SHALE: dark grey. | Fr | M-H | | | |
| | | 8 | | | | | | | - CS, 5°, 2mm.t |
| | | | | | | | | | - J, 15°, P, S, IS |
| | | 9 | | | | | | | - J, 45°, Un, S<br>- J, 20°, P, S |
| | | | | | | | | | - J, 50°, P, S |
| | | | | END OF BOREHOLE AT 9.62m | | | | | |
| | | 10 | | | | | | | |
| | | 11 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

**Borehole No. 7** 1/2

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.4m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | | | N = 11 5,3,8 | 0 | | | FILL: Gravelly silty clay, medium plasticity, light grey and brown, with shale and ironstone gravel. | MC < PL | | | GRASS COVER |
| | | | | | N = 13 5,7,6 | 1 | | | | | | | |
| ▼ AFTER 3.5 HRS | | | | | | 2 | | CL | SILTY CLAY: medium plasticity, orange brown and grey, with a trace of ironstone gravel. | MC≈PL | H | 420 480 460 | RESIDUAL |
| | | | | | | 3 | | - | SHALE: light grey, with clay bands. | DW | VL-L | - | LOW 'TC' BIT RESISTANCE |
| | | | | | | 4 | | | SHALE: grey and dark grey. | | L | | LOW TO MODERATE RESISTANCE |
| | | | | | | 5 | | | | SW | L-M | | MODERATE RESISTANCE |
| | | | | | | 6 | | | | | M-H | | MODERATE TO HIGH RESISTANCE |
| | | | | | | 7 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **7** 2/2

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.4m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ■ | | | | | SHALE: dark grey. | SW | M-H | | HIGH RESISTANCE |
| | | | | | | 8 | | | END OF BOREHOLE AT 7.5m | | | | 50mm DIA. PVC STANDPIPE INSTALLED TO 6m DEPTH, MACHINE SLOTTED FROM 3m TO 6m DEPTH, BACKFILLED WITH 2mm SAND 1m TO 9m, BENTONITE COLLAR FROM 0m TO 1m. FINISHED WITH GATIC COVER SET IN CONCRETE |
| | | | | | | 9 | | | | | | | |
| | | | | | | 10 | | | | | | | |
| | | | | | | 11 | | | | | | | |
| | | | | | | 12 | | | | | | | |
| | | | | | | 13 | | | | | | | |
| | | | | | | 14 | | | | | | | |

# Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. 8 1/2

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 21.0m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** M.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION OF AUGERING | | | | | N = 8 6,4,4 | 0 | | | FILL: Silty clay, medium plasticity, brown and grey, with a trace of root fibres and shale gravel. | MC < PL | | >600 >600 | GRASS COVER |
| | | | | | | 1 | | CL | SILTY CLAY: medium plasticity, brown mottled red brown. | MC≈PL | H | | |
| ▼ ON COMPLETION OF CORING & AFTER 0.5 HRS | | | | | N = 16 3,6,10 | | | | SILTY CLAY: medium plasticity, grey mottled orange and red brown, with a trace of ironstone gravel. | | | 580 >600 >600 | |
| | | | | | | 2 | | - | SHALE: grey and brown, with iron indurated bands. | XW-DW | EL-VL | - | BANDED VERY LOW 'TC' BIT RESISTANCE |
| | | | | | N > 24 13,24/ 150mm REFUSAL | 3 | | | | | | >600 >600 >600 | |
| | | | | | | 4 | | | SHALE: dark grey and brown. | SW | M | | MODERATE RESISTANCE |
| | | | | | | 5 | | | REFER TO CORED BOREHOLE LOG | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |


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Job No:22466ZH BH8 START CORING AT 4.24m
4
5
6
7
END AT 7.08m

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# CORED BOREHOLE LOG

**Borehole No.** 8 2/2

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA
**Project:** PROPOSED NEW BUILDINGS AND CARPARK
**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Core Size:** NMLC **R.L. Surface:** ≈ 21.0m
**Date:** 15-11-08 **Inclination:** VERTICAL **Datum:** AHD
**Drill Type:** JK300 **Bearing:** - **Logged/Checked by:** M.P./

| Water Loss/Level | Barrel Lift | Depth (m) | Graphic Log | CORE DESCRIPTION<br>Rock Type, grain characteristics, colour, structure, minor components. | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_S(50)$ EL VL L M H VH EH | DEFECT DETAILS<br>DEFECT SPACING (mm) 600 300 100 50 30 10 | DESCRIPTION<br>Type, inclination, thickness, planarity, roughness, coating.<br>Specific / General |
|---|---|---|---|---|---|---|---|---|---|
| | | 4 | | START CORING AT 4.24m | | | | | |
| FULL RET-URN | | 5 | | SHALE: dark grey and dark brown, with light grey and brown laminae, bedded at 0-5°. | DW | M-H | | | - XWS, 8mm.t<br>- XWS, 7mm.t<br>- XWS, 10mm.t<br>- J, 40-60°, Un, S<br>- J, Un, S<br>- Cr, 50mm.t<br>- Cr, 100mm.t<br>- Cr, 20mm.t<br>- J, 35°, P, S |
| | | 6 | | SHALE: dark grey, with light grey laminae, bedded at 0-5°. | SW | H | | | - J, 10-20°, Un, S |
| | | 7 | | END OF BOREHOLE AT 7.08m | | | | | |
| | | 8 | | | | | | | |
| | | 9 | | | | | | | |
| | | 10 | | | | | | | |

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Borehole No. **9** 1/1

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.8m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | | | | 0 | | | ASPHALTIC CONCRETE: 100mm.t | | | | |
| | | | | | N = 7 1,3,4 | | | - | FILL: Gravelly silty sand, fine to medium grained, grey, igneous gravel. | M | - | - | |
| | | | | | | 1 | | | FILL: Silty clay, medium plasticity, grey and light brown, with a trace of shale and ironstone gravel. | MC≈PL | | | APPEARS MODERATELY COMPACTED |
| | | | | | N = 14 3,5,9 | | | CL | SILTY CLAY: medium plasticity, grey mottled orange brown, with a trace of ironstone gravel. | MC≈PL | H | - | RESIDUAL |
| | | | | | | 2 | | | | | | 420 410 430 | |
| | | | | | | | | - | SHALE: light grey, with clay bands. | DW | L | - | LOW 'TC' BIT RESISTANCE |
| | | | | | | 3 | | | | | | | |
| | | | | | | | | | | | M | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | | | | SHALE: dark grey. | SW | H | | HIGH RESISTANCE |
| ▼ AFTER 3.5 HRS | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | END OF BOREHOLE AT 6.0m | | | | |
| | | | | | | 7 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

**Borehole No. 10** 1/1

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.7m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | ■ | | N = 38 12,19,19 | 0 | | | FILL: Silty sandy clay, medium plasticity, light brown, with igneous and sandstone gravel and bitumen fragments. | MC < PL | | | GRASS COVER<br><br>APPEARS WELL COMPACTED |
| | | | | | | 1 | | | | | | | |
| | | | | | | | | | END OF BOREHOLE AT 1.5m | | | | |
| | | | | | | 2 | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No. **11** 1/1

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.5m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | | | N = 8 3,4,4 | 0 | | - | ASPHALTIC CONCRETE: 50mm.t | M | - | - | |
| | | | | | | | | | FILL: Gravelly silty sand, fine to medium grained, light brown, with sandstone and igneous gravel. | | | | |
| | | | | | | 1 | | | FILL: Silty clay, medium plasticity, grey and brown, with sandstone and ironstone gravel. | MC≈PL | | | APPEARS MODERATELY COMPACTED |
| | | | | | | | | | END OF BOREHOLE AT 1.5m | | | | |
| | | | | | | 2 | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
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**Borehole No. 12** 1/1

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 21.8n

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | ■ | | | 0 | | | FILL: Silty clay, medium plasticity, grey and brown, with shale and igneous gravel. | MC < PL | | | GRASS COVER |
| | | | ■ | | | | | CL | | MC < PL | H | - | RESIDUAL |
| | | | ■ | | N = 23 11,13,10 | | | | SILTY CLAY: medium plasticity, grey and brown, with shale and ironstone gravel. | | | > 600 > 600 > 600 | |
| | | | | | | 1 | | | | | | | |
| | | | | | | | | | END OF BOREHOLE AT 1.5m | | | | |
| | | | | | | 2 | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

**Borehole No. 13** 1/1

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.9m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | | | N = 16 6,8,8 | 0 | | | FILL: Silty clay, medium plasticity, light brown, with shale, sandstone and ironstone gravel. | MC < PL | | | GRASS COVER<br><br>APPEARS WELL COMPACTED |
| | | | | | | 1 | | | | | | | |
| | | | | | | | | | END OF BOREHOLE AT 1.5m | | | | |
| | | | | | | 2 | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

**Borehole No. 14** 1/1

# BOREHOLE LOG

**Client:** CATHOLIC EDUCATION OFFICE PARRAMATTA

**Project:** PROPOSED NEW BUILDINGS AND CARPARK

**Location:** WESTMEAD CATHOLIC PRECINCT, DARCY ROAD, WESTMEAD, NSW

**Job No.** 22466ZH **Method:** SPIRAL AUGER JK350 **R.L. Surface:** ≈ 20.5m

**Date:** 15-11-08 **Datum:** AHD

**Logged/Checked by:** J.P./

| Groundwater Record | SAMPLES ES | SAMPLES U50 | SAMPLES DB | SAMPLES DS | Field Tests | Depth (m) | Graphic Log | Unified Classification | DESCRIPTION | Moisture Condition/ Weathering | Strength/ Rel. Density | Hand Penetrometer Readings (kPa.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DRY ON COMPLETION | | | | | N = 16 6,8,8 | 0 | | | FILL: Silty clay, medium plasticity, grey and brown, with ironstone gravel. | MC < PL | | | GRASS COVER<br><br>APPEARS MODERATELY COMPACTED |
| | | | | | | 1 | | | | | | | |
| | | | | | | | | | END OF BOREHOLE AT 1.5m | | | | |
| | | | | | | 2 | | | | | | | |
| | | | | | | 3 | | | | | | | |
| | | | | | | 4 | | | | | | | |
| | | | | | | 5 | | | | | | | |
| | | | | | | 6 | | | | | | | |
| | | | | | | 7 | | | | | | | |

# Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
ABN 17 003 550 801


# REPORT EXPLANATION NOTES

## INTRODUCTION

These notes have been provided to amplify the geotechnical report in regard to classification methods, field procedures and certain matters relating to the Comments and Recommendations section. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

## DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, the SAA Site Investigation Code. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg sandy clay) as set out below:

| Soil Classification | Particle Size |
|---|---|
| Clay | less than 0.002mm |
| Silt | 0.002 to 0.06mm |
| Sand | 0.06 to 2mm |
| Gravel | 2 to 60mm |

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

| Relative Density | SPT 'N' Value (blows/300mm) |
|---|---|
| Very loose | less than 4 |
| Loose | 4 – 10 |
| Medium dense | 10 – 30 |
| Dense | 30 – 50 |
| Very Dense | greater than 50 |

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

| Classification | Unconfined Compressive Strength kPa |
|---|---|
| Very Soft | less than 25 |
| Soft | 25 – 50 |
| Firm | 50 – 100 |
| Stiff | 100 – 200 |
| Very Stiff | 200 – 400 |
| Hard | Greater than 400 |
| Friable | Strength not attainable – soil crumbles |

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

## SAMPLING

Sampling is carried out during drilling or from other excavations to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

Undisturbed samples are taken by pushing a thin-walled sample tube, usually 50mm diameter (known as a U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

## INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

**Test Pits:** These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

**Hand Auger Drilling:** A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Premature refusal of the hand augers can occur on a variety of materials such as hard clay, gravel or ironstone, and does not necessarily indicate rock level.

**Continuous Spiral Flight Augers:** The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

**Rock Augering:** Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

**Wash Boring:** The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration.

**Mud Stabilised Drilling:** Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg from SPT and U50 samples) or from rock coring, etc.

**Continuous Core Drilling:** A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

**Standard Penetration Tests:** Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N>30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as "$N_c$" on the borehole logs, together with the number of blows per 150mm penetration.

**Static Cone Penetrometer Testing and Interpretation:** Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- Cone resistance – the actual end bearing force divided by the cross sectional area of the cone – expressed in MPa.
- Sleeve friction – the frictional force on the sleeve divided by the surface area – expressed in kPa.
- Friction ratio – the ratio of sleeve friction to cone resistance, expressed as a percentage.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

**Portable Dynamic Cone Penetrometers:** Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a sliding hammer and counting the blows for successive 100mm increments of penetration.

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various Road Authorities.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

## LOGS

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

## GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it 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 and may not be the same at the time of construction.
- 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 be washed out of the hole or 'reverted' chemically if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising at intervals ranging from several days to 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 perched water tables or surface water.

## FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg bricks, steel etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

## LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soil for Engineering Purposes'*. Details of the test procedure used are given on the individual report forms.

## ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building) the information and interpretation may not be relevant if the design proposal is changed (eg to a twenty storey building). If this happens, the company 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 aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions – the potential for this will be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve any problems occurring.

## 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, the company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed that at some later stage, well after the event.

## REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document *'Guidelines for the Provision of Geotechnical Information in Tender Documents'*, published by the Institution of Engineers, Australia. Where information obtained from this investigation 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. The company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

## REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

## SITE INSPECTION

The company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to

ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or

iii) full time engineering presence on site.

**Jeffery and Katauskas Pty Ltd**
CONSULTING GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

# GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

## SOIL


FILL


TOPSOIL


CLAY (CL, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CH)


SILTY CLAY (CL, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML)


PEAT AND ORGANIC SOILS

## ROCK


CONGLOMERATE


SANDSTONE


SHALE


SILTSTONE, MUDSTONE, CLAYSTONE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

## DEFECTS AND INCLUSIONS


CLAY SEAM


SHEARED OR CRUSHED SEAM


BRECCIATED OR SHATTERED SEAM/ZONE


IRONSTONE GRAVEL


ORGANIC MATERIAL

## OTHER MATERIALS


CONCRETE


BITUMINOUS CONCRETE, COAL


COLLUVIUM

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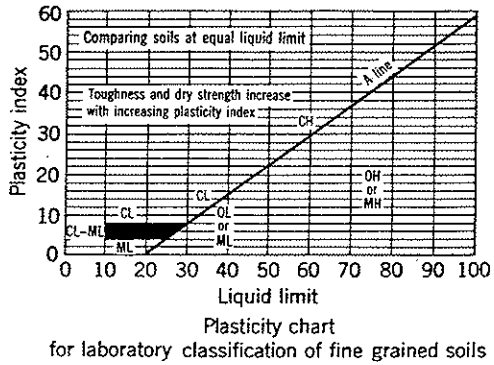
# UNIFIED SOIL CLASSIFICATION TABLE

| Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights) | | | | | | Group Symbols[a] | Typical Names | Information Required for Describing Soils | Laboratory Classification Criteria |
|---|---|---|---|---|---|---|---|---|---|
| Coarse-grained soils: More than half of material is *larger* than 75 μm sieve size[b] (The 75 μm sieve size is about the smallest particle visible to naked eye) | Gravels: More than half of coarse fraction is larger than 4 mm sieve size | Clean gravels (little or no fines) | Wide range in grain size and substantial amounts of all intermediate particle sizes | | | *GW* | Well graded gravels, gravel-sand mixtures, little or no fines | Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses<br>For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics<br>Example:<br>*Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*) | Use grain size curve in identifying the fractions as given under field identification<br>Determine percentages of gravel and sand from grain size curve<br>Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows:<br>Less than 5% — *GW, GP, SW, SP*<br>More than 12% — *GM, GC, SM, SC*<br>5% to 12% — *Borderline* cases requiring use of dual symbols<br>$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4<br>$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 |
| | | | Predominantly one size or a range of sizes with some intermediate sizes missing | | | *GP* | Poorly graded gravels, gravel-sand mixtures, little or no fines | | Not meeting all gradation requirements for *GW* |
| | | Gravels with fines (appreciable amount of fines) | Nonplastic fines (for identification procedures see *ML* below) | | | *GM* | Silty gravels, poorly graded gravel-sand-silt mixtures | | Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols |
| | | | Plastic fines (for identification procedures, see *CL* below) | | | *GC* | Clayey gravels, poorly graded gravel-sand-clay mixtures | | Atterberg limits above "A" line, with *PI* greater than 7 |
| | Sands: More than half of coarse fraction is smaller than 4 mm sieve size | Clean sands (little or no fines) | Wide range in grain sizes and substantial amounts of all intermediate particle sizes | | | *SW* | Well graded sands, gravelly sands, little or no fines | | $C_U = \frac{D_{60}}{D_{10}}$ Greater than 6<br>$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 |
| | | | Predominantly one size or a range of sizes with some intermediate sizes missing | | | *SP* | Poorly graded sands, gravelly sands, little or no fines | | Not meeting all gradation requirements for *SW* |
| | | Sands with fines (appreciable amount of fines) | Nonplastic fines (for identification procedures, see *ML* below) | | | *SM* | Silty sands, poorly graded sand-silt mixtures | | Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols |
| | | | Plastic fines (for identification procedures, see *CL* below) | | | *SC* | Clayey sands, poorly graded sand-clay mixtures | | Atterberg limits below "A" line with *PI* greater than 7 |
| Fine-grained soils: More than half of material is *smaller* than 75 μm sieve size | Identification Procedures on Fraction Smaller than 380 μm Sieve Size | | Dry Strength (crushing characteristics) | Dilatancy (reaction to shaking) | Toughness (consistency near plastic limit) | | | | |
| | Silts and clays: liquid limit less than 50 | | None to slight | Quick to slow | None | *ML* | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity | Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses<br>For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions<br>Example:<br>*Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*) | |
| | | | Medium to high | None to very slow | Medium | *CL* | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | |
| | | | Slight to medium | Slow | Slight | *OL* | Organic silts and organic silt-clays of low plasticity | | |
| | Silts and clays: liquid limit greater than 50 | | Slight to medium | Slow to none | Slight to medium | *MH* | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts | | |
| | | | High to very high | None | High | *CH* | Inorganic clays of high plasticity, fat clays | | |
| | | | Medium to high | None to very slow | Slight to medium | *OH* | Organic clays of medium to high plasticity | | |
| Highly Organic Soils | | | Readily identified by colour, odour, spongy feel and frequently by fibrous texture | | | *Pt* | Peat and other highly organic soils | | |




Plasticity chart
for laboratory classification of fine grained soils

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).

2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

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## LOG SYMBOLS

| LOG COLUMN | SYMBOL | DEFINITION |
|---|---|---|
| Groundwater Record |  | Standing water level. Time delay following completion of drilling may be shown. |
| |  | Extent of borehole collapse shortly after drilling. |
| |  | Groundwater seepage into borehole or excavation noted during drilling or excavation. |
| Samples | ES | Soil sample taken over depth indicated, for environmental analysis. |
| | U50 | Undisturbed 50mm diameter tube sample taken over depth indicated. |
| | DB | Bulk disturbed sample taken over depth indicated. |
| | DS | Small disturbed bag sample taken over depth indicated. |
| | ASB | Soil sample taken over depth indicated, for asbestos screening. |
| | ASS | Soil sample taken over depth indicated, for acid sulfate soil analysis. |
| | SAL | Soil sample taken over depth indicated, for salinity analysis. |
| Field Tests | N = 17<br>4, 7, 10 | Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below. |
| | $N_c$ = 5<br>7<br>3R | Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment. |
| | VNS = 25 | Vane shear reading in kPa of Undrained Shear Strength. |
| | PID = 100 | Photoionisation detector reading in ppm (Soil sample headspace test). |
| Moisture Condition (Cohesive Soils) | MC>PL | Moisture content estimated to be greater than plastic limit. |
| | MC≈PL | Moisture content estimated to be approximately equal to plastic limit. |
| | MC<PL | Moisture content estimated to be less than plastic limit. |
| (Cohesionless Soils) | D | DRY - runs freely through fingers. |
| | M | MOIST - does not run freely but no free water visible on soil surface. |
| | W | WET - free water visible on soil surface. |
| Strength (Consistency) Cohesive Soils | VS | VERY SOFT - Unconfined compressive strength less than 25kPa |
| | S | SOFT - Unconfined compressive strength 25-50kPa |
| | F | FIRM - Unconfined compressive strength 50-100kPa |
| | St | STIFF - Unconfined compressive strength 100-200kPa |
| | VSt | VERY STIFF - Unconfined compressive strength 200-400kPa |
| | H | HARD - Unconfined compressive strength greater than 400kPa |
| | ( ) | Bracketed symbol indicates estimated consistency based on tactile examination or other tests. |
| Density Index/ Relative Density (Cohesionless Soils) | | **Density Index (Id) Range (%)** / **SPT 'N' Value Range (Blows/300mm)** |
| | VL | Very Loose <15 0-4 |
| | L | Loose 15-35 4-10 |
| | MD | Medium Dense 35-65 10-30 |
| | D | Dense 65-85 30-50 |
| | VD | Very Dense >85 >50 |
| | ( ) | Bracketed symbol indicates estimated density based on ease of drilling or other tests. |
| Hand Penetrometer Readings | 300<br>250 | Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise. |
| Remarks | 'V' bit | Hardened steel 'V' shaped bit. |
| | 'TC' bit | Tungsten carbide wing bit. |
| | T 60 | Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers. |

# Jeffery and Katauskas Pty Ltd

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ABN 17 003 550 801


# LOG SYMBOLS

## ROCK MATERIAL WEATHERING CLASSIFICATION

| TERM | SYMBOL | DEFINITION |
|---|---|---|
| Residual Soil | RS | Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported. |
| Extremely weathered rock | XW | Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water. |
| Distinctly weathered rock | DW | Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. |
| Slightly weathered rock | SW | Rock is slightly discoloured but shows little or no change of strength from fresh rock. |
| Fresh rock | FR | Rock shows no sign of decomposition or staining. |

## ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

| TERM | SYMBOL | Is (50) MPa | FIELD GUIDE |
|---|---|---|---|
| Extremely Low: | EL | 0.03 | Easily remoulded by hand to a material with soil properties. |
| Very Low: | VL | 0.1 | May be crumbled in the hand. Sandstone is "sugary" and friable. |
| Low: | L | 0.3 | A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling. |
| Medium Strength: | M | 1 | A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife. |
| High: | H | 3 | A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer. |
| Very High: | VH | 10 | A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer. |
| Extremely High: | EH | | A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer. |

## ABBREVIATIONS USED IN DEFECT DESCRIPTION

| ABBREVIATION | DESCRIPTION | NOTES |
|---|---|---|
| Be | Bedding Plane Parting | Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes) |
| CS | Clay Seam | |
| J | Joint | |
| P | Planar | |
| Un | Undulating | |
| S | Smooth | |
| R | Rough | |
| IS | Ironstained | |
| XWS | Extremely Weathered Seam | |
| Cr | Crushed Seam | |
| 60t | Thickness of defect in millimetres | |

# Attachment G – General Geotechnical Recommendations

# Geotechnical Recommendations

## Important Recommendations About Your Site (1 of 2)

*These general geotechnical recommendations have been prepared by Martens to help you deliver a safe work site, to comply with your obligations, and to deliver your project. Not all are necessarily relevant to this report but are included as general reference. Any specific recommendations made in the report will override these recommendations.*

### Batter Slopes

Excavations in soil and extremely low to very low strength rock exceeding 0.75 m depth should be battered back at grades of no greater than 1 Vertical (V) : 2 Horizontal (H) for temporary slopes (unsupported for less than 1 month) and 1 V : 3 H for longer term unsupported slopes.

Vertical excavation may be carried out in medium or higher strength rock, where encountered, subject to inspection and confirmation by a geotechnical engineer. Long term and short term unsupported batters should be protected against erosion and rock weathering due to, for example, stormwater run-off.

Batter angles may need to be revised depending on the presence of bedding partings or adversely oriented joints in the exposed rock, and are subject to on-site inspection and confirmation by a geotechnical engineer. Unsupported excavations deeper than 1.0 m should be assessed by a geotechnical engineer for slope instability risk.

Any excavated rock faces should be inspected during construction by a geotechnical engineer to determine whether any additional support, such as rock bolts or shotcrete, is required.

### Earthworks

Earthworks should be carried out following removal of any unsuitable materials and in accordance with AS3798 (2007). A qualified geotechnical engineer should inspect the condition of prepared surfaces to assess suitability as foundation for future fill placement or load application.

Earthworks inspections and compliance testing should be carried out in accordance with Sections 5 and 8 of AS3798 (2007), with testing to be carried out by a National Association of Testing Authorities (NATA) accredited testing laboratory.

### Excavations

All excavation work should be completed with reference to the *Work Health and Safety (Excavation Work) Code of Practice (2015)*, by Safe Work Australia. Excavations into rock may be undertaken as follows:

1. Extremely low to low strength rock - conventional hydraulic earthmoving equipment.

2. Medium strength or stronger rock - hydraulic earthmoving equipment with rock hammer or ripping tyne attachment.

Exposed rock faces and loose boulders should be monitored to assess risk of block / boulder movement, particularly as a result of excavation vibrations.

### Fill

Subject to any specific recommendations provided in this report, any fill imported to site is to comprise approved material with maximum particle size of two thirds the final layer thickness. Fill should be placed in horizontal layers of not more than 300 mm loose thickness, however, the layer thickness should be appropriate for the adopted compaction plant.

### Foundations

All exposed foundations should be inspected by a geotechnical engineer prior to footing construction to confirm encountered conditions satisfy design assumptions and that the base of all excavations is free from loose or softened material and water. Water that has ponded in the base of excavations and any resultant softened material is to be removed prior to footing construction.

Footings should be constructed with minimal delay following excavation. If a delay in construction is anticipated, we recommend placing a concrete blinding layer of at least 50 mm thickness in shallow footings or mass concrete in piers / piles to protect exposed foundations.

A geotechnical engineer should confirm any design bearing capacity values, by further assessment during construction, as necessary.

### Shoring - Anchors

Where there is a requirement for either soil or rock anchors, or soil nailing, and these structures penetrate past a property boundary, appropriate permission from the adjoining land owner must be obtained prior to the installation of these structures.

### Shoring - Permanent

Permanent shoring techniques may be used as an alternative to temporary shoring. The design of such structures should be in accordance with the findings of this report and any further testing recommended by this report. Permanent shoring may include [but not be limited to] reinforced block work walls, contiguous and semi contiguous pile walls, secant pile walls and soldier pile walls with or without reinforced shotcrete infill panels. The choice of shoring system will depend on the type of structure, project budget and site specific geotechnical conditions.

Permanent shoring systems are to be engineer designed and backfilled with suitable granular

material and free-draining drainage material. Backfill should be placed in maximum 100 mm thick layers compacted using a hand operated compactor. Care should be taken to ensure excessive compaction stresses are not transferred to retaining walls.

Shoring design should consider any surcharge loading from sloping / raised ground behind shoring structures, live loads, new structures, construction equipment, backfill compaction and static water pressures. All shoring systems shall be provided with adequate foundation designs.

Suitable drainage measures, such as geotextile enclosed 100 mm agricultural pipes embedded in free-draining gravel, should be included to redirect water that may collect behind the shoring structure to a suitable discharge point.

**Shoring - Temporary**

In the absence of providing acceptable excavation batters, excavations should be supported by suitably designed and installed temporary shoring / retaining structures to limit lateral deflection of excavation faces and associated ground surface settlements.

**Soil Erosion Control**

Removal of any soil overburden should be performed in a manner that reduces the risk of sedimentation occurring in any formal stormwater drainage system, on neighbouring land and in receiving waters. Where possible, this may be achieved by one or more of the following means:

1. Maintain vegetation where possible
2. Disturb minimal areas during excavation
3. Revegetate disturbed areas if possible

All spoil on site should be properly controlled by erosion control measures to prevent transportation of sediments off-site. Appropriate soil erosion control methods in accordance with Landcom (2004) shall be required.

**Trafficability and Access**

Consideration should be given to the impact of the proposed works and site subsurface conditions on trafficability within the site e.g. wet clay soils will lead to poor trafficability by tyred plant or vehicles.

Where site access is likely to be affected by any site works, construction staging should be organised such that any impacts on adequate access are minimised as best as possible.

**Vibration Management**

Where excavation is to be extended into medium or higher strength rock, care will be required when using a rock hammer to limit potential structural distress from excavation-induced vibrations where nearby structures may be affected by the works.

To limit vibrations, we recommend limiting rock hammer size and set frequency, and setting the hammer parallel to bedding planes and along defect planes, where possible, or as advised by a geotechnical engineer. We recommend limiting vibration peak particle velocities (PPV) caused by construction equipment or resulting from excavation at the site to 5 mm/s (AS 2187.2, 2006, Appendix J).

**Waste – Spoil and Water**

Soil to be disposed off-site should be classified in accordance with the relevant State Authority guidelines and requirements.

Any collected waste stormwater or groundwater should also be tested prior to discharge to ensure contaminant levels (where applicable) are appropriate for the nominated discharge location.

MA can complete the necessary classification and testing if required. Time allowance should be made for such testing in the construction program.

**Water Management - Groundwater**

If the proposed works are likely to intersect ephemeral or permanent groundwater levels, the management of any potential acid soil drainage should be considered. If groundwater tables are likely to be lowered, this should be further discussed with the relevant State Government Agency.

**Water Management – Surface Water**

All surface runoff should be diverted away from excavation areas during construction works and prevented from accumulating in areas surrounding any retaining structures, footings or the base of excavations.

Any collected surface water should be discharged into a suitable Council approved drainage system and not adversely impact downslope surface and subsurface conditions.

All site discharges should be passed through a filter material prior to release. Sump and pump methods will generally be suitable for collection and removal of accumulated surface water within any excavations.

**Contingency Plan**

In the event that proposed development works cause an adverse impact on geotechnical hazards, overall site stability or adjacent properties, the following actions are to be undertaken:

1. Works shall cease immediately.
2. The nature of the impact shall be documented and the reason(s) for the adverse impact investigated.
3. A qualified geotechnical engineer should be consulted to provide further advice in relation to the issue.

# Attachment H – Notes Relating To This Report

# Information

## Important Information About Your Report (1 of 2)

*These notes have been prepared by Martens to help you interpret and understand the limitations of your report. Not all are necessarily relevant to all reports but are included as general reference.*

### Engineering Reports - Limitations

The recommendations presented in this report are based on limited investigations and include specific issues to be addressed during various phases of the project. If the recommendations presented in this report are not implemented in full, the general recommendations may become inapplicable and Martens & Associates accept no responsibility whatsoever for the performance of the works undertaken.

Occasionally, sub-surface conditions between and below the completed boreholes or other tests may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact Martens & Associates.

Relative ground surface levels at borehole locations may not be accurate and should be verified by on-site survey.

### Engineering Reports – Project Specific Criteria

Engineering reports are prepared by qualified personnel. They are based on information obtained, on current engineering standards of interpretation and analysis, and on the basis of your unique project specific requirements as understood by Martens. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the Client.

Where the report has been prepared for a specific design proposal (e.g. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (e.g. to a twenty storey building). Your report should not be relied upon, if there are changes to the project, without first asking Martens to assess how factors, which changed subsequent to the date of the report, affect the report's recommendations. Martens will not accept responsibility for problems that may occur due to design changes, if not consulted.

### Engineering Reports – Recommendations

Your report is based on the assumption that site conditions, as may be revealed through selective point sampling, are indicative of actual conditions throughout an area. This assumption often cannot be substantiated until project implementation has commenced. Therefore your site investigation report recommendations should only be regarded as preliminary.

Only Martens, who prepared the report, are fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report, there is a risk that the report will be misinterpreted and Martens cannot be held responsible for such misinterpretation.

### Engineering Reports – Use for Tendering Purposes

Where information obtained from investigations is provided for tendering purposes, Martens recommend 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.

Martens would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

### Engineering Reports – Data

The report as a whole presents the findings of a site assessment and should not be copied in part or altered in any way.

Logs, figures, drawings *etc* are customarily included in a Martens report and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), desktop studies and laboratory evaluation of field samples. These data should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

### Engineering Reports – Other Projects

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

### Subsurface Conditions - General

Every care is taken with the report in relation to interpretation of subsurface conditions, discussion of geotechnical aspects, relevant standards and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions - the potential will depend partly on test point

(eg. excavation or borehole) spacing and sampling frequency, which are often limited by project imposed budgetary constraints.

- Changes in guidelines, standards and policy or interpretation of guidelines, standards and policy by statutory authorities.

- The actions of contractors responding to commercial pressures.

- Actual conditions differing somewhat from those inferred to exist, because no professional, no matter how qualified, can reveal precisely what is hidden by earth, rock and time.

  The actual interface between logged materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

If these conditions occur, Martens will be pleased to assist with investigation or providing advice to resolve the matter.

## Subsurface Conditions - Changes

Natural processes and the activity of man create subsurface conditions. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Reports are based on conditions which existed at the time of the subsurface exploration / assessment.

Decisions should not be based on a report whose adequacy may have been affected by time. If an extended period of time has elapsed since the report was prepared, consult Martens to be advised how time may have impacted on the project.

## Subsurface Conditions - Site Anomalies

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

## Report Use by Other Design Professionals

To avoid potentially costly misinterpretations when other design professionals develop their plans based on a Martens report, retain Martens to work with other project professionals affected by the report. This may involve Martens explaining the report design implications and then reviewing plans and specifications produced to see how they have incorporated the report findings.

## Subsurface Conditions – Geo-environmental Issues

Your report generally does not relate to any findings, conclusions, or recommendations about the potential for hazardous or contaminated materials existing at the site unless specifically required to do so as part of Martens' proposal for works.

Specific sampling guidelines and specialist equipment, techniques and personnel are typically used to perform geo-environmental or site contamination assessments. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Martens for information relating to such matters.

## Responsibility

Geo-environmental reporting relies on interpretation of factual information based on professional judgment and opinion and has an inherent level of uncertainty attached to it and is typically far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded.

To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Martens to other parties but are included to identify where Martens' responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Martens closely and do not hesitate to ask any questions you may have.

## Site Inspections

Martens will always be pleased to provide engineering inspection services for aspects of work to which this report relates. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site. Martens is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction.

# Soil Data

## Explanation of Terms (1 of 3)

### Definitions

In engineering terms, soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material does not exhibit any visible rock properties and can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

The methods of description and classification of soils and rocks used in this report are typically based on Australian Standard 1726 and the Unified Soil Classification System (USCS) – refer Soil Data Explanation of Terms (2 of 3). In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

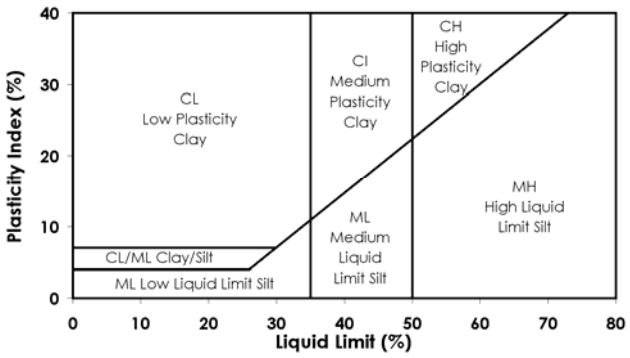
### Particle Size

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (e.g. sandy CLAY). Unless otherwise stated, particle size is described in accordance with the following table.

| Division | Subdivision | Size (mm) |
|---|---|---|
| BOULDERS | | >200 |
| COBBLES | | 63 to 200 |
| GRAVEL | Coarse | 20 to 63 |
| | Medium | 6 to 20 |
| | Fine | 2.36 to 6 |
| SAND | Coarse | 0.6 to 2.36 |
| | Medium | 0.2 to 0.6 |
| | Fine | 0.075 to 0.2 |
| SILT | | 0.002 to 0.075 |
| CLAY | | < 0.002 |

### Plasticity Properties

Plasticity properties of cohesive soils can be assessed in the field by tactile properties or by laboratory procedures.




### Moisture Condition

| | |
|---|---|
| Dry | Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands. |
| Moist | Soil feels cool and damp and is darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere. |
| Wet | As for moist but with free water forming on hands when handled. |

### Consistency of Cohesive Soils

Cohesive soils refer to predominantly clay materials.

| Term | $C_u$ (kPa) | Approx. SPT "N" | Field Guide |
|---|---|---|---|
| Very Soft | <12 | 2 | A finger can be pushed well into the soil with little effort. Sample extrudes between fingers when squeezed in fist. |
| Soft | 12 - 25 | 2 – 4 | A finger can be pushed into the soil to about 25mm depth. Easily moulded in fingers. |
| Firm | 25 - 50 | 4 – 8 | The soil can be indented about 5mm with the thumb, but not penetrated. Can be moulded by strong pressure in the figures. |
| Stiff | 50 - 100 | 8 – 15 | The surface of the soil can be indented with the thumb, but not penetrated. Cannot be moulded by fingers. |
| Very Stiff | 100 - 200 | 15 – 30 | The surface of the soil can be marked, but not indented with thumb pressure. Difficult to cut with a knife. Thumbnail can readily indent. |
| Hard | > 200 | > 30 | The surface of the soil can be marked only with the thumbnail. Brittle. Tends to break into fragments. |
| Friable | - | - | Crumbles or powders when scraped by thumbnail. |

### Density of Granular Soils

Non-cohesive soils are classified on the basis of relative density, generally from standard penetration test (SPT) or Dutch cone penetrometer test (CPT) results as below:

| Relative Density | % | SPT 'N' Value* (blows/300mm) | CPT Cone Value ($q_c$ MPa) |
|---|---|---|---|
| Very loose | < 15 | < 5 | < 2 |
| Loose | 15 - 35 | 5 - 10 | 2 - 5 |
| Medium dense | 35 - 65 | 10 - 30 | 5 - 15 |
| Dense | 65 - 85 | 30 - 50 | 15 - 25 |
| Very dense | > 85 | > 50 | > 25 |

* Values may be subject to corrections for overburden pressures and equipment type.

### Minor Components

Minor components in soils may be present and readily detectable, but have little bearing on general geotechnical classification. Terms include:

| Term | Assessment | Proportion of Minor component In: |
|---|---|---|
| Trace of | Presence just detectable by feel or eye. Soil properties little or no different to general properties of primary component. | Coarse grained soils: < 5 %<br>Fine grained soils: < 15 % |
| With some | Presence easily detectable by feel or eye. Soil properties little different to general properties of primary component. | Coarse grained soils: 5 – 12 %<br>Fine grained soils: 15 – 30 % |

# Soil Data

## Explanation of Terms (2 of 3)

martens consulting engineers

### Symbols for Soils and Other

**SOILS**


COBBLES/BOULDERS


GRAVEL (GP OR GW)


SILTY GRAVEL (GM)


CLAYEY GRAVEL (GC)


SAND (SP OR SW)


SILTY SAND (SM)


CLAYEY SAND (SC)


SILT (ML OR MH)


ORGANIC SILT (OH)


CLAY (CL, CI OR CH)


SILTY CLAY


SANDY CLAY


PEAT


TOPSOIL

**OTHER**


FILL


TALUS


ASPHALT


CONCRETE

### Unified Soil Classification Scheme (USCS)

| FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass) | | | | | USCS | Primary Name |
|---|---|---|---|---|---|---|
| COARSE GRAINED SOILS More than 50 % of material less than 63 mm is larger than 0.075 mm | (A 0.075 mm particle is about the smallest particle visible to the naked eye) | GRAVELS More than half of coarse fraction is larger than 2.0 mm. | CLEAN GRAVELS (Little or no fines) | Wide range in grain size and substantial amounts of all intermediate particle sizes. | GW | Gravel |
| | | | | Predominantly one size or a range of sizes with more intermediate sizes missing | GP | Gravel |
| | | | GRAVELS WITH FINES (Appreciable amount of fines) | Non-plastic fines (for identification procedures see ML below) | GM | Silty Gravel |
| | | | | Plastic fines (for identification procedures see CL below) | GC | Clayey Gravel |
| | | SANDS More than half of coarse fraction is smaller than 2.0 mm | CLEAN SANDS (Little or no fines) | Wide range in grain sizes and substantial amounts of intermediate sizes missing. | SW | Sand |
| | | | | Predominantly one size or a range of sizes with some intermediate sizes missing | SP | Sand |
| | | | SANDS WITH FINES (Appreciable amount of fines) | Non-plastic fines (for identification procedures see ML below) | SM | Silty Sand |
| | | | | Plastic fines (for identification procedures see CL below) | SC | Clayey Sand |

| FINE GRAINED SOILS More than 50 % of material less than 63 mm is smaller than 0.075 mm | IDENTIFICATION PROCEDURES ON FRACTIONS < 0.2 MM | | | | | |
|---|---|---|---|---|---|---|
| | DRY STRENGTH (Crushing Characteristics) | DILATANCY | TOUGHNESS | DESCRIPTION | USCS | Primary Name |
| | None to Low | Quick to Slow | None | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity | ML | Silt |
| | Medium to High | None | Medium | Inorganic clays of low to medium plasticity [1], gravely clays, sandy clays, silty clays, lean clays | CL [2] | Clay |
| | Low to Medium | Slow to Very Slow | Low | Organic slits and organic silty clays of low plasticity | OL | Organic Silt |
| | Low to Medium | Slow to Very Slow | Low to Medium | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts | MH | Silt |
| | High | None | High | Inorganic clays of high plasticity, fat clays | CH | Clay |
| | Medium to High | None | Low to Medium | Organic clays of medium to high plasticity | OH | Organic Silt |
| HIGHLY ORGANIC SOILS | Readily identified by colour, odour, spongy feel and frequently by fibrous texture | | | | Pt | Peat |

**Notes:**

1. Low Plasticity – Liquid Limit $W_L$ < 35 % Medium Plasticity – Liquid limit $W_L$ 35 to 60 % High Plasticity - Liquid limit $W_L$ > 60 %.
2. CI may be adopted for clay of medium plasticity to distinguish from clay of low plasticity.

# Soil Data

## Explanation of Terms (3 of 3)

### Soil Agricultural Classification Scheme

In some situations, such as where soils are to be used for effluent disposal purposes, soils are often more appropriately classified in terms of traditional agricultural classification schemes. Where a Martens report provides agricultural classifications, these are undertaken in accordance with descriptions by Northcote, K.H. (1979) *The factual key for the recognition of Australian Soils*, Rellim Technical Publications, NSW, p 26 - 28.

| Symbol | Field Texture Grade | Behaviour of moist bolus | Ribbon length | Clay content (%) |
|---|---|---|---|---|
| S | Sand | Coherence nil to very slight; cannot be moulded; single grains adhere to fingers | 0 mm | < 5 |
| LS | Loamy sand | Slight coherence; discolours fingers with dark organic stain | 6.35 mm | 5 |
| CLS | Clayey sand | Slight coherence; sticky when wet; many sand grains stick to fingers; discolours fingers with clay stain | 6.35mm - 1.3cm | 5 - 10 |
| SL | Sandy loam | Bolus just coherent but very sandy to touch; dominant sand grains are of medium size and are readily visible | 1.3 - 2.5 | 10 - 15 |
| FSL | Fine sandy loam | Bolus coherent; fine sand can be felt and heard | 1.3 - 2.5 | 10 - 20 |
| SCL$^-$ | Light sandy clay loam | Bolus strongly coherent but sandy to touch, sand grains dominantly medium size and easily visible | 2.0 | 15 - 20 |
| L | Loam | Bolus coherent and rather spongy; smooth feel when manipulated but no obvious sandiness or silkiness; may be somewhat greasy to the touch if much organic matter present | 2.5 | 25 |
| Lfsy | Loam, fine sandy | Bolus coherent and slightly spongy; fine sand can be felt and heard when manipulated | 2.5 | 25 |
| SiL | Silt loam | Coherent bolus, very smooth to silky when manipulated | 2.5 | 25 + > 25 silt |
| SCL | Sandy clay loam | Strongly coherent bolus sandy to touch; medium size sand grains visible in a finer matrix | 2.5 - 3.8 | 20 - 30 |
| CL | Clay loam | Coherent plastic bolus; smooth to manipulate | 3.8 - 5.0 | 30 - 35 |
| SiCL | Silty clay loam | Coherent smooth bolus; plastic and silky to touch | 3.8 - 5.0 | 30- 35 + > 25 silt |
| FSCL | Fine sandy clay loam | Coherent bolus; fine sand can be felt and heard | 3.8 - 5.0 | 30 - 35 |
| SC | Sandy clay | Plastic bolus; fine to medium sized sands can be seen, felt or heard in a clayey matrix | 5.0 - 7.5 | 35 - 40 |
| SiC | Silty clay | Plastic bolus; smooth and silky | 5.0 - 7.5 | 35 - 40 + > 25 silt |
| LC | Light clay | Plastic bolus; smooth to touch; slight resistance to shearing | 5.0 - 7.5 | 35 - 40 |
| LMC | Light medium clay | Plastic bolus; smooth to touch, slightly greater resistance to shearing than LC | 7.5 | 40 - 45 |
| MC | Medium clay | Smooth plastic bolus, handles like plasticine and can be moulded into rods without fracture, some resistance to shearing | > 7.5 | 45 - 55 |
| HC | Heavy clay | Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to shearing | > 7.5 | > 50 |

# Rock Data

## Explanation of Terms (1 of 2)

### Symbols for Rock

**SEDIMENTARY ROCK**


BRECCIA


CONGLOMERATE


CONGLOMERATIC SANDSTONE


SANDSTONE/QUARTZITE


SILTSTONE


MUDSTONE/CLAYSTONE


SHALE


COAL


LIMESTONE


LITHIC TUFF

**IGNEOUS ROCK**


GRANITE


DOLERITE/BASALT

**METAMORPHIC ROCK**


SLATE, PHYLLITE, SCHIST


GNEISS


METASANDSTONE


METASILTSTONE


METAMUDSTONE

### Definitions

Descriptive terms used for Rock by Martens are based on AS1726 and encompass rock substance, defects and mass.

*Rock Substance* In geotechnical engineering terms, rock substance is any naturally occurring aggregate of minerals and organic matter which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Rock substance is effectively homogeneous and may be isotropic or anisotropic.

*Rock Defect* Discontinuity or break in the continuity of a substance or substances.

*Rock Mass* Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

### Degree of Weathering

Rock weathering is defined as the degree of decline in rock structure and grain property and can be determined in the field.

| Term | Symbol | Definition |
|---|---|---|
| Residual soil[1] | Rs | Soil derived from the weathering of rock. The mass structure and substance fabric are no longer evident. There is a large change in volume but the soil has not been significantly transported. |
| Extremely weathered[1] | EW | Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident. |
| Highly weathered[2] | HW | Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decrease compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original rock substance is no longer recognisable. |
| Moderately weathered[2] | MW | Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable. |
| Slightly weathered | SW | Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable. |
| Fresh | FR | Rock substance unaffected by weathering |

**Notes:**
1 The term "Distinctly Weathered" (DW) may be used to cover the range of substance weathering between EW and SW.
2 Rs and EW material is described using soil descriptive terms.

### Rock Strength

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the loading. The test procedure is described by the International Society of Rock Mechanics.

| Term | Is (50) MPa | Field Guide | Symbol |
|---|---|---|---|
| Very low | >0.03 ≤0.1 | May be crumbled in the hand. Sandstone is 'sugary' and friable. | VL |
| Low | >0.1 ≤0.3 | A piece of core 150mm long x 50mm diameter may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling. | L |
| Medium | >0.3 ≤1.0 | A piece of core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife. | M |
| High | >1 ≤3 | A piece of core 150mm long x 50mm diameter cannot be broken by unaided hands, can be slightly scratched or scored with a knife. | H |
| Very high | >3 ≤10 | A piece of core 150mm long x 50mm diameter may be broken readily with hand held hammer. Cannot be scratched with pen knife. | VH |
| Extremely high | >10 | A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer. | EH |

# Rock Data

## Explanation of Terms (2 of 2)

### Degree of Fracturing

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude fractures such as drilling breaks (DB) or handling breaks (HB).

| Term | Description |
|---|---|
| Fragmented | The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than core diameter. |
| Highly fractured | Core lengths are generally less than 20 mm to 40 mm with occasional fragments. |
| Fractured | Core lengths are mainly 30 mm to 100 mm with occasional shorter and longer sections. |
| Slightly fractured | Core lengths are generally 300 mm to 1000 mm, with occasional longer sections and sections of 100 mm to 300 mm. |
| Unbroken | The core does not contain any fractures. |

### Rock Core Recovery

TCR = Total Core Recovery

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

SCR = Solid Core Recovery

$$= \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100\%$$

RQD = Rock Quality Designation

$$= \frac{\sum \text{Axial lengths of core} > 100\,\text{mm long}}{\text{Length of core run}} \times 100\%$$

### Rock Strength Tests

▼ Point load strength Index (Is50) - axial test (MPa)

► Point load strength Index (Is50) - diametral test (MPa)

● Unconfined compressive strength (UCS) (MPa)

### Defect Type Abbreviations and Descriptions

**Defect Type (with inclination given)**

| | |
|---|---|
| BP | Bedding plane parting |
| FL | Foliation |
| CL | Cleavage |
| JT | Joint |
| FC | Fracture |
| SZ/SS | Sheared zone/ seam (Fault) |
| CZ/CS | Crushed zone/ seam |
| DZ/DS | Decomposed zone/ seam |
| FZ | Fractured Zone |
| IS | Infilled seam |
| VN | Vein |
| CO | Contact |
| HB | Handling break |
| DB | Drilling break |

**Planarity**

| | |
|---|---|
| Pl | Planar |
| Cu | Curved |
| Un | Undulating |
| St | Stepped |
| Ir | Irregular |
| Dis | Discontinuous |

**Roughness**

| | |
|---|---|
| Pol | Polished |
| Sl | Slickensided |
| Sm | Smooth |
| Ro | Rough |
| VR | Very rough |

**Thickness**

| | |
|---|---|
| Zone | > 100 mm |
| Seam | > 2 mm < 100 mm |
| Plane | < 2 mm |

**Coating or Filling**

| | |
|---|---|
| Cn | Clean |
| Sn | Stain |
| Ct | Coating |
| Vnr | Veneer |
| Fe | Iron Oxide |
| X | Carbonaceous |
| Qz | Quartzite |
| MU | Unidentified mineral |

**Inclination**

Inclination of defect is measured from perpendicular to and down the core axis.
Direction of defect is measured clockwise (looking down core) from magnetic north.

# Test, Drill and Excavation Methods

## Explanation of Terms (1 of 3)

### Sampling

Sampling is carried out during drilling or excavation to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling or excavation provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples may be taken by pushing a thin-walled sampling tube, e.g. $U_{50}$ (50 mm internal diameter thin walled tube), into soils and withdrawing a soil sample in a relatively undisturbed state. Such samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Other sampling methods may be used. Details of the type and method of sampling are given in the report.

### Drilling / Excavation Methods

The following is a brief summary of drilling and excavation methods currently adopted by the Company and some comments on their use and application.

Hand Excavation - in some situations, excavation using hand tools, such as mattock and spade, may be required due to limited site access or shallow soil profiles.

Hand Auger - the hole is advanced by pushing and rotating either a sand or clay auger, generally 75-100 mm in diameter, into the ground. The penetration depth is usually limited to the length of the auger pole; however extender pieces can be added to lengthen this.

Test Pits - these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils and, if it is safe to descend into the pit, collection of bulk disturbed samples. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (e.g. Pengo) - the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling (Push Tube) - the hole is advanced by pushing a 50 - 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength *etc.* is only marginally affected.

Continuous Spiral Flight Augers - the hole is advanced using 90 - 115 mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface or, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling - similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling - a continuous core sample is obtained using a diamond tipped core barrel of usually 50 mm internal diameter. Provided full core recovery is achieved (not always possible in very weak or fractured rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

### In-situ Testing and Interpretation

Cone Penetrometer Testing (CPT)

Cone penetrometer testing (sometimes referred to as Dutch Cone) described in this report has been carried out using an electrical friction cone penetrometer.

The test is described in AS 1289.6.5.1-1999 (R2013). In the test, a 35 mm diameter rod with a cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system.

Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the push rod centre to an amplifier and recorder unit mounted on the control truck. As penetration occurs (at a rate of approximately 20 mm per second) the information is output on continuous chart recorders. The plotted results given in this report have been traced from the original records. The information provided on the charts comprises:

(i) Cone resistance ($q_c$) - the actual end bearing force divided by the cross sectional area of the cone, expressed in MPa.

(ii) Sleeve friction ($q_f$) - the frictional force of the sleeve divided by the surface area, expressed in kPa.

(iii) Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower (A) scale (0 - 5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main (B) scale (0 - 50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1 % - 2 % are commonly encountered in sands and very soft clays rising to 4 % - 10 % in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6)\ N \text{ (blows/300 mm)}$$

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:

$$q_c = (12 \text{ to } 18)\ C_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes *etc.* This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Standard Penetration Testing (SPT)

Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample.

The test procedure is described in AS 1289.6.3.1-2004. The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm penetration depth increments and the 'N' value is taken as the number of blows for the last two 150 mm depth increments (300 mm total penetration). In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued. The test results are reported in the following form:

(i) Where full 450 mm penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7 blows:

as 4, 6, 7
N = 13

(ii) Where the test is discontinued, short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm

as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

Dynamic Cone (Hand) Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods. Two relatively similar tests are used.

**Perth sand penetrometer (PSP)** - a 16 mm diameter flat ended rod is driven with a 9 kg hammer, dropping 600 mm. The test, described in AS 1289.6.3.3-1997 (R2013), was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

**Cone penetrometer (DCP)** - sometimes known as the Scala Penetrometer, a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm. The test, described in AS 1289.6.3.2-1997 (R2013), was developed initially for pavement sub-grade investigations, with correlations of the test results with California Bearing Ratio published by various Road Authorities.

Pocket Penetrometers

The pocket (hand) penetrometer (PP) is typically a light weight spring hand operated device with a stainless steel loading piston, used to estimate unconfined compressive strength, $q_u$, (UCS in kPa) of a fine grained soil in field conditions. In use, the free end of the piston is pressed into the soil at a uniform penetration rate until a line, engraved near the piston tip, reaches the soil surface level. The reading is taken from a gradation scale, which is attached to the piston via a built-in spring mechanism and calibrated to kilograms per square centimetre (kPa) UCS. The UCS measurements are used to evaluate consistency of the soil in the field moisture condition. The results may be used to assess the undrained shear strength, $C_u$, of fine grained soil using the approximate relationship:

$$q_u = 2 \times C_u.$$

It should be noted that accuracy of the results may be influenced by condition variations at selected test surfaces. Also, the readings obtained from the PP test are based on a small area of penetration and could give misleading results. They should not replace laboratory test results. The use of the results from this test is typically limited to an assessment of consistency of the soil in the field and not used directly for design of foundations.

## Test Pit / Borehole Logs

Test pit / borehole log(s) presented herein are an engineering and / or geological interpretation of the subsurface conditions. Their reliability will depend to some extent on frequency of sampling and methods of excavation / drilling. Ideally, continuous undisturbed sampling or excavation / 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 test pit / borehole logs 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 test pits / boreholes, the frequency of sampling and the possibility of other than 'straight line' variation between the test pits / boreholes.

## Laboratory Testing

Laboratory testing is carried out in accordance with AS 1289 Methods of Testing Soil for Engineering Purposes. Details of the test procedure used are given on the individual report forms.

## Ground Water

Where ground water levels are measured in boreholes, there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all during the time it 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 prior weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations 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.

# Test, Drill and Excavation Methods

## Explanation of Terms (3 of 3)

### DRILLING / EXCAVATION METHOD

| | | | | | |
|---|---|---|---|---|---|
| HA | Hand Auger | RD | Rotary Blade or Drag Bit | NQ | Diamond Core - 47 mm |
| AD/V | Auger Drilling with V-bit | RT | Rotary Tricone bit | NMLC | Diamond Core – 51.9 mm |
| AD/T | Auger Drilling with TC-Bit | RAB | Rotary Air Blast | HQ | Diamond Core – 63.5 mm |
| AS | Auger Screwing | RC | Reverse Circulation | HMLC | Diamond Core – 63.5 mm |
| HSA | Hollow Stem Auger | CT | Cable Tool Rig | DT | Diatube Coring |
| S | Excavated by Hand Spade | PT | Push Tube | NDD | Non-destructive digging |
| BH | Tractor Mounted Backhoe | PC | Percussion | PQ | Diamond Core - 83 mm |
| JET | Jetting | E | Tracked Hydraulic Excavator | X | Existing Excavation |

### SUPPORT

| | | | | | |
|---|---|---|---|---|---|
| Nil | No support | S | Shotcrete | RB | Rock Bolt |
| C | Casing | Sh | Shoring | SN | Soil Nail |
| WB | Wash bore with Blade or Bailer | WR | Wash bore with Roller | T | Timbering |

### WATER

▽ Water level at date shown

▷ Water inflow

◁ Partial water loss

◀ Complete water loss

| | |
|---|---|
| GROUNDWATER NOT OBSERVED (NO) | The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit. |
| GROUNDWATER NOT ENCOUNTERED (NX) | The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period. |

### PENETRATION / EXCAVATION RESISTANCE

| | |
|---|---|
| L | Low resistance: Rapid penetration possible with little effort from the equipment used. |
| M | Medium resistance: Excavation possible at an acceptable rate with moderate effort from the equipment used. |
| H | High resistance: Further penetration possible at slow rate & requires significant effort equipment. |
| R | Refusal/ Practical Refusal. No further progress possible without risk of damage/ unacceptable wear to digging implement / machine. |

These assessments are subjective and dependent on many factors, including equipment power, weight, condition of excavation or drilling tools, and operator experience.

### SAMPLING

| | | | | | |
|---|---|---|---|---|---|
| D | Small disturbed sample | W | Water Sample | C | Core sample |
| B | Bulk disturbed sample | G | Gas Sample | CONC | Concrete Core |

U63 Thin walled tube sample - number indicates nominal undisturbed sample diameter in millimetres

### TESTING

| | |
|---|---|
| SPT<br>4,7,11<br>N=18 | Standard Penetration Test to AS1289.6.3.1-2004<br>4,7,11 = Blows per 150mm.<br>'N' = Recorded blows per 300mm penetration following 150mm seating |
| DCP | Dynamic Cone Penetration test to AS1289.6.3.2-1997.<br>'n' = Recorded blows per 150mm penetration |

**Notes:**

| | |
|---|---|
| RW | Penetration occurred under the rod weight only |
| HW | Penetration occurred under the hammer and rod weight only |
| HB 30/80mm | Hammer double bouncing on anvil after 80 mm penetration |
| N=18 | Where practical refusal occurs, report blows and penetration for that interval |

| | |
|---|---|
| CPT | Static cone penetration test |
| CPTu | CPT with pore pressure (u) measurement |
| PP | Pocket penetrometer test expressed as instrument reading (kPa) |
| FP | Field permeability test over section noted |
| VS | Field vane shear test expressed as uncorrected shear strength (sv = peak value, sr = residual value) |
| PM | Pressuremeter test over section noted |
| PID | Photoionisation Detector reading in ppm |
| WPT | Water pressure tests |

### SOIL DESCRIPTION

| Density | | Consistency | | Moisture | |
|---|---|---|---|---|---|
| VL | Very loose | VS | Very soft | D | Dry |
| L | Loose | S | Soft | M | Moist |
| MD | Medium dense | F | Firm | W | Wet |
| D | Dense | St | Stiff | Wp | Plastic limit |
| VD | Very dense | VSt | Very stiff | Wl | Liquid limit |
| | | H | Hard | | |

### ROCK DESCRIPTION

| Strength | | Weathering | |
|---|---|---|---|
| VL | Very low | EW | Extremely weathered |
| L | Low | HW | Highly weathered |
| M | Medium | MW | Moderately weathered |
| H | High | SW | Slightly weathered |
| VH | Very high | FR | Fresh |
| EH | Extremely high | | |