



Douglas Partners

Geotechnics | Environment | Groundwater

Report on
Geotechnical Investigation

Preliminary Geotechnical Investigation
Block 7 Section 4, Yarralumla

Prepared for
The Shepherd Foundation

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

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Report on Geotechnical Investigation

Preliminary Geotechnical Investigation

Block 7 Section 4, Yarralumla

1. Introduction

This report presents the results of a preliminary geotechnical investigation at Block 7 Section 4, Yarralumla. The investigation was commissioned in an email dated 12 November 2020 by Mr Justin Micallef of The Shepherd Foundation and was undertaken in accordance with Douglas Partners' proposal CAN200386 dated 12 Nov 2020.

It is understood that the site is proposed for redevelopment comprising the demolition of the existing buildings and the construction of a number of multi-storey buildings, potentially with up to two basement levels.

The aim of the investigation was to broadly assess the subsurface conditions to assist with preliminary design and planning, and provide comments on the following:

- Evaluation of subsurface strata including presence of existing fill, groundwater and rock conditions (where encountered);
- Earthworks and site preparation including for pavements;
- Excavation conditions;
- Excavation support (including indicative design parameters for basement walls and retaining walls);
- Bearing pressures and footing recommendations for both piled and shallow foundations; and
- Recommended subgrade CBR (for pavement design by others).

The investigation included the excavation of seven test pits, the drilling of nineteen boreholes and laboratory testing of selected samples. The details of the field work are presented in this report, together with preliminary comments and recommendations on the items listed above.

2. Proposed Development

It is understood that the redevelopment of the site will comprise the demolishing of the existing buildings and the construction of a number of multi-storey buildings, potentially with up to two basement levels and internal pavements. For the purpose of this report, it has been assumed that excavations up to 6 m in depth will be required for the basement levels.

3. Site Description

The site is located at Block 7, Section 4 in Yarralumla and comprises an irregular near-C shaped area. The site is bordered by Banks Street to the east, Bentham Street to the south and south west, by the historic Westridge house to the north, and by the Royal Canberra Golf Club to the north west and south west. Forestry Oval is located in the middle/the eastern part of the site. Lake Burley Griffin is located around 450 m to the northeast of the site. Figure 1 - Site layout and boundaries below from ACTmapi shows the current aerial photography of the site and the site boundaries.



Figure 1 - Site layout and boundaries

A walkover was undertaken at the site on 30 November 2020. During the site walkover, the following was observed:

- Large parts of the site are occupied by open space covered with low lying grassy vegetation and trees of heights up to ~25 m. In the south east corner the trees are placed in a dense, grid-like pattern.
- A number of single and multi-storey buildings are present across the site. Drawing 1 in Appendix B show the existing building layout and numbering.
- Multiple carparks and roads are located across the site including Wilf Crane Crescent which forms the inside boundary of the C shaped site (next to Forestry Oval). The roads/carparks are asphalt surfaced, with the exception of the carparks around Buildings 4A-4H which are concreted.
- The carparks are in generally good condition with minor cracking.
- Minor discoloration, staining and cracking was observed in the concrete of the carparks surrounding Buildings 4A – 4H.
- Roads are in generally good condition, with sections of Wilf Crane Crescent having patch replacement works undertaken. Cracking from tree roots was observed in the road to the north of Building 2.
- A chain-link wire fence with barbed wire surrounds the carpark in between Buildings 12 – 15, 16 and 18. This fence has two gates to it, one in the eastern edge and one in the south west corner.
- The north west corner of the site (to the north of Building 2 and west of Building 22 was fenced off by a chain link fence, with access via a gate south of Building 15.
- Buildings across the site generally comprised either 1960s-1970s low to medium rise office buildings or original 1920's single/double storey buildings. Several greenhouses and other assorted research facilities and warehouses are interspersed between the office buildings.
- The majority of buildings are built at grade with minimal site cut and/or fill. It is noted that Buildings 3 and 4A-4H have the largest amount of earthworks for their construction, with cuts and fills of up to approximately 2.0 m estimated.
- A cut of approximately 1.4 m in height is located in the northern carpark to the south of Building 16. Cuts of similar heights were observed in the western boundary of the carpark to the west of Building 2 and the north of Building 3.
- Small retaining walls up to 0.7 m in height are interspersed across the site as part of the landscaping and earthworks around buildings.
- The site is undulating in elevation, with heights ranging from 571 m AHD to 592 m AHD.
- There is a ridge running from the south west to the north east from the north west of Building No. 2 through to Building No. 12, with the site sloping to the north west from the north of this ridge and to the south from the south of this ridge.
- The south east section of the site slopes from the south west to north east.
- No surface water was observed during the site investigation.
- A dirt track, likely from pedestrian traffic was observed between Building 3 and Building 1.
- Anthropogenically placed boulders were observed to the west of Building 5A as landscaping.
- A telecommunications tower is located to the north west of Building 2.

- Two disused tennis courts are located to the west of Building 17.
- At the time of site investigation, workers were in the process of cutting down and removing the trees in the north west corner of the site (to the west of Buildings 13 and 22) and were demolishing Building No. 13.

Figures 2 – 7 show the general conditions of the site at the time of the site walkover.



Figure 2 – View west on Wilf Crane Crescent at the southern end of the site



Figure 3 – View of Buildings 1a and 1b looking north west



Figure 4 - View looking west to Building 3 (left) and Buildings 4A – 4D (right) showing cut, landscaping and climate controlled greenhouses.



Figure 5 - Cut approximately 1.4 m in height in the western edge of the carpark behind Building 2



Figure 6 - View looking west of the northern carpark. NOTE: Bore 103 in the foreground.



Figure 7 - Retaining wall approximately 0.7 m tall to the west of Building 19

4. Regional Geology

Reference to BMR (1992) indicates that the site is underlain by sedimentary rocks of the Yarralumla Formation that typically comprise calcareous and tuffaceous mudstone and siltstone with minor limestone, calc-silicate hornfels and quartz sandstone. There is a pronounced northeast / southwest structural trend and the rocks are gently folded. As shown below in Figure 8 – Site Geology., there is a fault as part of the Yarralumla formation running from the north west to south east through the north east corner of the site.



Figure 8 – Site Geology.

5. Field Work Methods

The field work comprised the excavation of seven test pits (Pits 1 – 5, 8 and 10) and drilling of five boreholes (Bores 6, 7, 9, 11 and 12) within areas of proposed and existing pavements and drilling of 14 boreholes (Bores 101 – 113 and 110A) in areas of proposed buildings as outlined in Section 5.1 – 5.3 below. Dynamic cone penetrometer (DCP) tests were undertaken adjacent to the test pits and from below the existing pavement level in the boreholes.

It is noted that Bore 110 was redrilled as Bore 110A due to shallow refusal in the original hole.

The bores and pits were logged onsite by a geotechnical engineer and incorporated the collection of disturbed and bulk samples to assist in strata identification and for laboratory testing. The approximate locations of the boreholes and test pits are shown on Drawing 2 (Appendix B).

5.1 Test Pits (Pits 1 – 5, 8 and 10)

The test pits were excavated using a CAT304CR mini-excavator fitted with a 300 mm wide bucket to depths of 1.8 m to 2.0 m.

5.2 Existing Pavement Boreholes (Bores 6, 7, 9, 11, 12)

The boreholes within the existing pavement were drilled using a CAT 304CR mini-excavator fitted with a 300 mm diameter auger to depths of 1.5 m to 2.0 m.

5.3 Proposed Building Boreholes (Bores 101 – 113 & 110A)

The 13 boreholes were drilled to depths of 2.4 m to 9.0 m using a hydropower Scout truck mounted auger/ rotary soil sampling and rock coring drilling rig. The boreholes were drilled with 110 mm diameter solid flight augers with the incorporation of Standard penetration tests (SPT's) to refusal depths of 2.4 m – 7.3 m or to the limit of investigation depth of 9.0 m (in Bore 102 only). Four of the boreholes (one in each precinct) were continued into the bedrock using NMLC coring techniques to depths of 7.0 m to 8.5 m depth.

Standpipe piezometers were installed to the full depths of Bores 102 and 112 to measure groundwater levels.

6. Field Work Results

Details of the conditions encountered in the boreholes and test pits are given in the logs included in Appendix C. These must be read in conjunction with the accompanying standard notes which define classification methods and descriptive terms. The principal succession of strata encountered in the boreholes and test pits are summarised in Sections 6.1 and 6.2 below.

6.1 Proposed Pavement Areas (Pits 1 – 5, 8 and 10 and Bores 6, 7, 9, 11 and 12)

- **TOPSOIL:** sandy silt or silty sand clay topsoil/topsoil fill in Pits 1 – 5, 8 and 10 to depths of 0.1 m to 0.4 m. Natural topsoil was also encountered underlying the fill in Pit 8 from 1.5 m to 1.8 m depth.
- **FILL (PAVEMENT MATERIALS):** 50 mm of asphalt overlying 250 mm to 300 mm of roadbase gravel in Bores 6, 7, 9, 11 and 12.
- **FILL (GENERAL):** medium to high plasticity clay or sandy gravel fill at Test Locations 5 and 8 – 11 to depths of 0.3 m to 1.5 m. It is noted that a boulder up to 500 mm in size was encountered within the fill in Pit 5 at 0.3 m depth.
- **CLAY/SILTY CLAY/SANDY CLAY:** firm to hard, medium to high plasticity clay, silty clay and sandy clay at all test locations to depths of 1.2 m to 2.0 m depth. Test locations 1 and 5 – 7 were terminated in this strata at the limit of investigation depth of 1.5 m to 2.0 m.
- **BEDROCK:** very low to low strength, highly weathered siltstone and sandstone bedrock at Test Locations 2 – 4 and 9 – 12 below depths of 1.2 m to 1.8 m to the limit of investigation depths of 1.8 m to 2.0 m.

Table 1 below summarises the existing pavement profile in Bores 6, 7, 9, 11 and 12.

Table 1: Summary of Existing Road Subsurface Conditions

Bore No	Asphalt Layer Thickness (mm)	Road base Layer Thickness (mm)	Subgrade Conditions
6	50	250	Natural silty clay and clay (moisture affected to 1.2 m)
7	50	300	Natural sandy clay and silty clay
9	50	250	Clay fill then natural clay and silty clay overlying siltstone bedrock
11	50	250	Sandy gravel select fill then natural clay overlying siltstone bedrock
12	50	250	Natural silty clay overlying siltstone bedrock

6.2 Proposed Building Areas (Bores 6, 7, 9, 11, 12, 101 – 113 & 110A)

- **TOPSOIL:** sandy silt topsoil/topsoil fill in Bores 101, 104, 105, 107, 111 and 113 to depths of 0.15 m to 0.4 m.
- **FILL (PAVEMENT MATERIALS):** 50 mm of asphalt overlying 150 mm to 250 mm of road base gravel in Bores 102, 103, 106, 109, 110A and 112 and 60 mm and 80 mm thick concrete in Bores 108 and 110, with 120 mm of road base gravel in Bore 110 only.
- **FILL (GENERAL):** medium to high plasticity clay fill in Bore 108 to 1.6 m depth.

- **CLAY/SILTY CLAY/SANDY CLAY:** stiff to hard (and firm in Bore 109 to 1.8 m depth), low to high plasticity clay, silty clay and sandy clay at all test locations, excluding Bores 110 and 110A, to depths of 1.4 – 2.0 m depth.
- **BEDROCK:** variably very low to high strength, highly to slightly weathered siltstone and sandstone bedrock at all test locations below depths of 0.5 m to 4.5 m to the termination depths of 2.4 – 9.0 m at either the limit of investigation or auger refusal. Table 1 below provides a summary of the depth to bedrock, auger refusal and termination depths.

Table 2 – Summary of Drilling Depths

Bore No	Approx. Surface RL	Depth to Bedrock		Auger Refusal Depth		Termination Depth	
	(mAHD)	(m)	RL (mAHD)	(m)	RL (mAHD)	(m)	RL (mAHD)
101	579	1.8	577.2	4.4	574.6	4.4	574.6
102	582	4.5	577.5	NE	-	9.0	573
103	582	1.2	580.8	4.2	577.8	8.5	573.5
104	577	1.2	575.8	4.3	572.7	4.3	572.7
105	580	1.7	578.3	4.0	576	7.0	572.96
106	579	1.0	578.05	2.5	576.5	2.5	576.5
107	582	0.9	581.1	2.4	579.6	2.4	579.6
108	587	2.6	584.4	4.0	583	7.0	580.0
109	587	2.7	584.3	6.0	581	6.0	581.0
110	587	0.2	586.8	0.5	586.5	0.5	586.5
110A	587	0.2	586.8	3.9	583.1	3.9	583.1
111	588	0.5	587.5	2.9	585.1	2.9	585.1
112	584	1.8	582.2	7.3	576.7	7.3	576.7
113	580	1.6	578.4	4.0	576	7.5	572.5

6.3 Groundwater

Free groundwater was only encountered during the augering phase of Bore 102 at 6.6 m. It is also noted that the use of water as a drilling fluid precluded groundwater observations during the coring of the selected boreholes. Instead, the depth to water was measured post investigation via the observation wells installed in Bores 102 and 112. The water was purged from the monitoring wells following installation. It is noted that the standpipe from Bore 112 was taken from the borehole between the two visits to measure the groundwater.

Table 3: Groundwater Recordings

Bore	Groundwater Depth and Estimated Reduced Level			
	10/12/2020		21/12/2020	
	Depth (m)	RL (m)*	Depth (m)	RL (m)*
102	dry	-	dry	-
112	4.85	579.15	#	-

*Surface levels given in Table 3 are based on the survey data provided.

#Measurement of groundwater not possible due to the standpipe being taken from the hole and the bore subsequently collapsing.

It should be noted that groundwater conditions rarely remain constant and can change seasonally due to variations in rainfall and other factors. The groundwater table would be expected to be at a similar depth of Lake Burley Griffin, which is at RL 556 mAHD.

7. Laboratory Testing

Seven samples collected from the site investigation were tested in the laboratory for measurement of plasticity properties, linear shrinkage, California bearing ratio (CBR) and/or compaction properties. Soil aggressivity testing was also carried out by Envirolab Services Pty Ltd. The detailed laboratory test report sheets are given in Appendix D with the results summarised in Tables 3 – 5.

Table 4: Results of CBR Testing and Emerson Crumb Tests

Pit / Bore No.	Depth (m)	Field Description	FMC (%)	OMC (%)	MDD (t/m ³)	CBR (%)	Swell (%)
Pit 4	0.4 – 0.6	Clay	23.5	22.5	1.61	12	0.5
Bore 6	0.6 – 0.8	Silty Clay	17.2	12.5	1.92	7	0.0
Bore 11	0.6 – 0.8	Clay	17.8	22.0	1.60	2.5	3.0

Where OMC = Optimum moisture content (standard)
 MDD = Maximum dry density (standard)

CBR = California bearing ratio
 FMC = Field moisture content

Table 5: Results of Atterberg Limits and Linear Shrinkage Tests

Bore No.	Depth (m)	LL (%)	PI (%)	LS (%)	FMC (%)	Field Description
105	1.0 - 1.45	80	57	16.5	24.3	Clay
107	0.5 – 0.95	39	20	8.5	14.4	Silty Clay
108	1.9	55	36	15	22.1	Clay
112	0.5 – 0.95	31	16	8.0	9.6	Silty Clay

Where LL = Liquid Limit
 LS = Linear Shrinkage

PI = Plasticity Index
 FMC = Field moisture content

Table 6: Results of Soil Aggressivity Testing

Pit / Bore No.	Depth (m)	Field Description	pH	Chloride (mg/kg)	Sulphate, as SO ₄ (mg/kg)	Resistivity ⁽²⁾ (ohm.cm)	Electrical Conductivity (µS/cm)
3	0.5	Silty Clay	6.7	<10	10	38460	26
5	0.1	Silty Sandy Clay/Clay	7.5	<10	32	8335	120
102	3.0	Sandy Clay	9.1	<10	42	15385	65
104	2.0	Sandstone	8.5	<10	<10	100000	10
108	1.0	Clay (FILL)	7.7	<10	24	20410	49
112	0.5	Silty Clay	6.5	<10	20	15875	63
Criteria for "Non-aggressive" Soil Conditions (low permeability soils or soils above the groundwater table) ⁽¹⁾			>5.5 (concrete) >5.0 (steel)	<5,000 (steel)	<5,000 (concrete)	>5,000 (steel)	-

Notes:

(1) AS 2159:2009

(2) Resistivity (ohm.cm) is the inverse of Electrical Conductivity (S/cm)

8. Comments

8.1 Site Preparation

In order to achieve satisfactory slab and pavement performance, it is suggested that site preparation should be undertaken in accordance with the following guidelines:

- Strip topsoils, vegetation, moisture affected soils, existing fill and other deleterious materials and remove to spoil or stockpile for later re-use in landscaping. Where deeper fill is present in pavement areas (i.e. in the vicinity of Pit 8), the fill could be removed to say 0.5 m below subgrade level and test rolled/assessed in the presence of a geotechnical engineer for suitability for pavement construction;
- Excavate to design subgrade/underside of floor level;
- If clay soils are exposed at subgrade level, tyne and adjust the moisture content of the subgrade clays to close to optimum value for standard compaction;
- Test roll the exposed subgrade with a smooth drum roller of at least 10 tonnes static deadweight capacity with inspection by a geotechnical engineer after a minimum of 6 passes of the roller;
- Where soft spots or unacceptable subgrade conditions are encountered, remove the unsuitable material for a further 300 mm and inspect. Place approved low plasticity (granular) fill in layers of 250 mm maximum thickness and compact to at least 100% standard dry density ratio with moisture contents maintained within 2 % of standard optimum values; and
- Where fill is required to achieve design levels, the fill material should be of low plasticity and should be placed in layers of maximum thickness of 300 mm and each layer compacted to achieve at least 100% standard maximum dry density ratio, with moisture contents maintained within 2 % of standard optimum values.

The site preparation works and all fill placement within the building and pavement areas should be under controlled conditions with reference made to AS 3798:2007 where appropriate.

8.2 Excavation Conditions

The investigation has indicated subsurface conditions generally comprising topsoil/topsoil fill, pavement and clayey fill, natural clayey soils overlying variably very low strength to high strength siltstone and sandstone bedrock.

The topsoil fill, fill, natural soils and bedrock of up to low strength could be expected to be removed using conventional earthmoving plant and as such, no significant excavation difficulties are anticipated to depths of around 1.9 m to 7.5 m at the proposed northern buildings (Bores 101 – 105), 0.2 m to 4.0 m at the central buildings (Bores 106 – 110) and around 1.8 m to 4.0 m at the southern buildings. Excavation below these depths into medium or greater strength rock, will require large excavators fitted with toothed buckets, single tyne rippers and pneumatic hammers and will prove to be difficult and slow. The excavatability of the rock will be largely dependent on the degree of fracturing, the dip of bedding within the rock mass and the extent of weaker zones. From the four boreholes that were core drilled, the rock at the northern part of the site (Bores 103 and 105) was less fractured and the boreholes at the southern half of the site (Bores 108 and 113) were highly fractured with some fragmented zones. Low

production rates must be anticipated, particularly below where auger refusal was encountered (i.e. variably below depths of 0.5 – 7.3 m) and where fewer weaker zones were encountered (i.e Bores 103 and 105).

Groundwater was only encountered in two boreholes, in Bore 102 at 6.6 m depth during the field investigation and in Bore 112 at 4.85 m depth in a standpipe piezometer. It is expected that the groundwater in each was like perched water and not the standing groundwater table, which would be expected to be at a similar depth of Lake Burley Griffin, which is at RL 556 mAHD. It is noted that the standpipe installed in Bore 102 was dry following the investigation.

It is noted that the extent of groundwater inflow into excavations would be dependent on prior weather conditions. Groundwater seepages should be anticipated following rainfall through fractured rock and any sandy or gravelly seams that could be present within the clay soils. Permanent groundwater level is not expected to be encountered within the proposed two basement levels, though should be verified with further detailed investigations.

8.3 Excavation Support

The soils and fractured rock exposed in cut cannot be expected to stand vertically without support even over limited periods of time. Where space permits, it is suggested that the natural soils and up to low strength rock exposed in the sides of the excavation be cut with a maximum temporary batter slope of 45°. Medium and greater strength rock could be battered steeper, say up to 60°, however it would depend on the extent and orientation of the joints and bedding and should be inspected by a geotechnical engineer for further advice on a suitable batter slope during excavation works. Any battered excavation face must be protected from the effects of the weather in particular overland stormwater flows.

Where excavation is proposed right up to the property boundary, or where battering of the excavation is not possible, there will be a need for retaining structures to prevent lateral movement of the retained soils and rock in order to reduce the risk of potential damage to neighbouring land, structures, footpaths and/or services. Feasible options would include either anchored soldier piles with close shuttering or sprayed concrete infill panels or anchored contiguous piling.

In order to achieve required embedment within the rock, it will be necessary to employ an appropriate high-torque piling rig.

8.4 Design Parameters for Retaining Systems

In areas where cantilevered or single propped retaining structures are proposed (suitable for single basement excavations), it is suggested that earth pressures on retaining walls due to the retained soils be based on a triangular pressure distribution calculated as follows:

$$h_z = \gamma k_a z$$

where,

h_z	=	horizontal pressure at depth z
γ	=	unit weight of retained soil
	=	20 kN/m ³ (fill and soil)

$$\begin{aligned}
 &= 22 \text{ kN/m}^3 \text{ (very low or greater strength rock)} \\
 k_a &= \text{active earth pressure coefficient} \\
 &= 0.3 \text{ for fill and natural at least stiff/medium dense soils} \\
 &= 0.3 \text{ for very low to low strength rock} \\
 &= 0.25 \text{ for medium and greater strength rock}
 \end{aligned}$$

For two storey basement excavations, it is suggested that the horizontal earth/rock pressures acting on an anchored soldier pier wall with infill panels of reinforced shotcrete can be calculated on the basis of a trapezoidal pressure distribution given by:

$$\begin{aligned}
 \text{and} \quad p_o &= 0.5 \gamma (4z/H) & 0 < z < 0.25H \\
 p_o &= 0.5 \gamma H & 0.25H < z < H
 \end{aligned}$$

$$\begin{aligned}
 \text{where} \quad p_o &= \text{horizontal pressure at depth } z \text{ (kPa)} \\
 z &= \text{depth below top of retained ground (m)} \\
 \gamma &= \text{unit weight of retained soil/rock (kN/m}^3\text{)} \\
 H &= \text{total height of retained ground (m)}
 \end{aligned}$$

The above pressure distribution is appropriate for tied-back (anchored) or propped walls and is considered to represent an 'at-rest' pressure condition for soil and the fractured rock. Its use will help minimise deflection of the wall and any possible resulting horizontal and vertical movement in the surrounding ground. An averaged unit weight (γ) of 22 kN/m³ should be used for the retained ground of soil and weathered rock. Design must make allowance for the ground slope behind any retaining structure as the earth pressures given above are based on horizontal backfill/ground surface only. Where applicable, super imposed surcharge loads due to adjacent driveways and buildings should also be accommodated in the design of such structures.

The above suggested design lateral pressure does not account for hydrostatic pressure from groundwater as it is assumed that suitable backfill drains connecting to a basement pump-out unit will be provided. This will depend on the depth of the excavated basement level.

The design of the shoring system needs to account for any imposed lateral loadings from future adjacent structures within the development. Existing inground services will also need to be taken into consideration with respect to lengths of ground anchors that may be required.

It is suggested that the ultimate passive resistance on sections of soldier piers socketed into medium or greater strength bedrock from at least 1 m below surrounding ground surface can be calculated on the basis of a passive pressure of 5000 kPa.

Provided the centre to centre spacing between the soldier pier sockets is greater than 2.0 times the diameter of the sockets, the effective width of the socket for resistance calculation can be assumed to be equivalent to twice the actual pile width.

A suitable factor of safety should be obtained in stability calculations for a retaining wall. A minimum factor of safety of 1.5 is considered satisfactory for a temporary structure and 2.0 for a permanent structure.

8.5 Foundations

It is considered that bored piers, strip or pad footings founding in the underlying weathered bedrock would be required to support the proposed multi-storey buildings. Given the potential for groundwater seepages, bored cased piers would be suggested.

Suggested allowable end bearing pressures and shaft adhesion values are provided in Table 6 below.

Table 7: Recommended Allowable End Bearing Pressures

Foundation Type	Allowable End Bearing Pressure Values		
	Spread or Pad Footings	Bored Cast In-Situ Piles	
	End Bearing	End Bearing	Shaft Adhesion (Tensile)
At least Very Stiff Natural Soil	150 kPa	NA	NA
Very Low to Low Strength Rock	750 kPa	1000 kPa	100 kPa
Medium Strength Rock	2000 kPa	2500 kPa	250 kPa

8.6 Soil aggressivity

The soil aggressivity test results are included in Appendix D and are summarised in Table 4 in Section 7. The results indicate that based on the Soil Conditions B and with reference to the AS 2159 Tables 6.4.2(C) and 6.5.2(C) that the exposure classifications for steel and concrete piles is *Non-Aggressive*.

8.7 Subgrade CBR

It is expected that following the site preparation outlined in Section 8.1, the subgrade of the proposed roads would likely have clayey soils or fill exposed, for which a design CBR of 3% would be suggested.

In areas that require controlled fill to obtain subgrade level, the design CBR would be dependent on the type and thickness of the material placed. Should weathered rock be utilised as a select fill in the upper zone of the subgrade, an increase in effective CBR could be warranted. DP could provide further assistance in determining the resulting effective CBR's during earthworks, if required.

For basement slabs, it would be expected that two storey basement excavations would expose medium strength siltstone or sandstone bedrock for which a design CBR of 10% for the in situ rock would be applicable. Should some buildings have single basements, it is likely low strength rock would be exposed for which a design CBR of 7% would be considered suitable for in situ rock. Should clays be exposed at basement level (potentially in the vicinity of Bores 102, 108 and 109 where bedrock was deeper), a design CBR of 3% should be used.

Subgrade conditions should be reviewed during construction. The review should be carried out by a suitably qualified engineer and would involve additional CBR testing to confirm the design assumptions regarding subgrade strength.

All earthworks should be undertaken under close supervision and consultation with the geotechnical consultant in order to avoid any unnecessary over excavation. The standard of construction, the selection of materials and quality of workmanship for the roads should satisfy the requirements of the latest edition of the ACT Standard Specification for Urban Infrastructure Works.

8.8 Drainage

It is recommended that subsurface and surface drainage be installed early in the works programme and maintained at the site to minimise groundwater and overland flows. It is suggested that a contour drain be installed at the high (southern) side of the site. Subsoil drainage must also be installed and maintained to protect the new pavements and subgrade and should be installed at a minimum of 0.5 m depth below subgrade level.

A sump and pump out unit should be installed in the basement to control any seepage water collected by the basement wall backfill drains and under slab drainage systems. It is suggested that waterproofing treatment be provided to the ground slab and to the exterior surface of the basement walls.

9. References

BMR (1992), *Geology of Canberra 1:100 000 Geological Series Sheet 8727*, Bureau of Mineral Resources, Geology and Geophysics.

AS 1170.4:2007, *Structural design actions, Part 4: Earthquake actions in Australia*, Standards Australia.

AS 2159:2009, *Piling – Design and Installation*, Standards Australia.

AS 3798:2007, *Guidelines on Earthworks for Commercial and Residential Developments*, Standards Australia.

10. Limitations

Douglas Partners (DP) has prepared this report for this project at Block 7 Section 4, Yarralumla in accordance with DP's proposal CAN200386 dated 12 Nov 2020 and acceptance received from Mr Justin Micallef of The Shepherd Foundation dated 12 Nov 2020. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of The Shepherd Foundation for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In

preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

The assessment of atypical safety hazards arising from this advice is restricted to the (geotechnical / environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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

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

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners



Introduction

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

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

Copyright

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

Borehole and Test Pit Logs

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

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

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

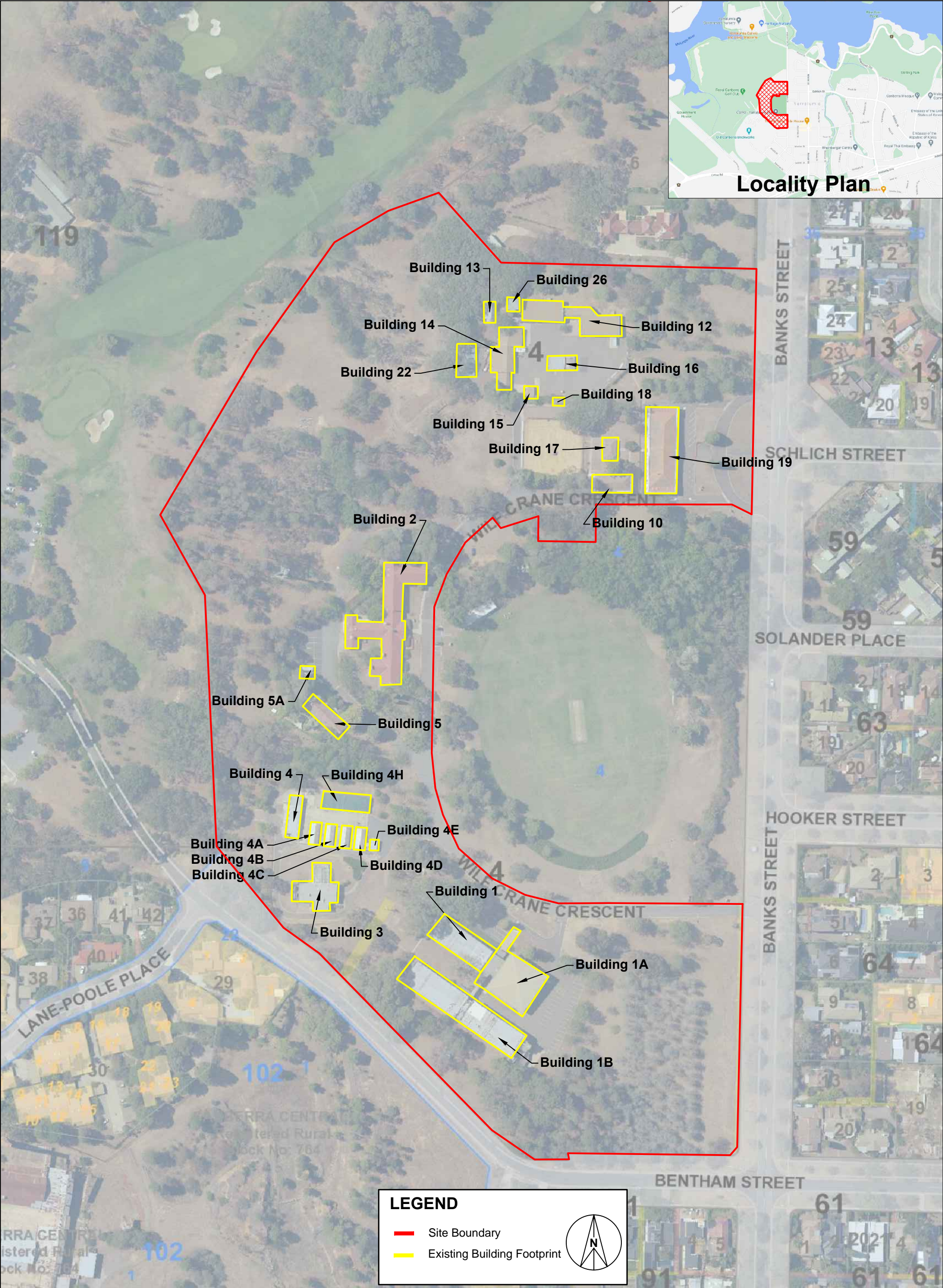
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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


Site Inspection

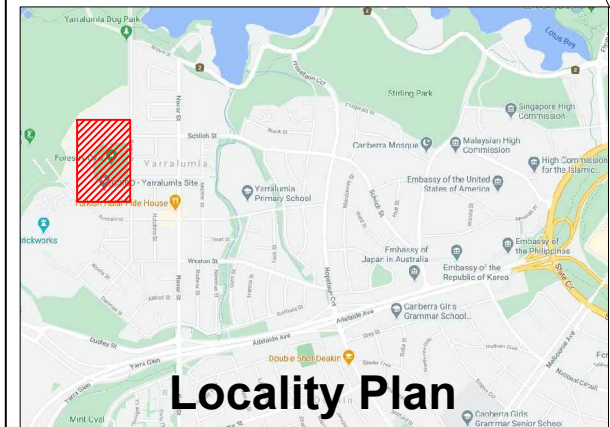
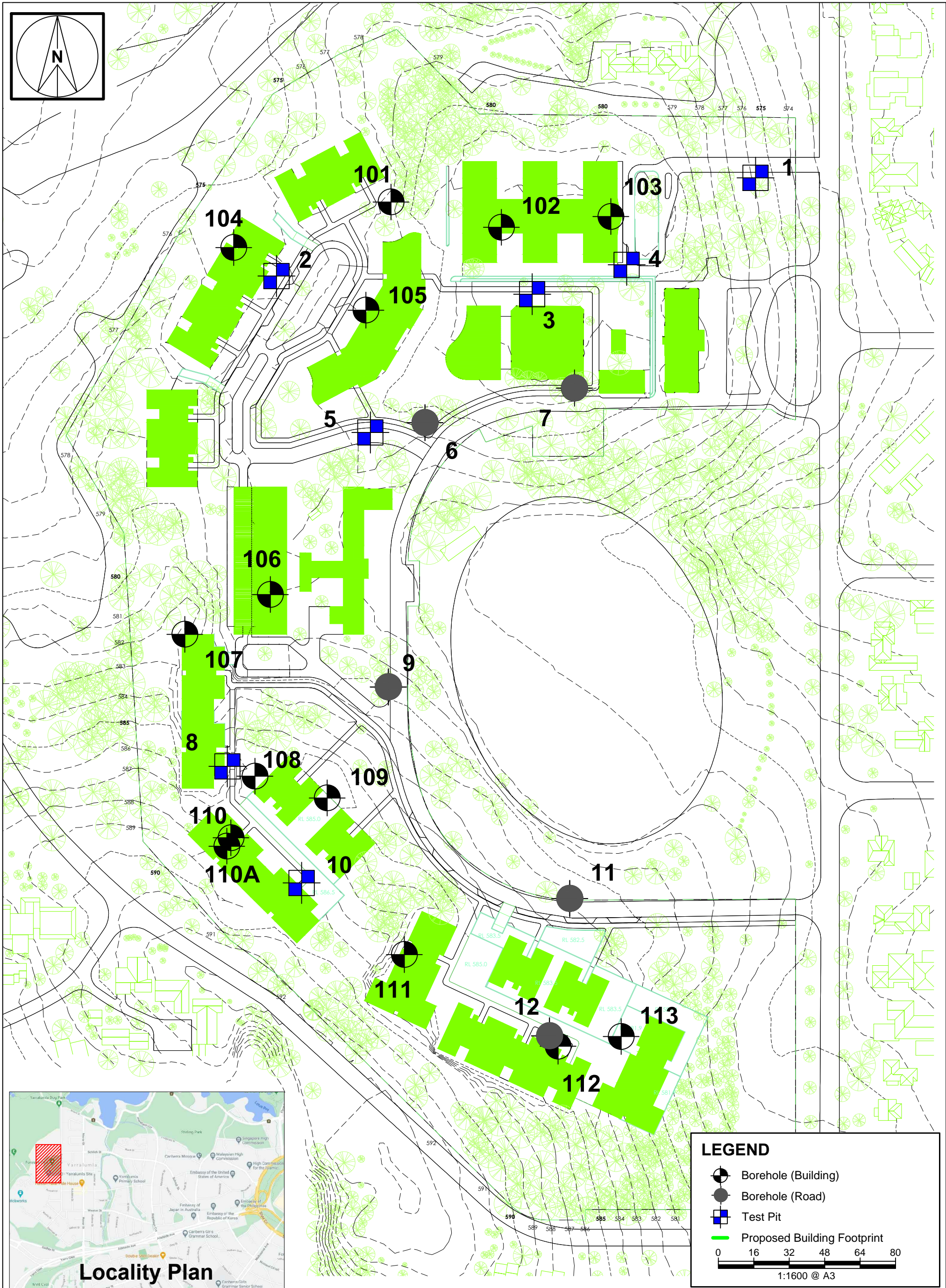
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.


Appendix B

Drawing 1 – Site Layout Plan
Drawing 2 – Test Location Plan



<div>Douglas Partners <i>Geotechnics Environment Groundwater</i></div>			<div>Site Layout Plan Preliminary Geotechnical Investigation Block 7 Section 4, Yarralumla</div>	PROJECT No: 103111.00
				DRAWING No: 1
				REVISION: 0
OFFICE: Canberra	DRAWN BY: ADFH	SCALE: NTS	CLIENT: The Shepherd Foundation	DATE: 01.02.2021



 Douglas Partners <i>Geotechnics Environment Groundwater</i>			Test Location Plan Preliminary Geotechnical Investigation Block 7 Section 4, Yarralumla		PROJECT No: 103111.00
					DRAWING No: 2
					REVISION: 0
OFFICE: Canberra	DRAWN BY: ADFH	SCALE: As shown	CLIENT: The Shepherd Foundation		DATE: 27.01.2021

Appendix C

Explanatory Notes
Field Work Results
(Pits 1 – 5, 8 & 10 & Bores 6, 7, 9, 11, 12, 101 – 113 & 110A)



Sampling

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

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

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil 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.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally 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 samples.

Continuous Spiral Flight Augers

The borehole 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 sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud 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 the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils 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 6.3.1.

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 increments and the 'N' value is taken as the number of blows for the last 300 mm. 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.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This 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.



Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are generally based on Australian Standard AS1726:2017, Geotechnical Site Investigations. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	19 - 63
Medium gravel	6.7 - 19
Fine gravel	2.36 - 6.7
Coarse sand	0.6 - 2.36
Medium sand	0.21 - 0.6
Fine sand	0.075 - 0.21

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

The proportions of secondary constituents of soils are described as follows:

In fine grained soils (>35% fines)

Term	Proportion of sand or gravel	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	>30%	Sandy Clay
With	15 - 30%	Clay with sand
Trace	0 - 15%	Clay with trace sand

In coarse grained soils (>65% coarse)

- with clays or silts

Term	Proportion of fines	Example
And	Specify	Sand (70%) and Clay (30%)
Adjective	>12%	Clayey Sand
With	5 - 12%	Sand with clay
Trace	0 - 5%	Sand with trace clay

In coarse grained soils (>65% coarse)

- with coarser fraction

Term	Proportion of coarser fraction	Example
And	Specify	Sand (60%) and Gravel (40%)
Adjective	>30%	Gravelly Sand
With	15 - 30%	Sand with gravel
Trace	0 - 15%	Sand with trace gravel

The presence of cobbles and boulders shall be specifically noted by beginning the description with 'Mix of Soil and Cobbles/Boulders' with the word order indicating the dominant first and the proportion of cobbles and boulders described together.

Soil Descriptions

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	VS	<12
Soft	S	12 - 25
Firm	F	25 - 50
Stiff	St	50 - 100
Very stiff	VSt	100 - 200
Hard	H	>200
Friable	Fr	-

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	Density Index (%)
Very loose	VL	<15
Loose	L	15-35
Medium dense	MD	35-65
Dense	D	65-85
Very dense	VD	>85

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;

- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

For coarse grained soils the moisture condition should be described by appearance and feel using the following terms:

- Dry (D) Non-cohesive and free-running.
- Moist (M) Soil feels cool, darkened in colour.
Soil tends to stick together.
Sand forms weak ball but breaks easily.
- Wet (W) Soil feels cool, darkened in colour.
Soil tends to stick together, free water forms when handling.

Moisture Condition – Fine Grained Soils

For fine grained soils the assessment of moisture content is relative to their plastic limit or liquid limit, as follows:

- 'Moist, dry of plastic limit' or 'w < PL' (i.e. hard and friable or powdery).
- 'Moist, near plastic limit' or 'w ≈ PL' (i.e. soil can be moulded at moisture content approximately equal to the plastic limit).
- 'Moist, wet of plastic limit' or 'w > PL' (i.e. soils usually weakened and free water forms on the hands when handling).
- 'Wet' or 'w ≈ LL' (i.e. near the liquid limit).
- 'Wet' or 'w > LL' (i.e. wet of the liquid limit).



Rock Strength

Rock strength is defined by the Unconfined Compressive Strength and it refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects.

The Point Load Strength Index $Is_{(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

Strength Term	Abbreviation	Unconfined Compressive Strength MPa	Point Load Index * $Is_{(50)}$ MPa
Very low	VL	0.6 - 2	0.03 - 0.1
Low	L	2 - 6	0.1 - 0.3
Medium	M	6 - 20	0.3 - 1.0
High	H	20 - 60	1 - 3
Very high	VH	60 - 200	3 - 10
Extremely high	EH	>200	>10

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Residual Soil	RS	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.
Extremely weathered	XW	Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible
Highly weathered	HW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Moderately weathered	MW	The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.
Slightly weathered	SW	Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.
<i>Note: If HW and MW cannot be differentiated use DW (see below)</i>		
Distinctly weathered	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores.

Rock Descriptions

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with occasional fragments
Fractured	Core lengths of 30-100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths of 300 mm or longer with occasional sections of 100-300 mm
Unbroken	Core contains very few fractures

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or stronger. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Douglas Partners



Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

Symbols & Abbreviations

Graphic Symbols for Soil and Rock

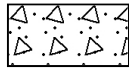
General



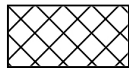
Asphalt



Road base



Concrete



Filling

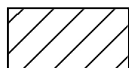
Soils



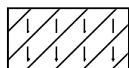
Topsoil



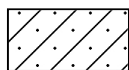
Peat



Clay



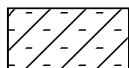
Silty clay



Sandy clay



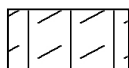
Gravelly clay



Shaly clay



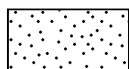
Silt



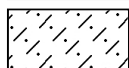
Clayey silt



Sandy silt



Sand



Clayey sand



Silty sand



Gravel



Sandy gravel



Cobbles, boulders



Talus

Sedimentary Rocks



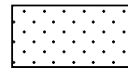
Boulder conglomerate



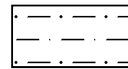
Conglomerate



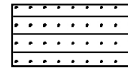
Conglomeratic sandstone



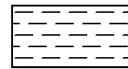
Sandstone



Siltstone



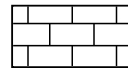
Laminite



Mudstone, claystone, shale

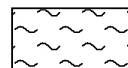


Coal

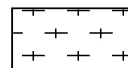


Limestone

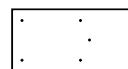
Metamorphic Rocks



Slate, phyllite, schist

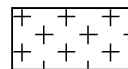


Gneiss

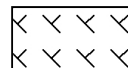


Quartzite

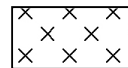
Igneous Rocks



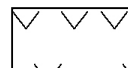
Granite



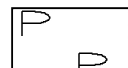
Dolerite, basalt, andesite



Dacite, epidote



Tuff, breccia



Porphyry

TEST PIT LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 576 AHD
EASTING: 690496
NORTHING: 6091327

PIT No: 1
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
576		TOPSOIL/Sandy SILT (ML): low plasticity, brown, fine to coarse grained sand, with rootlets, moist to dry, firm, TOPSOIL							
	0.4	CLAY (CI): medium plasticity, brown-yellow brown, with ironstone nodules to 15mm, iron staining, trace silt, fine to coarse grained sand, moist, w~PL, stiff, colluvium		B	0.4				
	0.7	Silty CLAY (CI): medium plasticity, yellow-brown, trace fine to coarse grained sand, moist, w~Pl, very stiff, colluvium			0.6				
575	1			D	1.0				
	1.3	Silty CLAY (CH): high plasticity, yellow-grey brown, moist to dry, w<PL, hard, very stiff to hard, colluvium		D	1.5		pp = 350-500		
574	2	Pit discontinued at 2.0m -limit of investigation							
573	3								
572	4								

RIG: CAT304C CR mini-excavator fitted with a 300mm wide bucket

LOGGED: ADFH

SURVEY DATUM: MGA94 Zone 55

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 578 AHD
EASTING: 690268
NORTHING: 6091285

PIT No: 2
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
578		TOPSOIL/Sandy SILT (ML): low plasticity, brown, fine to coarse grained sand, with rootlets, moist to dry, very stiff, TOPSOIL							
	0.3	Silty CLAY (CI): medium plasticity, red-brown, moist, w<PL, stiff, alluvial		B	0.4				
	0.7	CLAY (CI/CH): medium to high plasticity, yellow-brown, with silt, trace fine to coarse grained sand, moist, w~PL, stiff, residual			0.6				
577	1			D	1.0				
	1.2	SANDSTONE: fine to coarse grained, pale grey-brown, dry to moist, very low to low strength, highly weathered, highly fractured		D	1.6				
576	1.8	Pit discontinued at 1.8m -limit of investigation							
575	2								
	3								
574	4								

RIG: CAT304C CR mini-excavator fitted with a 300mm wide bucket

LOGGED: ADFH

SURVEY DATUM: MGA94 Zone 55

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 583 AHD
EASTING: 690389
NORTHING: 6091274

PIT No: 3
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

[illegible]

RIG: CAT304C CR mini-excavator fitted with a 300mm wide bucket

LOGGED: ADFH

SURVEY DATUM: MGA94 Zone 55

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



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TEST PIT LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 582 AHD
EASTING: 690434
NORTHING: 6091287

PIT No: 4
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
582		TOPSOIL/Sandy SILT (ML): low plasticity, brown, fine to coarse grained sand, with rootlets, moist to dry, very stiff, TOPSOIL							
	0.35	Silty CLAY (CI/CH): medium to high plasticity, red/brown, trace rootlets, moist, w~PL, stiff, alluvial		B	0.4				
					0.6				
	0.8	CLAY (CI): medium plasticity, yellow brown, with silt, moist, w<PL, stiff, alluvial		D	1.0				
	1.2	CLAY (CH): high plasticity, yellow/grey brown, trace silt and fine to coarse grained sand, moist, w<PL, hard, residual		D	1.4		pp >400		
	1.6	SANDSTONE: fine to coarse grained, pale white/grey, trace silt, dry to moist, low strength, highly weathered, highly fractured		D	1.8				
580	2.0	Pit discontinued at 2.0m -limit of investigation							
579									
578									

RIG: CAT304C CR mini-excavator fitted with a 300mm wide bucket

LOGGED: ADFH

SURVEY DATUM: MGA94 Zone 55

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 580 AHD
EASTING: 690311
NORTHING: 6091210

PIT No: 5
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
580	0.1	TOPSOIL FILL/Silty Sandy CLAY (CL): low plasticity, dark grey, fine to coarse grained sand, moist to dry, w<PL, stiff, FILL		E	0.1		PID = 0.4ppm		5
	0.4	FILL/CLAY (CI): medium plasticity, red/orange brown, with gravel to 50mm, trace fine to coarse grained sand and rootlets, moist to dry, w<PL, stiff, FILL -at 0.3m, concrete boulder to 500mm in size		E	0.5		PID = 0.2ppm		10
		CLAY (CI/CH): medium to high plasticity, red/yellow brown, trace silt and iron staining, moist, w~PL, very stiff, alluvial		D	0.8				15
579	1			E	1.0		PID < 0.1ppm	1	20
		-from 1.2m, yellow brown		D	1.3				
	1.5	CLAY (CH): high plasticity, yellow/grey brown, trace silt, moist, w~PL, very stiff, alluvial		E	1.5		PID < 0.1ppm		
				D	1.7		pp = 250-310		
578	2.0	Pit discontinued at 2.0m -limit of investigation						2	
577	3							3	
576	4							4	

RIG: CAT304C CR mini-excavator fitted with a 300mm wide bucket

LOGGED: ADFH

SURVEY DATUM: MGA94 Zone 55

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 579 AHD
EASTING: 690337
NORTHING: 6091214
DIP/AZIMUTH: 90°/-

BORE No: 6
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
579	0.05	ASPHALT: 6mm aggregate, blue grey, 50mm thick, asphaltic concrete										
	0.3	FILL/Sandy GRAVEL (GW): gravel to 30mm, well graded, brown, fine to coarse grained sand, moist to dry, apparently dense, roadbase FILL		D	0.4							
	0.5	Silty CLAY (CL/CI): medium plasticity, dark brown, wet to moist, w<PL, firm, possible FILL			0.6							
		Silty CLAY (CI/CH): medium to high plasticity, red/yellow brown, wet, w>PL, firm to stiff		B	0.8							
578	1.0	CLAY (CL/CI): medium plasticity, pale grey brown, with gravel to 10mm, wet, soft		D	1.1		pp <50		1			
	1.2	CLAY (CI/CH): medium to high plasticity, red brown, with silt, trace fine to coarse grained sand, moist, w<PL, stiff		D	1.4		pp = 180					
	1.5	CLAY (CI/CH): medium to high plasticity, pale yellow/grey brown, with silt, moist to dry, w<PL, very stiff		D	1.7		pp = 280-320					
577	2.0	Bore discontinued at 2.0m -limit of investigation							2			
576	3								3			
575	4								4			

RIG: CAT304CR mini-excavator

DRILLER: Bingley

LOGGED: ADFH

CASING:

TYPE OF BORING: 300mm diameter auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and based on a single point measurement. ☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 580 AHD
EASTING: 690408
NORTHING: 6091229
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 103111.00
DATE: 2/12/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
580	0.05	ASPHALT: 7mm aggregate size, blue grey, 50mm thick, asphaltic concrete								
	0.35	FILL/Sandy GRAVEL (GW): well graded, gravel to 20mm, yellow/grey, fine to coarse grained sand, moist to dry, apparently medium dense to dense, roadbase FILL								
		Sandy CALY (CI): medium plasticity, red/grey yellow/brown, fine to coarse grained sand, dry to moist, w<PL, hard		S	0.5		10,17,18 N = 35			
	0.9	Silty CLAY (CL/CI): low to medium plasticity, yellow brown, moist to dry, w<PL, hard		S	0.95 1.0		10,20,22 N = 42			
579	1									
	1.5	Bore discontinued at 1.5m -limit of investigation			1.45					
578	2									
577	3									
576	4									

RIG: Hydrapower Scout MkV

DRILLER: RMX

LOGGED: ADFH

CASING:

TYPE OF BORING: 110mm continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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TEST PIT LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 586 AHD
EASTING: 690240
NORTHING: 6091053

PIT No: 8
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
586	0.2	TOPSOIL FILL/Silty Sandy CLAY (CL): low plasticity, dark grey, fine to coarse grained sand, moist to dry, w<PL, stiff, FILL		D	0.3							
		FILL/CLAY (CI): medium plasticity, grey/brown, trace silt and rootlets, gravel to 60mm and cobbles to 130mm, moist, w<PL, very stiff, FILL										
	0.5	FILL/CLAY (CI/CH): medium to high plasticity, grey/brown, trace silt and rootlets, gravel to 60mm and cobbles to 130mm, moist, w<PL, apparently firm to stiff, poorly compacted, FILL										
				B	0.7							
					0.9							
585	1											
	1.5	TOPSOIL/Silty CLAY (CI): medium plasticity, dark brown, with fine to coarse grained sand, trace silt, roots and rootlets, moist, w>PL, stiff, TOPSOIL		D	1.6		pp = 120-140					
	1.8	CLAY (CI/CH): medium to high plasticity, yellow/brown, trace silt, moist, w~PL, stiff, alluvial										
584	2	Pit discontinued at 2.0m -limit of investigation		D	1.9							
	2.0											
583	3											
582	4											

RIG: CAT304C CR mini-excavator fitted with a 300mm wide bucket

LOGGED: ADFH

SURVEY DATUM: MGA94 Zone 55

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 582 AHD
EASTING: 690317
NORTHING: 6091089
DIP/AZIMUTH: 90°/-

BORE No: 9
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
582	0.05	ASPHALT: aggregate to 8mm, blue grey, asphaltic concrete, 5mm thick										
	0.3	FILL/Sandy GRAVEL (GW): gravel to 30mm, well graded, brown, fine to coarse grained sand, moist to dry, apparently dense, roadbase FILL										
		FILL/CLAY (CI): medium plasticity, grey brown, with gravel to 15mm, moist, w<PL, very stiff, FILL		D	0.5							
	0.7	CLAY (CI): medium plasticity, brown, trace silt and gravel to 20mm, moist, w~PL, stiff, alluvial		B	0.8		pp = 130-180					
581	1				1.0							
	1.2	CLAY (CH): high plasticity, yellow/grey brown, with silt, moist, w<PL, very stiff, residual		D	1.4		pp = 220-260					
	1.5	Silty CLAY (CI/CH): medium to high plasticity, yellow/brown, moist to dry, w<PL, very stiff to hard, extremely weathered siltstone		D	1.7		pp = 380-500					
	1.8	SILTSTONE: fine grained, orange brown, dry to moist, low strength, highly weathered, highly fractured										
580	1.9	Bore discontinued at 1.9m -limit of investigation										
	2											
	3											
579	3											
	4											
578	4											

RIG: CAT304CR mini-excavator

DRILLER: Bingley

LOGGED: ADFH

CASING:

TYPE OF BORING: 300mm diameter auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon.
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 590 AHD
EASTING: 690274
NORTHING: 6090997

PIT No: 10
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
590	0.2	TOPSOIL FILL/Silty Sandy CLAY (CL): low plasticity, dark grey, fine to coarse grained sand, moist to dry, w<PL, stiff, FILL							
	0.45	FILL/CLAY (CI): medium plasticity, red/grey brown, with silt and fine to coarse grained sand, trace dacite gravel to 40mm and rootlets, moist to dry, w<PL, apparently very stiff, FILL		D	0.3				
	0.85	Silty CLAY (CI): medium plasticity, red brown, trace fine to coarse grained sand and rootlets, moist, w~PL, stiff, alluvial		D	0.6				
589	1.0	CLAY (CI): medium plasticity, yellow brown, with silt, trace gravel to 8mm and rootlets, moist, w~PL, stiff		D	1.0			1	
	1.35	CLAY (CI/CH): medium to high plasticity, yellow/grey, with silt, moist to dry, w<PL, very stiff, residual		D	1.5		pp = 300-340		
	1.8	-from 1.6m, hard							
588	2.0	SILTSTONE: fine grained, grey, dry to moist, low strength, highly weathered, highly fractured						2	
		Pit discontinued at 2.0m -limit of investigation							
587	3							3	
586	4							4	

RIG: CAT304C CR mini-excavator fitted with a 300mm wide bucket

LOGGED: ADFH

SURVEY DATUM: MGA94 Zone 55

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 581 AHD
EASTING: 690401
NORTHING: 6090987
DIP/AZIMUTH: 90°/-

BORE No: 11
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
581	0.05	ASPHALT: aggregate to 8mm, blue grey, asphaltic concrete. 50mm thick		E	0.1		PID = 28.9ppm					
	0.3	FILL/Sandy GRAVEL (GW): gravel to 20mm, well graded, blue grey, fine to coarse grained sand, moist to dry, apparently dense, roadbase FILL		D	0.4							
	0.5	FILL/Sandy GRAVEL (GW): gravel to 20mm, well graded, yellow/grey, fine to coarse grained sand, moist to dry, apparently dense, select FILL		E	0.5		PID = 0.2ppm					
				B	0.6							
		CLAY (CI): medium plasticity, brown, with gravel to 30mm, trace fine to coarse grained sand, moist to dry, w<PL, hard, possible FILL			0.8							
580	0.9	CLAY (CH): high plasticity, grey brown, with silt, trace siltstone gravel to 10mm, moist, w<PL, very stiff, alluvial		D	1.0							
	1.1			E	1.1		PID < 0.1ppm					
		CLAY (CL/CI): medium plasticity, brown, with gravel to 20mm, trace fine to coarse grained sand, moist to dry, very stiff, residual		D	1.2							
	1.4											
		SILTSTONE: fine grained, orange brown, dry to moist, low strength, highly weathered, highly fractured		E	1.5		PID < 0.1ppm					
				D	1.6							
579	2.0	Bore discontinued at 2.0m -limit of investigation										
578	3											
577	4											

RIG: CAT304CR mini-excavator

DRILLER: Bingley

LOGGED: ADFH

CASING:

TYPE OF BORING: 300mm diameter auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 584 AHD
EASTING: 690390
NORTHING: 6090922
DIP/AZIMUTH: 90°/--

BORE No: 12
PROJECT No: 103111.00
DATE: 30/11/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)			
				Type	Depth	Sample	Results & Comments		5	10	15	20
584	0.05	ASPHALT: aggregate to 8mm, blue grey, asphaltic concrete, 50mm thick		E	0.1		PID = 4.2ppm					
	0.3	FILL/Sandy GRAVEL (GW): gravel to 30mm, well graded, brown, fine to coarse grained sand, moist to dry, apparently dense, roadbase FILL		D	0.4							
	0.45	Silty CLAY (CI): medium plasticity, red brown, with fine to coarse grained sand, trace gravel to 6mm, moist, w<PL, very stiff, possible FILL		E	0.5		PID = 0.3ppm					
		Silty CLAY (CL/CI): low to medium plasticity, brown, trace iron staining, moist, w<PL, very stiff, residual		B	0.7							
583	1			E	1.0		PID < 0.1ppm	1				
				D	1.2							
	1.4	SILTSTONE: fine grained, brown, dry to moist, very low strength, highly weathered, highly fractured		E	1.5		PID < 0.1ppm					
				D	1.6							
582	1.9	Bore discontinued at 1.9m -limit of investigation						2				
581	3							3				
580	4							4				

RIG: CAT304CR mini-excavator

DRILLER: Bingley

LOGGED: ADFH

CASING:

TYPE OF BORING: 300mm diameter auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and based on a single point measurement. ☒ Cone Penetrometer AS1289.6.3.3

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 579 AHD
EASTING: 690323
NORTHING: 6091319
DIP/AZIMUTH: 90°/-

BORE No: 101
PROJECT No: 103111.00
DATE: 2/12/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
579	0.2	TOPSOIL/Sandy SILT (ML): low plasticity, brown, fine to medium grained sand, with rootlets, moist to dry, w<PL, TOPSOIL		E	0.1					
		CLAY (CL/CI): low to medium plasticity, red brown, with silt, trace rootlets, moist, w>PL, stiff, alluvial		E	0.5		3,5,8 N = 13			
				S						
578	0.9	Sandy CLAY (CI): medium plasticity, yellow brown, fine to coarse grained sand, trace sub-rounded gravel to 8mm, moist, w~PL, very stiff, residual		E	0.95					
				S	1.0		7,20,22 N = 42			
					1.45					
		-from 1.5m, w<PL, hard		D	1.7					
577	1.8	SANDSTONE: fine to coarse grained, yellow/brown, dry to moist, very low strength, highly weathered, highly fractured		E	2.0					
		-from 2.3m, low strength, highly weathered, fractured		S	2.5		15/60 refusal			
					2.56					
576	3	-from 2.9m, medium strength, moderately weathered		E	3.0					
				D	3.8					
575	4			E	4.0					
		-from 4.2m, medium to high strength								
	4.4	Bore discontinued at 4.4m -refusal								

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 582 AHD
EASTING: 690375
NORTHING: 6091306
DIP/AZIMUTH: 90°/-

BORE No: 102
PROJECT No: 103111.00
DATE: 1/12/2020
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
582	0.05	ASPHALT: 8mm aggregate, blue grey, 50mm thick, asphaltic concrete		E	0.1					
	0.3	FILL/Sandy GRAVEL (GW): well graded, gravel to 20mm, green/grey, fine to coarse grained sand, moist to dry, apparently medium dense to dense, roadbase FILL		E	0.5					
	0.7	CLAY (CI/CH): medium to high plasticity, yellow/grey brown, with silt, trace fine to medium grained sand and gravel to 15mm, moist, w<PL, very stiff, residual		S	0.8		8,12,10 N = 22			
		Silty CLAY (CI): medium plasticity, yellow brown, moist, w~PL, stiff		D	0.95					
581	1			E	1.0					1
	1.3			S			10,12,19 N = 31			
		CLAY (CI): medium plasticity, pale yellow brown, with silt, trace fine to medium grained sand, moist, w<PL, very stiff			1.45					
580	2			E	2.0					2
				S	2.5		12,28,20/50 refusal			
	2.8									
		Sandy CLAY (CI): medium plasticity, dark brown, fine to coarse grained sand, moist to dry, w<PL, hard, extremely weathered sandstone		D	2.9					
579	3			E	3.0					3
				E	4.0					
578	4			S	4.08		20/80 refusal			4
	4.5									
		SANDSTONE: fine to coarse grained, yellow/grey brown, dry to moist, very low strength, highly weathered, highly fractured								

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: Free groundwater observed at 6.60m

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 582 AHD
EASTING: 690375
NORTHING: 6091306
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 103111.00
DATE: 1/12/2020
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
577		SANDSTONE: fine to coarse grained, yellow/grey brown, dry to moist, very low strength, highly weathered, highly fractured (<i>continued</i>)								
		-from 5.4m, low strength		D	5.5					
576	6									
		-from 6.6m, moist to wet, groundwater observed						▽		
575	7			D	7.0					
		-from 7.5m, low to medium strength								
574	8									
				D	8.8					
573	9	Bore discontinued at 9.0m -limit of investigation								

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: Free groundwater observed at 6.60m

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test $ls(50)$ (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test $ls(50)$ (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 582 AHD
EASTING: 690427
NORTHING: 6091310
DIP/AZIMUTH: 90°/-

BORE No: 103
PROJECT No: 103111.00
DATE: 1/12/2020
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing					
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %
582	0.05	SPRAY SEAL: 8mm aggregate, blue grey, 50mm thick, asphaltic concrete																					E			
	0.3	FILL/Sandy GRAVEL (GW): well graded, gravel to 20mm, green/grey, fine to coarse grained sand, moist to dry, apparently medium dense to dense, roadbase FILL																					E			
	0.75	Silty CLAY (CI): medium plasticity, red brown, moist, w~PL, firm to stiff																					S			3,3,5 N = 8
581	1	CLAY (CI/CH): medium to high plasticity, yellow/grey brown, with silt, trace fine to medium grained sand, moist, w<PL, stiff, residual																					E			32/80 refusal
	1.2	-from 1.0m, blue grey, hard																					S			
		SANDSTONE: fine to coarse grained, yellow/grey brown, dry to moist, very low strength, highly weathered, highly fractured																					D			
		-from 2.0m, low strength																					E			
																							S			20/50 refusal
		-from 2.8m, low to medium strength, highly to moderately weathered, fractured																					E			
																							D			
																							E			

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: HQ

TYPE OF BORING: 110mm diameter continuous flight spiral auger to refusal at 4.2m, then NMLC coring to 8.5m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 582 AHD
EASTING: 690427
NORTHING: 6091310
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 103111.00
DATE: 1/12/2020
SHEET 2 OF 2

[illegible]

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: HQ

TYPE OF BORING: 110mm diameter continuous flight spiral auger to refusal at 4.2m, then NMLC coring to 8.5m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test (s(50) (MPa)
		PL(D)	Point load diametral test (s(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



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PRELIMINARY GEOTECHNICAL INVESTIGATION

BLOCK 7 SECTION 4, YARRALUMLA

BORE: 103 DEPTH: 4.5 m – 8.5 m PROJECT: 103111.00 January 2021



BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 577 AHD
EASTING: 690248
NORTHING: 6091299
DIP/AZIMUTH: 90°/-

BORE No: 104
PROJECT No: 103111.00
DATE: 2/12/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
577	0.15	TOPSOIL FILL/Silty Sandy CLAY (CL): low plasticity, dark grey, fine to coarse grained sand, moist to dry, w<PL, stiff, TOPSOIL FILL		E	0.1					
		CLAY (CI/CH): medium to high plasticity, red brown, with silt and fine to coarse grained sand, moist, w~PL, stiff		E	0.5					
				S			4,6,8 N = 14			
576	0.9	Sandy CLAY (CI): medium plasticity, yellow brown, fine to coarse grained sand, moist, w<PL, hard, residual		E	0.95					
1	1.2	SANDSTONE: fine to coarse grained, yellow brown, mottled pink brown, dry to moist, low strength, highly weathered, fractured		S	1.0		18,20/110 refusal			1
					1.25					
				D	1.9					
575	2	-from 1.9m, low to medium strength, some medium strength seams		E	2.0					2
574	3									3
573	4	-from 4.1m, high strength, moderately to slightly weathered		D	4.2					4
	4.3	Bore discontinued at 4.3m -refusal								

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 580 AHD
EASTING: 690310
NORTHING: 6091268
DIP/AZIMUTH: 90°/-

BORE No: 105
PROJECT No: 103111.00
DATE: 2/12/2020
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering EW HW MW SW FS FR	Graphic Log	Rock Strength					Water	Fracture Spacing (m) 0.01 0.05 0.10 0.50 1.00	Discontinuities		Sampling & In Situ Testing			
					Ex Low	Very Low	Low	Medium	High	Very High		B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %	Test Results & Comments
580	0.2	TOPSOIL/Sandy SILT (ML): low plasticity, brown, fine to coarse grained sand, with rootlets, moist to dry, very stiff, TOPSOIL												E			
	0.6	Silty CLAY (CI/CH): medium to high plasticity, brown, trace sub-rounded gravel to 6mm and fine to coarse grained sand, moist, w<PL, stiff, alluvial												E			
		CLAY (CH): high plasticity, red/yellow brown, with silt, moist, w<PL, stiff, residual												S			6,7,7 N = 14
579	1	-from 1.2m, trace fine to medium grained sand, very stiff												E			
														S			4,7,11 N = 18
	1.7	SANDSTONE: fine grained, grey, dry to moist, very low strength, highly weathered, highly fractured												E			
578	2	-from 2.6m, low to medium strength, highly to moderately weathered, fractured												D			
														S			15/100 refusal
577	3	-from 3.5m, medium to high strength, slightly weathered															
576	4.0	SANDSTONE: fine to coarse grained, pale grey/brown, dry to moist												D			PL(A) = 0.15 PL(D) = 1
												4.12m: J, 16°, sm, cu, sand vn					
												4.52m: J, 18°, sm, pl		C	100	88	PL(A) = 1.8
												4.73m: B, 3°, sm, pl, cln					
												4.78m: J, 7°, sm, pl					
												4.82m: J, 7°, ro, pl					

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: HQ

TYPE OF BORING: 110mm diameter continuous flight spiral auger to refusal at 4.0m, then NMLC coring to 7.0m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	G Gas sample	PID Photo ionisation detector (ppm)
B Bulk sample	P Piston sample	PL(A) Point load axial test Is(50) (MPa)
BLK Block sample	U Tube sample (x mm dia.)	PL(D) Point load diametral test Is(50) (MPa)
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)
D Disturbed sample	> Water seep	S Standard penetration test
E Environmental sample	≡ Water level	V Shear vane (kPa)



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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 580 AHD
EASTING: 690310
NORTHING: 6091268
DIP/AZIMUTH: 90°/-

BORE No: 105
PROJECT No: 103111.00
DATE: 2/12/2020
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing			
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type
575		SANDSTONE: fine to coarse grained, pale grey/brown, dry to moist <i>(continued)</i>																			
574	6																	C	100	88	PL(A) = 1.15 PL(D) = 0.9 Point load failed along plane of pre-existing weakness during point load test PL(D) = 0.75 Point load failed along plane of pre-existing weakness during point load test PL(A) = 0.15 Point load failed along plane of pre-existing weakness during point load test PL(A) = 0.4 PL(D) = 0.4 PL(D) = 0.65
573	7.0	Bore discontinued at 7.0m -limit of investigation																			
572	8																				
571	9																				

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: HQ

TYPE OF BORING: 110mm diameter continuous flight spiral auger to refusal at 4.0m, then NMLC coring to 7.0m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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PRELIMINARY GEOTECHNICAL INVESTIGATION

BLOCK 7 SECTION 4, YARRALUMLA

BORE: 105 DEPTH: 4.0 m – 7.0 m PROJECT: 103111.00 January 2021



BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 579 AHD
EASTING: 690262
NORTHING: 6091134
DIP/AZIMUTH: 90°/--

BORE No: 106
PROJECT No: 103111.00
DATE: 2/12/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
579	0.05	ASPHALT: 8mm aggregate size, blue grey, 50mm thick, asphaltic concrete		E	0.1					
	0.3	FILL/Sandy GRAVEL (GW): gravel to 20mm, well graded, yellow/grey, fine to coarse grained sand, moist to dry, apparently medium dense to dense, roadbase FILL		E	0.5		4.4,20 N = 24			
		CLAY (CI/CH): medium to high plasticity, grey/brown, with siltstone gravel to 8mm and silt, moist, w<PL, very stiff, residual		S						
578	1.0	SILTSTONE: fine grained, grey, dry to moist, very low strength, highly weathered, highly fractured		E	0.95		15/20 refusal			
				S	1.0					
					1.02					
		-from 1.4m, low to medium strength, highly to moderately weathered								
		-from 1.6m to 1.7m, very low strength, highly weathered								
577	2			E	2.0					
		-from 2.3m, medium to high strength, slightly weathered, slightly fractured		D	2.4					
	2.5	Bore discontinued at 2.5m -refusal								
576	3									
575	4									

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 582 AHD
EASTING: 690221
NORTHING: 6091116
DIP/AZIMUTH: 90°/--

BORE No: 107
PROJECT No: 103111.00
DATE: 2/12/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
582	0.15	TOPSOIL/Sandy SILT (ML): low plasticity, brown, fine to medium grained sand, with rootlets, moist, w<PL, TOPSOIL		E	0.1					
		Silty CLAY (CI/CH): medium to high plasticity, red/yellow brown, moist, w~PL, stiff, residual		E	0.5					
		-from 0.65m, very stiff		S			6,12,17 N = 29			
581	0.9	SILTSTONE: fine grained, grey, dry to moist, low strength, highly weathered, highly fractured		E	0.95		18/120 refusal			
				S	1.0					
		-from 1.5m, medium strength, moderately weathered		D	1.8					
				E	2.0					
580	2	-from 2.1m, medium to high strength		D	2.3					
	2.4	Bore discontinued at 2.4m -refusal								
579	3									
578	4									

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 587 AHD
EASTING: 690253
NORTHING: 6091048
DIP/AZIMUTH: 90°/-

BORE No: 108
PROJECT No: 103111.00
DATE: 2 - 3/12/2020
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)				Discontinuities		Sampling & In Situ Testing						
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium		High	Very High	Ex High	0.01	0.05	0.10	0.50	1.00	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %
587	0.06	CONCRETE: 10mm aggregate size, grey, 60mm thick																									
		FILL/CLAY (CI/CH): medium to high plasticity, brown, trace silt, fine to coarse grained sand and gravel to 80mm, moist, w<PL, apparently firm, FILL																									
		-from 0.8m, moist to wet, w>PL																									
586	1																										
	1.6	CLAY (CH): high plasticity, brown/yellow brown, with silt, trace fine to coarse grained sand, moist, w<PL, residual																									
585	2																										
	2.6	SANDSTONE: fine to coarse grained, yellow-brown, dry to moist, very low strength, highly weathered, highly fractured																									
584	3	-from 3.2m, low to medium strength, highly to moderately weathered																									
	4.0	CORE LOSS																									
583	4.2	SANDSTONE: fine to coarse grained, pale brown, dry to moist																									
		-from 4.9m, with quartz seams																									

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: HQ

TYPE OF BORING: 110mm diameter continuous flight spiral auger to refusal at 4.0m, then NMLC coring to 7.0m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	G Gas sample	PID Photo ionisation detector (ppm)
B Bulk sample	P Piston sample	PL(A) Point load axial test Is(50) (MPa)
BLK Block sample	U Tube sample (x mm dia.)	PL(D) Point load diametral test Is(50) (MPa)
C Core drilling	W Water sample	pp Pocket penetrometer (kPa)
D Disturbed sample	> Water seep	S Standard penetration test
E Environmental sample	≡ Water level	V Shear vane (kPa)



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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 587 AHD
EASTING: 690253
NORTHING: 6091048
DIP/AZIMUTH: 90°/-

BORE No: 108
PROJECT No: 103111.00
DATE: 2 - 3/12/2020
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering					Graphic Log	Rock Strength					Water	Fracture Spacing (m)	Discontinuities		Sampling & In Situ Testing					
			EW	HW	MW	SW	FS		FR	Ex Low	Very Low	Low	Medium			High	Very High	Ex High	B - Bedding S - Shear	J - Joint F - Fault	Type	Core Rec. %	RQD %
582		SANDSTONE: fine to coarse grained, pale brown, dry to moist (continued)															5.05m: J, 6°, cu, sm, cly vn 5.09m: J, 15°, st, ro, cly vn 5.18m: J, 20°, cu, ro, cly vn 5.19m: - 5.28m: fg 5.32m: J, 55°, st, sm 5.37m: - 5.38m: fg 5.58m: J, 60°, ir, ro 5.63m: - 5.68m: J, 70°, pl, sm, 20mm spacing 5.68m: - 5.81m: fg	C	84	30	PL(D) = 0.55 PL(A) = 0.2 PL(D) = 0.2 PL(D) = 0.75 PL(A) = 0.85 PL(D) = 1		
581	6.0	CORE LOSS														6m: J, 50°, sm, pl, cly inf CORE LOSS: 200mm							
	6.2	SANDSTONE: fine to coarse grained, pale brown, dry to moist														6.25m: J, 80°, sm, pl, cly vn 6.3m: J, 30°, sm, pl, cly vn 6.35m: J, 25°, sm, pl 6.55m: J, 30°, sm, pl 6.6m: J, 65°, sm, ir 6.65m: J, 20°, sm, pl 6.69m: J, 70°, sm, pl 6.72m: J, 20°, ro, pl 6.76m: J, 25°, ro, pl 6.87m: J, 40°, ro, cu, cly inf and J, 25°, sm, pl 6.97m: J, 20°, ro, pl, cly in 6.98m: - 7.00m: fg	C				100	36	PL(D) = 1.4 PL(A) = 1.25 PL(D) = 1.15 PL(A) = 0.65
580	7.0	Bore discontinued at 7.0m -limit of investigation																					
579	8																						
578	9																						

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: HQ

TYPE OF BORING: 110mm diameter continuous flight spiral auger to refusal at 4.0m, then NMLC coring to 7.0m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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DOUGLAS PARTNERS PTY LTD

PRELIMINARY GEOTECHNICAL INVESTIGATION

BLOCK 7 SECTION 4, YARRALUMLA

BORE: 108 DEPTH: 4.2 m – 7.0 m PROJECT: 103111.00 January 2021



BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 587 AHD
EASTING: 690287
NORTHING: 6091037
DIP/AZIMUTH: 90°/-

BORE No: 109
PROJECT No: 103111.00
DATE: 3/12/2020
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
587	0.05	SPRAY SEAL: 10mm aggregate, blue grey, 50mm thick, asphaltic concrete		E	0.1					
	0.3	FILL/Sandy GRAVEL (GW): well graded, gravel to 20mm, green/grey, fine to coarse grained sand, moist to dry, apparently medium dense to dense, roadbase FILL		E	0.5					
	0.6	FILL/CLAY (CI/CH): medium to high plasticity, red/brown, with fine to coarse grained sand, trace gravel to 6mm and silt, moist to dry, w<PL, apparently firm, FILL		S			3.3,2 N = 5			
		Silty CLAY (CL): low plasticity, red brown, moist to wet, w>PL, firm		E	0.95					
586	1			S	1.0		1.2,4 N = 6			
	1.35	CLAY (CI/CH): medium to high plasticity, red/yellow brown, with silt, trace iron staining and ironstone nodules to 8mm, moist to wet, w>PL, firm			1.45					
	1.8	CLAY (CH): high plasticity, yellow/grey brown, with silt, moist, w>PL, residual		A E	2.0					
585	2				2.5					
	2.7	SANDSTONE: fine to coarse grained, pale brown, dry to moist, very low strength, highly weathered		S	2.78		10,16,25/80 refusal			
584	3									
		-from 4.0m, low to medium strength		S	4.0					
583	4				4.19		20/140 refusal			
	5.0									

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 587 AHD
EASTING: 690287
NORTHING: 6091037
DIP/AZIMUTH: 90°/--

BORE No: 109
PROJECT No: 103111.00
DATE: 3/12/2020
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
582		SANDSTONE: fine to coarse grained, pale brown, dry to moist, low to medium strength, highly to moderately weathered, high fractured								
		-from 5.60m, medium to high strength, slightly to moderately weathered, fractured		A	5.8					
581	6.0	Bore discontinued at 6.0m -refusal								
580	7									
579	8									
578	9									

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test $ls(50)$ (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test $ls(50)$ (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 587 AHD
EASTING: 690241
NORTHING: 6091019
DIP/AZIMUTH: 90°/--

BORE No: 110
PROJECT No: 103111.00
DATE: 2/12/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
587	0.08	CONCRETE: 10mm aggregate size, grey, 80mm thick		E	0.1					
	0.2	FILL/Sandy GRAVEL (GW): gravel to 20mm, well graded, green/grey, fine to coarse grained sand, moist to dry, apparently medium dense to dense, roadbase FILL								
	0.5	SILTSTONE: fine grained, grey, dry to moist, high strength, slightly weathered, slightly fractured Bore discontinued at 0.5m -refusal		D	0.45					
586	1									
585	2									
584	3									
583	4									

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND
































A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test $ls(50)$ (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test $ls(50)$ (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: --
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 110A
PROJECT No: 103111.00
DATE: 25/1/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
	0.05	ASPHALT: 50mm, grey, 7mm aggregate								
	0.2	FILL/GRAVEL (WG): well graded, grey-brown, fine to coarse gravel, with fine to coarse grained sand, trace silt, inferred dense, roadbase FILL								
		SILTSTONE: fine graded, purple-brown-grey, medium to high strength, moderately to slightly weathered, inferred highly fractured								
	1									
		-at 1.5m, extremely weathered seam (sandy clay), orange-brown, trace 300mm gravel								
	2									
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
										
	3.9	Bore discontinued at 3.9m								
	4	-refusal								

RIG: _____ **DRILLER:** _____ **LOGGED:** _____ **CASING:** _____

TYPE OF BORING:

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	W	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)


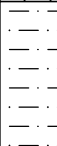
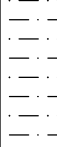
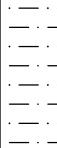
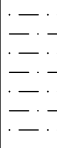


BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 588 AHD
EASTING: 690322
NORTHING: 6090962
DIP/AZIMUTH: 90°/--

BORE No: 111
PROJECT No: 103111.00
DATE: 3/12/2020
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Well Construction Details	
				Type	Depth	Sample		Results & Comments	
588	0.15	TOPSOIL/Sandy SILT (ML): low plasticity, grey/brown, fine to medium grained sand, with rootlets, moist to dry, w<PL, TOPSOIL		E	0.1				
	0.5	CLAY (CI): medium plasticity, grey brown, with silt, trace coarse grained sand and gravel to 6mm, moist to dry, w<PL, residual		E	0.5				
		SILTSTONE: fine grained, grey, dry to moist, very low to low strength, highly weathered, highly fractured		S	0.63		25/120 refusal		
587	1								
		-from 1.8m, low to medium strength, highly to moderately weathered		E	1.0		30/110 refusal	1	
				S	1.11				
586	2	-from 1.8m, low to medium strength, highly to moderately weathered		E	2.0			2	
		-from 2.7m, medium strength, slightly weathered		D	2.7				
				E	2.8				
585	2.9	Bore discontinued at 2.9m							
		-refusal							
584	4								

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	W	Water seep
E	Environmental sample	V	Water level
		PID	Photo ionisation detector (ppm)
		PL(A)	Point load axial test ls(50) (MPa)
		PL(D)	Point load diametral test ls(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)



Douglas Partners
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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 584 AHD
EASTING: 690394
NORTHING: 6090917
DIP/AZIMUTH: 90°/-

BORE No: 112
PROJECT No: 103111.00
DATE: 3/12/2020
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
584	0.05	FILL/SPRAY SEAL: aggregate to 8mm, blue grey, asphaltic concrete. 5mm thick		E	0.1					
	0.3	FILL/Sandy GRAVEL (GW): well graded, gravel to 20mm, green/grey, fine to coarse grained sand, moist to dry, apparently medium dense to dense, roadbase FILL		E	0.5					
		Silty CLAY (CI): medium plasticity, red brown, trace fine to coarse grained sand and gravel to 5mm, moist to dry, w<PL, very stiff		S			6,10,15 N = 25			
583	1			E	0.95 1.0					
	1.2	CLAY (CI): medium plasticity, yellow brown, with silt, trace fine to coarse grained sand, moist, w<PL, very stiff, residual		S			10,7,9 N = 16			
					1.45					
582	1.8	SILTSTONE: fine grained, pale grey, dry to moist, very low strength, highly weathered, highly fractured		E	2.0					
				S	2.5 2.57		20/70 refusal			
581	3	-from 2.8m, low strength								
580	4	-from 4.0m, medium strength, moderately weathered, fractured		D	4.2					

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)



Douglas Partners
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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 584 AHD
EASTING: 690394
NORTHING: 6090917
DIP/AZIMUTH: 90°/--

BORE No: 112
PROJECT No: 103111.00
DATE: 3/12/2020
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
579		SILTSTONE: fine grained, pale grey, dry to moist, very low strength, highly weathered, highly fractured (continued)								
578	6			D	5.8					
577	7	-from 7.0m, medium to high strength, moderately weathered, slightly fractured								
	7.3	Bore discontinued at 7.3m -refusal								
576	8									
575	9									

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: N/A

TYPE OF BORING: 110mm diameter continuous flight spiral auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 580 AHD
EASTING: 690424
NORTHING: 6090921
DIP/AZIMUTH: 90°/--

BORE No: 113
PROJECT No: 103111.00
DATE: 3/12/2020
SHEET 1 OF 2

[illegible]

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: HQ

TYPE OF BORING: 110mm diameter continuous flight spiral auger to 4.0m, then NMLC coring to 7.5m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND					
A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test (s(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test (s(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	W	Water seep	S	Standard penetration test
E	Environmental sample	W	Water level	V	Shear vane (kPa)



Douglas Partners
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BOREHOLE LOG

CLIENT: The Shepherd Foundation
PROJECT: Preliminary Geotechnical Investigation
LOCATION: Block 7 Section 4, Yarralumla

SURFACE LEVEL: 580 AHD
EASTING: 690424
NORTHING: 6090921
DIP/AZIMUTH: 90°/-

BORE No: 113
PROJECT No: 103111.00
DATE: 3/12/2020
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering EW HW MW SW FS FR	Graphic Log	Rock Strength Ex Low Very Low Low Medium High Very High Ex High	Water	Fracture Spacing (m) 0.01 0.05 0.10 0.50 1.00	Discontinuities B - Bedding J - Joint S - Shear F - Fault	Sampling & In Situ Testing			
									Type	Core Rec. %	RQD %	Test Results & Comments
575		SANDSTONE: fine to coarse grained, pale brown/brown, dry to moist (<i>continued</i>)						4.58m: - 4.71m: fg 4.82m: J, 5°, ro, cu, clay 4.91m: J, 5°, ro, pl 4.94m: J, 70°, sm, pl 4.951m: J, 5°, ro, pl 4.96m: - 5.09m: fg 5.12m: - 5.34m: J, 5°, sm, pl, 20mm spacing and J, 70°, sm, pl, 70mm spacing 5.34m: - 5.40m: fg 5.4m: CORE LOSS: 100mm 5.56m: B, 3°, sm, pl and J, 20°, sm, pl 5.66m: J, 10°, sm, pl 5.73m: J, 10°, ro, ir 5.74m: - 5.81m: fg 5.91m: J, 45°, sm, st 5.92m: - 6.25m: fg 6.25m: J, 50°, sm, pl 6.28m: J, 10°, sm, pl 6.3m: J, 90°, sm, pl 6.32m: J, 70°, sm, pl 6.33m: - 6.40m: fg 6.4m: CORE LOSS: 100mm 6.55m: - 6.59m: J, 10°, sm, pl, 20mm spacing 6.65m: J, 10°, am, pl and J, 35°, sm, pl 6.69m: B, 5°, sm, pl 6.71m: - 6.79m: J, 8°, sm, pl, 20mm spacing 6.79m: - 6.91m: fg 7.15m: - 7.18m: fg 7.22m: J, 20°, sm, pl 7.28m: - 7.30m: fg 7.32m: J, 5°, sm, pl 7.34m: J, 90°, ro, pl 7.35m: - 7.42m: fg 7.46m: J, 30°, ro, irr, clay inf 7.47m: - 7.5m: fg	C	95	20	PL(A) = 0.25 Point load failed along plane of pre-existing weakness during point load test
574	5.4	CORE LOSS							C	90	21	
	5.5	SANDSTONE: fine to coarse grained, pale brown/brown, dry to moist										
	6											
	6.4	CORE LOSS										
	6.5	SANDSTONE: fine to coarse grained, pale brown/brown, dry to moist										PL(D) = 0.45 PL(A) = 0.2 PL(D) = 0.45
573	7								C	100	24	
	7.5	Bore discontinued at 7.5m - limit of investigation										
572	8											
571	9											

RIG: Hydrapower Scout

DRILLER: RMX

LOGGED: ADFH

CASING: HQ

TYPE OF BORING: 110mm diameter continuous flight spiral auger to 4.0m, then NMLC coring to 7.5m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Location coordinates are in MGA94 Zone 55. Surface levels and coordinates are approximate only and must not be relied upon

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	>	Water seep	S	Standard penetration test
E	Environmental sample	≡	Water level	V	Shear vane (kPa)

DOUGLAS PARTNERS PTY LTD

PRELIMINARY GEOTECHNICAL INVESTIGATION

BLOCK 7 SECTION 4, YARRALUMLA

BORE: 113 DEPTH: 4.0 m – 7.5 m PROJECT: 103111.00 January 2021



Appendix D

Laboratory Test Results

Material Test Report

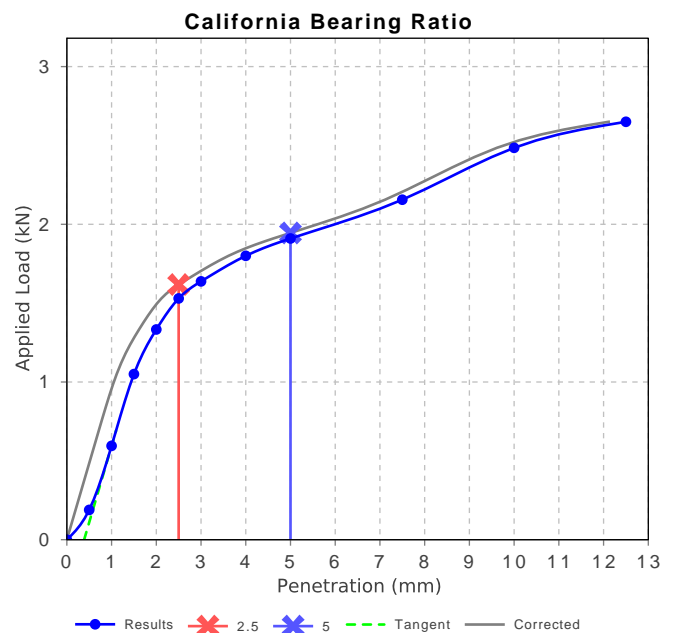
Report Number: 103111.00-1
Issue Number: 1
Date Issued: 16/12/2020
Client: The Shepherd Foundation
 C/- Oakstand, Sydney NSW 2000
Contact: Justin Micallef
Project Number: 103111.00
Project Name: Preliminary Geotechnical Investigation
Project Location: Block 7 Section 4, Yarralumla
Work Request: 5176
Sample Number: GU-5176A
Date Sampled: 30/11/2020
Dates Tested: 04/12/2020 - 14/12/2020
Sampling Method: Sampled by Engineering Department
 The results apply to the sample as received
Sample Location: Pit 4, Depth: 0.4-0.6
Material: Clay



Approved Signatory: Cameron Bromley
 Laboratory Manager

NATA Accredited Laboratory Number: 828

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	12		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m ³)	1.61		
Optimum Moisture Content (%)	22.5		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	98.5		
Dry Density after Soaking (t/m ³)	1.58		
Field Moisture Content (%)	23.5		
Moisture Content at Placement (%)	22.0		
Moisture Content Top 30mm (%)	24.2		
Moisture Content Rest of Sample (%)	23.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	145		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Material Test Report

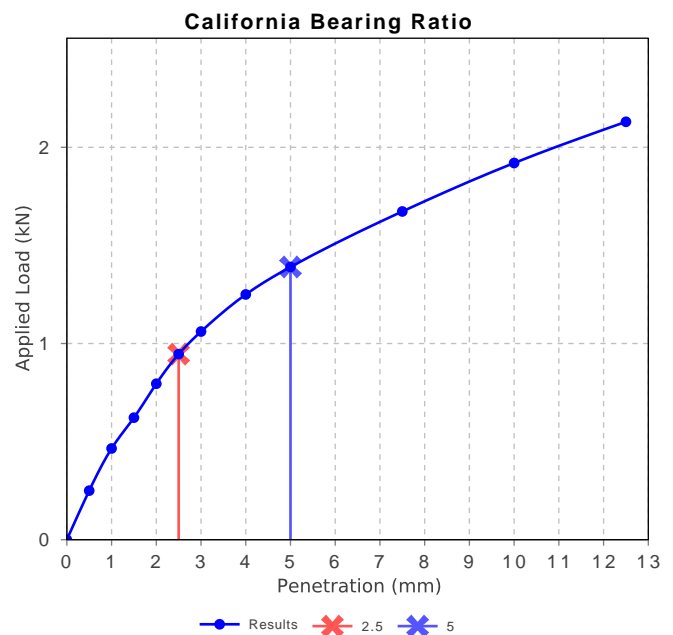


Approved Signatory: Cameron Bromley
Laboratory Manager

NATA Accredited Laboratory Number: 828

Report Number: 103111.00-1
Issue Number: 1
Date Issued: 16/12/2020
Client: The Shepherd Foundation
C/- Oakstand, Sydney NSW 2000
Contact: Justin Micallef
Project Number: 103111.00
Project Name: Preliminary Geotechnical Investigation
Project Location: Block 7 Section 4, Yarralumla
Work Request: 5176
Sample Number: GU-5176B
Date Sampled: 30/11/2020
Dates Tested: 04/12/2020 - 15/12/2020
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: Bore 6, Depth: 0.6-0.8
Material: Silty Clay

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	7		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m ³)	1.92		
Optimum Moisture Content (%)	12.5		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	98.5		
Dry Density after Soaking (t/m ³)	1.88		
Field Moisture Content (%)	17.2		
Moisture Content at Placement (%)	12.5		
Moisture Content Top 30mm (%)	14.3		
Moisture Content Rest of Sample (%)	14.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	72.4		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Material Test Report

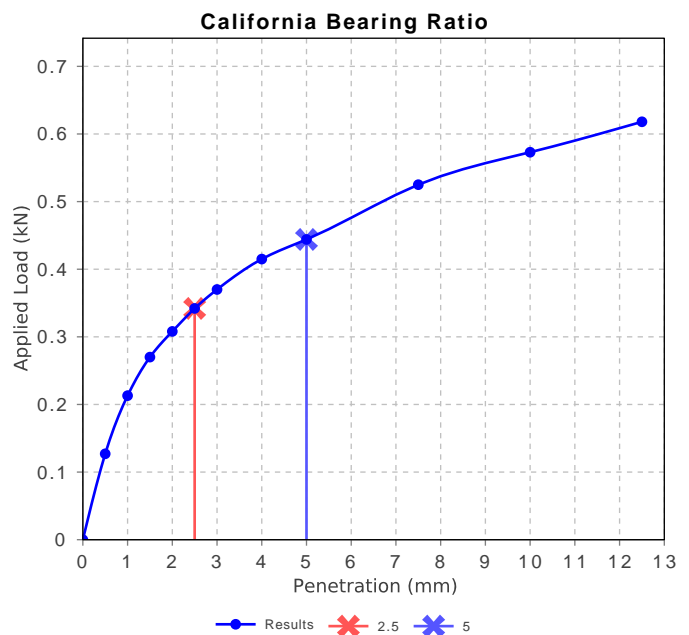


Approved Signatory: Cameron Bromley
Laboratory Manager

NATA Accredited Laboratory Number: 828

Report Number: 103111.00-1
Issue Number: 1
Date Issued: 16/12/2020
Client: The Shepherd Foundation
C/- Oakstand, Sydney NSW 2000
Contact: Justin Micallef
Project Number: 103111.00
Project Name: Preliminary Geotechnical Investigation
Project Location: Block 7 Section 4, Yarralumla
Work Request: 5176
Sample Number: GU-5176C
Date Sampled: 30/11/2020
Dates Tested: 04/12/2020 - 14/12/2020
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: Bore 11, Depth: 0.6-0.8
Material: Clay

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	2.5		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m ³)	1.60		
Optimum Moisture Content (%)	22.0		
Laboratory Density Ratio (%)	98.0		
Laboratory Moisture Ratio (%)	99.0		
Dry Density after Soaking (t/m ³)	1.52		
Field Moisture Content (%)	17.8		
Moisture Content at Placement (%)	21.8		
Moisture Content Top 30mm (%)	29.5		
Moisture Content Rest of Sample (%)	27.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	72.8		
Swell (%)	3.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)			



Material Test Report

Report Number: 103111.00-1
Issue Number: 1
Date Issued: 16/12/2020
Client: The Shepherd Foundation
C/- Oakstand, Sydney NSW 2000
Contact: Justin Micallef
Project Number: 103111.00
Project Name: Preliminary Geotechnical Investigation
Project Location: Block 7 Section 4, Yarralumla
Work Request: 5176
Dates Tested: 04/12/2020 - 04/12/2020



Douglas Partners Pty Ltd

Goulburn Laboratory

54 Sinclair Street Goulburn NSW 2580

Phone: 02 4822 8395

Email: cameron.bromley@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing



Approved Signatory: Cameron Bromley
Laboratory Manager

NATA Accredited Laboratory Number: 828

Moisture Content AS 1289 2.1.1

Sample Number	Sample Location	Moisture Content (%)	Material
GU-5176A	Pit 4, Depth: 0.4-0.6	17.0 %	Clay
GU-5176B	Bore 6, Depth: 0.6-0.8	17.2 %	Silty Clay
GU-5176C	Bore 11, Depth: 0.6-0.8	17.8 %	Clay

Material Test Report

Report Number: 103111.00-2
Issue Number: 1
Date Issued: 18/12/2020
Client: The Shepherd Foundation
C/- Oakstand, Sydney NSW 2000
Contact: Justin Micallef
Project Number: 103111.00
Project Name: Preliminary Geotechnical Investigation
Project Location: Block 7 Section 4, Yarralumla
Work Request: 5230
Sample Number: GU-5230A
Date Sampled: 30/11/2020
Dates Tested: 10/12/2020 - 16/12/2020
Sample Location: B105, Depth: 1.0 - 1.45
Material: Clay



Approved Signatory: Cameron Bromley
Laboratory Manager
NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	80		
Plastic Limit (%)	23		
Plasticity Index (%)	57		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	16.5		
Cracking Crumbling Curling	Curling		

Material Test Report

Report Number: 103111.00-2
Issue Number: 1
Date Issued: 18/12/2020
Client: The Shepherd Foundation
C/- Oakstand, Sydney NSW 2000
Contact: Justin Micallef
Project Number: 103111.00
Project Name: Preliminary Geotechnical Investigation
Project Location: Block 7 Section 4, Yarralumla
Work Request: 5230
Sample Number: GU-5230B
Date Sampled: 30/11/2020
Dates Tested: 10/12/2020 - 16/12/2020
Sample Location: B112, Depth: 0.5 - 0.95
Material: Silty Clay



Approved Signatory: Cameron Bromley
Laboratory Manager

NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	31		
Plastic Limit (%)	15		
Plasticity Index (%)	16		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	8.0		
Cracking Crumbling Curling	None		

Material Test Report

Report Number: 103111.00-2
Issue Number: 1
Date Issued: 18/12/2020
Client: The Shepherd Foundation
C/- Oakstand, Sydney NSW 2000
Contact: Justin Micallef
Project Number: 103111.00
Project Name: Preliminary Geotechnical Investigation
Project Location: Block 7 Section 4, Yarralumla
Work Request: 5230
Sample Number: GU-5230C
Date Sampled: 30/11/2020
Dates Tested: 10/12/2020 - 16/12/2020
Sample Location: B107, Depth: 0.5 - 0.95
Material: Silty Clay



Approved Signatory: Cameron Bromley
Laboratory Manager

NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	39		
Plastic Limit (%)	19		
Plasticity Index (%)	20		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	8.5		
Cracking Crumbling Curling	Cracking		

Material Test Report

Report Number: 103111.00-2
Issue Number: 1
Date Issued: 18/12/2020
Client: The Shepherd Foundation
C/- Oakstand, Sydney NSW 2000
Contact: Justin Micallef
Project Number: 103111.00
Project Name: Preliminary Geotechnical Investigation
Project Location: Block 7 Section 4, Yarralumla
Work Request: 5230
Sample Number: GU-5230D
Date Sampled: 30/11/2020
Dates Tested: 10/12/2020 - 16/12/2020
Sample Location: B108, Depth: 1.9 - 1.9
Material: Clay



Approved Signatory: Cameron Bromley
Laboratory Manager
NATA Accredited Laboratory Number: 828

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	55		
Plastic Limit (%)	19		
Plasticity Index (%)	36		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	15.0		
Cracking Crumbling Curling	Curling		

Material Test Report

Report Number: 103111.00-2
Issue Number: 1
Date Issued: 18/12/2020
Client: The Shepherd Foundation
C/- Oakstand, Sydney NSW 2000
Contact: Justin Micallef
Project Number: 103111.00
Project Name: Preliminary Geotechnical Investigation
Project Location: Block 7 Section 4, Yarralumla
Work Request: 5230
Dates Tested: 10/12/2020 - 11/12/2020



Approved Signatory: Cameron Bromley
Laboratory Manager

NATA Accredited Laboratory Number: 828

Moisture Content AS 1289 2.1.1

Sample Number	Sample Location	Moisture Content (%)	Material
GU-5230A	B105, Depth: 1.0 - 1.45	24.3 %	Clay
GU-5230B	B112, Depth: 0.5 - 0.95	9.6 %	Silty Clay
GU-5230C	B107, Depth: 0.5 - 0.95	14.4 %	Silty Clay
GU-5230D	B108, Depth: 1.9 - 1.9	22.1 %	Clay