Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Preliminary Geotechnical Investigation

Proposed Service Centre
37 - 41 Bengal Street, Coolongolook

Prepared for
Turnbull Planning International Pty Ltd

Project 91401.00
December 2019

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	91401.00	Document No.	R.002.Rev1
Document title	Report on Preliminary Geotechnical Investigation Proposed Service Centre		
Site address	37 - 41 Bengal Street, Coolongolook		
Report prepared for	Turnbull Planning International Pty Ltd		
File name	91401.00.R.002.Rev1		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Michael Gawn	John Harvey	28 November 2018
Revision 1	Michael Gawn	Scott McFarlane	2 December 2019

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Sophie Litherland, Turnbull Planning International Pty Ltd
Revision 1	1	0	Tia Gao – Turnbull Planning International Pty Ltd

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

	Signature	Date
Author		2 December 2019
Reviewer		2 December 2019

bsi. ISO 9001 Quality Management
FS 604853

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
15 Callistemon Close
Warabrook NSW 2304
PO Box 324
Hunter Region Mail Centre NSW 2310
Phone (02) 4960 9600
Fax (02) 4960 9601

Douglas Partners
Geotechnics / Environment / Groundwater

Table of Contents

Page

Report on Preliminary Geotechnical Investigation
Proposed Service Centre
37 - 41 Bengal Street, Coolongolook

1. Introduction

This report presents the results of a preliminary geotechnical investigation for the proposed service centre at 37 - 41 Bengal Street, Coolongolook. The work was undertaken for Turnbull Planning International Pty Ltd, acting on behalf of Galen Property Pty Limited, and was undertaken with reference with Douglas Partners Pty Ltd (DP) proposal NCL180321 dated 8 August 2018.

It is understood that the project is in the concept phase at present and the current investigation is required as part of the development application process.

The investigation comprised a desktop review of published geological and soil landscape maps, drilling of 10 boreholes and limited laboratory testing of retrieved samples.

The aim of the investigation was to provide comments on the following:

- Subsurface conditions;
- Indicative site classification as per AS 2870-2011;
- Excavation conditions;
- Suitability of the excavated material for reuse;
- Trafficability of the site materials
- Likely footing options/founding depths for the various building elements, such as building footings, canopy footings, internal concrete slabs, external pavements and retaining walls;
- Design subgrade CBR values;
- Subgrade and site preparation measures; and
- Infiltration rate for the storm water design.

For the purpose of the investigation, the client provided DP with the following relevant drawings:

- Proposed Site Plan, Drawing A-02, P5, dated August 2018;
- Dimensioned Site Plan, Drawing A-03, P5, dated August 2018;
- Sales Building Floor Plan, Drawing A-21, P5, dated August 2018;
- Sales Building Dimensioned Floor Plan, Drawing A-22, P5, dated August 2018;
- Sales Building Elevation, Drawing A-24, P5, dated August 2018; and
- Light Vehicle Canopy Plans, Drawing A-100, P2, dated August 2018.

DP has undertaken a concurrent preliminary site investigation for contamination (Ref 1).

2. Site Identification, Description and Surrounding Land Use

The site is located at 37 to 41 Bengal Street, Coolongolook and is identified as Lots 7 to 9 in DP 758278 (refer Figure 1).

Figure 1: Aerial image of site (sourced from GoogleEarth)

The site is approximately 6200 m^2 in area and roughly rectangular in shape.

The southern two thirds of the site (Lots 7 and 8) were cleared of vegetation at the time of the investigation with the exception of some scattered trees in the western part of Lot 8.

Figure 2: View of the site from Lot 7, looking north (Lot 9 contains house)

Figure 3: View of western area of Lot 8, looking south

The northern third of the site (Lot 9) contained an existing single storey residence, detached sheds and lawn areas.

Figure 4: Existing residence in Lot 9, looking north-west

A prominent gully passes through the site, entering in the south-western corner and flowing into a culvert under the Pacific Highway on the eastern boundary of Lot 9.

Figure 5: Broad gully passing through the site

An existing water body is located to the west of the residence (refer Figure 6). The depth of the water is not known.

Figure 6: Water body in north-western area of site

The site is bounded to the east by the existing Pacific Highway, to the south by residential allotments and to the north and west by unformed road reserves for Nelson Street and Lombard Lane respectively.

3. Regional Geology and Acid Sulfate Mapping

Reference to the digital 1:250,000 Geological Sheet for the area indicates the site is mapped as being underlain by Quaternary alluvium, which is characterised by channel and flood plain alluvium comprising gravel, sand, silty and clay. Areas to the west of the site are mapped as being underlain by the Boolambayte Formation, which is characterised by mudstone, sandstone and conglomerate.

The conditions in the bores indicated the presence of shallow alluvium overlying bedrock, described as meta-siltstone from the disturbed samples.

The site is mapped as having no known occurrence of acid sulfate soils.

4. Topography and Regional Groundwater Regime

Detailed survey of the site has not been provided to DP at this stage. Reference to the state wide 10 m digital contour mapping suggests that surface levels at the site range from about RL 10 m (within the gully) to possibly up to RL 15 m AHD in higher areas to the south and south-west.

A groundwater bore search undertaken with the Department of Infrastructure, Planning and Natural Resources indicated that three registered groundwater wells are located within 500 m of the site, as follows and as shown in Figure 7:

- GW200526, located approximately 300 m south of the site and upgradient;
- GW049935, located approximately 350 m south-south-east of the site and across gradient; and
- GW200403, located approximately 550 m east-north-east of the site and downgradient.

Standing groundwater within the bores were recorded at depths of 4 m (GW200403) and 5 m (GW049935). No groundwater details were provided in the report for GW200526. The subsurface conditions recorded in the wells included predominantly clay over shale and basalt bedrock. Groundwater at the site is expected to flow into the broad gully and then in a north-easterly direction under the highway before entering Coolongolook River, approximately 900 m to the east of the site. This water body is considered to be the nearest environmentally sensitive receptor.

Figure 7: Aerial image of the surrounding area, watercourses and registered groundwater bores

5. Field Work Methods

Field work was conducted on 6 and 7 November 2018 and included the following:

- Ten (10) test bores (Bores 1 to 10);
- Dynamic cone penetrometer tests at Bores 1 to 9 to depths of up to 1.95 m;
- Double ring infiltration testing at four locations (INF3, 4, 6 and 10) drilled at the corresponding Bores 3, 4, 6 and 10.

The approximate location of the bores and infiltration testing are shown on Drawing 1 in Appendix D.

The bores were drilled using a truck mounted DT100 drilling rig fitted with solid flight augers. Standard penetrometer testing (SPT) was undertaken at regular depths in the bores. The conditions encountered in the bores were logged by a senior geotechnical field officer.

Bulk samples of anticipated subgrade materials were obtained for laboratory testing by drilling with 300 mm diameter auger adjacent to the numbered bore.

Constant head permeameter testing was undertaken at Locations INF 3, 4, 6 and 10. The testing was undertaken in accordance with the procedures outlined in AS1547:2012 Appendix 4.1F (Ref 8). Prior to testing, a 0.6 m deep hole was drilled using hand auger tools.

Table 1, below, provides a summary of field work for the investigation. It should be noted that the location rationale was based on previous DA drawings and hence are no longer relevant for the current plans as outlined above.

Table 1: Summary of Field Work

Bore	Area of Site / Rationale for Bore	Depth of Investigation (m)
1	Retail building (foundation and also surface filling)	3.0 (Ref)
2	Pavement area (surficial filling and broad spaced bores)	3.95 (Ref)
3	Entry area (broad spaced bores)	2.85 (Ref)
4	Existing Gully (broad gully)	3.1 (Ref)
5	Retail building (foundation and also surface filling)	2.7 (Ref)
6	Truck parking area (existing buildings and surficial filling)	2.55 (Ref)
7	Car canopy area (broad spaced gully and surface filling)	3.27 (Ref)
8	Truck parking area (existing buildings and surficial filling)	2.8
9	Car canopy area (broad spaced gully and surface filling)	4.18 (Ref)
10	Truck parking area (existing buildings and surficial filling)	1.6 (Hand auger refusal)
INF3	Entry area (shallow residual soils)	0.6
INF4	Existing gully (alluvial soils)	0.6
INF6	Truck parking area (shallow residual soils)	0.6
INF10	Truck parking area (shallow residual soils)	0.6

Notes to Table 1: Ref = tungsten bit refusal

Following completion of drilling, all bores were reinstated using excavated spoil, which was compacted using the drilling equipment and manual tamping.

6. Field Work Results

The results of the subsurface investigation are shown in the borehole logs and results of dynamic penetrometer tests in Appendix B, together with notes defining classification methods and descriptive terms.

The boreholes encountered relatively uniform conditions over the site. The general subsurface profile is summarised as follows:

Unit 1.1 (Filling)	Generally gravelly silty clay filling;
Unit 2 (Alluvium)	Soft to firm dark brown gravelly clayey silt or stiff silty clay;
Unit 3 (Residual Clay)	Hard light grey or brown gravelly clay / silty clay or orange brown clay.
Unit 4 (Bedrock)	Siltstone or sandstone or meta-siltstone, inferred to be initially very low strength based on drill string penetration, increasing to low strength or stronger towards auger refusal depth.

Table 2 provides a summary of subsurface conditions encountered in the bores.

Table 2: Summary of Subsurface Conditions

Bore	Depth of Investigation(1) (m)	Depth to Base of Each Unit (m)			
		Unit 1 (Filling)	Unit 2 (Alluvial Soils)	Unit 3 (Residual Clay)	Unit 4 (Bedrock)
1	3.0	NE	2.3	3.0	>3.0
2	3.95	NE	0.8	3.5	>3.95
3	2.85	NE	NE	2.85	>2.85
4	3.1	NE	2.0	3.1	>3.1
5	2.7	NE	NE	2.5	>2.7
6	2.53	0.2	0.4	2.4	>2.55
7	3.27	0.4	NE	3.05	>3.27
8	2.8	NE	0.3	2.8	NE
9	4.18	NE	0.35	3.3	>4.18
10	1.6	NE	0.5	>1.6	NE

Notes to Table 2:

NE – Not encountered

(1) below existing ground level

Groundwater observations were made during the drilling and are summarised in Table 3.

Table 3: Groundwater Observations

Bore	Groundwater Observations
1	Free groundwater observed at 0.3 m during drilling
2	Free groundwater observed at 0.7 m during drilling
3	No free groundwater observed during drilling
4	Free groundwater observed at 0.7 m during drilling
5	No free groundwater observed during drilling
6	No free groundwater observed during drilling
7	No free groundwater observed during drilling
8	No free groundwater observed during drilling
9	No free groundwater observed during drilling
10	No free groundwater observed during drilling

It should be noted that groundwater levels are affected by factors such as climatic conditions and soil permeability and will therefore vary with time.

Results of the permeability testing are summarised in Table 4 below.

Table 4: Summary of In-situ Permeability Testing

Bore	Type of Test	Depth of Test (m BGL)	Calculated Permeability	
			m/sec	m/day
3	Permeameter	0.6	3.6×10^{-7}	0.03
4	Permeameter	0.6	1.6×10^{-7}	0.01
6	Permeameter	0.6	5.1×10^{-7}	0.04
10	Permeameter	0.6	3.7×10^{-7}	0.03
10	Permeameter (second test)	0.6	1.7×10^{-7}	0.01

Notes to Table 4:
mBGL – metres below ground level

Comparison between the results of the permeability testing and published values indicates that these estimated permeabilities are consistent with clay soils.

7. Laboratory Testing

Laboratory testing included the following:

- California bearing ratio (CBR) testing on two samples of the anticipated subgrade;
- Shrink-swell testing on two samples of the cohesive soils retrieved from the bores; and
- Atteberg limits and linear shrinkage testing on two samples.

Detailed results of laboratory testing are provided in Appendix C and summarised in Table 5 below.

Table 5: Results of Laboratory Testing

Pit	Depth (m)	Unit	Description	FMC (%)	SOMC (%)	SMDD (t/m^3)	CBR (%)	Iss (% per ΔpF)	LL (%)	PL (%)	PI (%)
3	0.5 – 0.8	3	Light grey mottled orange CLAY	28.9	26	1.53	7	-	-	-	-
6	0.5 – 0.8	3	Light grey mottled orange CLAY	22.1	20.5	1.67	6	-	-	-	-
8	0.5 – 0.8	3	Orange brown CLAY	-	-	-	-	2.6	-	-	-
9	0.5 – 0.9	3	Orange brown CLAY	-	-	-	-	1.5	-	-	-
1	1 – 1.45	2	Dark brown GRAVELLY CLAYEY SILT	-	-	-	-	-	35	20	15
4	0.5 – 0.9	2	Dark brown CLAYEY SILT	-	-	-	-	-	31	18	13

Notes to Table 5:

FMC – Field Moisture content
SOMC – Optimum Moisture Content (Standard)
CBR – Californian Bearing Ratio
SMDD – Maximum Dry Density (Standard)
LS – Linear Shrinkage
Iss – Shrink Swell Index
LL – Liquid Limit
PL – Plastic Limit
PI – Plasticity Index

The results of the testing indicate that the clayey silt is of low to intermediate plasticity (refer Figure 8).

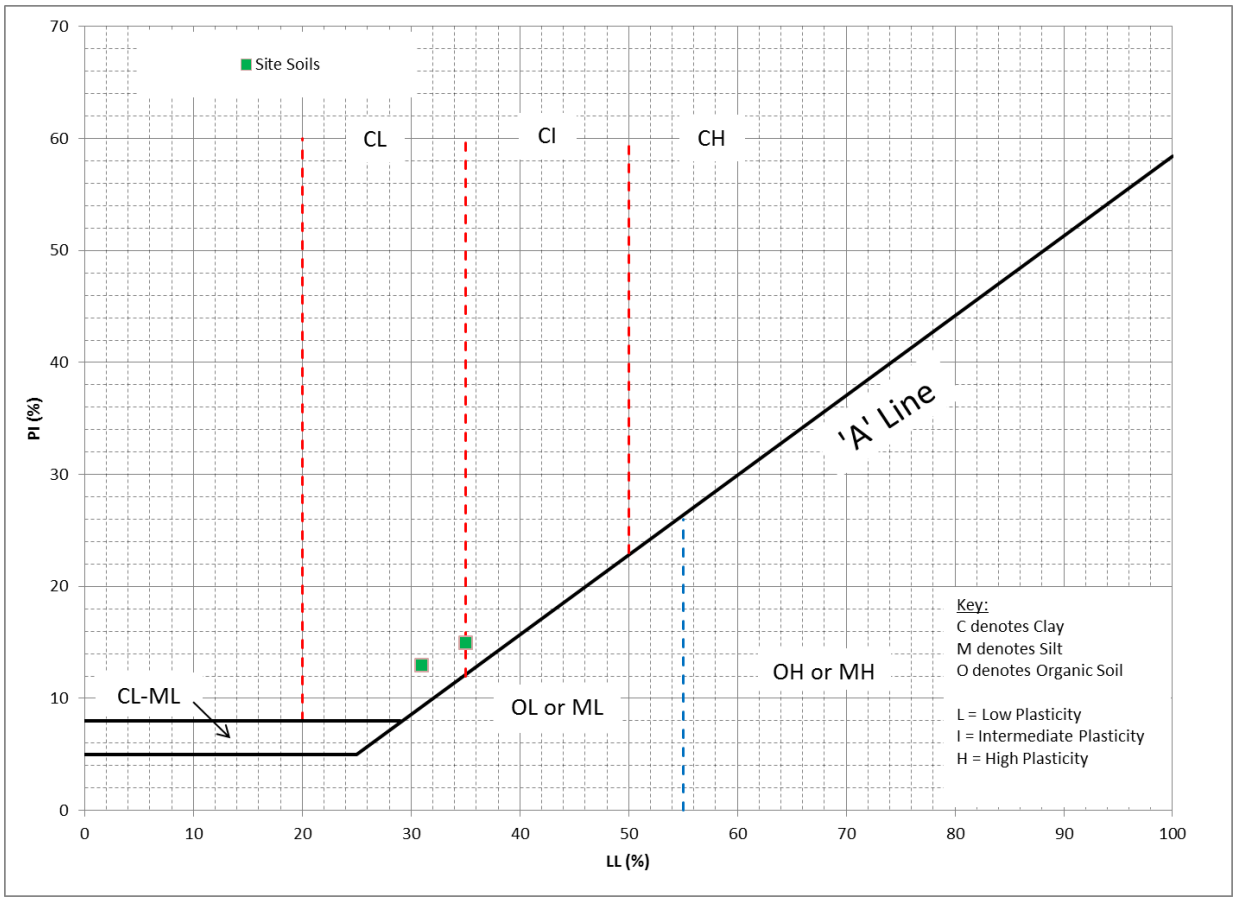


Figure 8: Graphical representation of Atteberg Results

8. Proposed Development

The proposed development includes the construction of a highway service centre, which will comprise the following:

- A retail food outlet and sales building in the central area of the site;
- Car refuelling area and canopy;
- Truck refuelling area; and
- Pavements surrounding the proposed structures.

The quantity of site re-grading (cut and fill) is not known at this stage. It is noted, however, that a broad gully runs through the site and that a small water body is located in the north-western corner of Lot 9. Hence some surface water diversion and drainage works together with placement of engineered filling is likely to be required.

The design loads for the proposed structures are not known at this stage.

9. Comments

9.1 Subsurface Conditions

The pertinent subsurface conditions encountered in the bores are summarised as follows:

Filling
Generally shallow (less than 0.7 m) filling, however may be deeper in untested areas of the site.

The filling is generally gravelly clay although some anthropogenic inclusions, such as metal, plastic and brick fragments, were observed. The filling should not be relied upon to support structures or pavements. It is likely, however, that regrading of the site during development may require removal of some or all of this material. It may also be possible to re-use the filling from a geotechnical viewpoint once the deleterious and oversized material is removed.

Gravelly Clayey Silt in Broad Gully
Watercharged, soft to firm gravelly clayey silt, was encountered to depths of up to 2.3 m within the bores located in the broad gully (Bores 1 and 4). Similarly, soft to firm clay was encountered in Bore 2 also located in the broad gully (refer Drawing 1). The concept layout plans indicate that the pavement areas will cover the existing gully and hence earthworks will be required to raise site levels.

Trafficability on this watercharged soil is anticipated to be difficult during construction and ground improvement measures are likely to be locally required to allow passage of excavation equipment and construction of pavements in this area. Similarly, if filling is to be placed over this area of the site, rigorous site preparation, including the provision of drainage, may be required to allow adequate compaction of overlying filling layers. This is discussed in more detail in Section 9.2.

Residual Clay and Underlying Bedrock
The natural residual, stiff to hard clay and silty clay encountered at depths ranging from about 2.5 m to 3.5 m and the underlying bedrock, as encountered or inferred in all bores except Bores 8 and 10 may be suitable for the support of the proposed structures.

9.2 Planning of Site Works

Site preparation for the development of the site could be problematic due to the presence of the watercharged, soft to firm soils within the broad gully in the central area of the site. Therefore, careful site management will be required to facilitate construction.

Because the site appears to be a natural drainage path, rainfall on adjacent upslope properties tends to migrate as surface runoff or subsurface seepage to the subject site and results in high soil moisture contents and shallow groundwater within the broad gully. In order to manage the site during earthworks, it is suggested that appropriate drainage measures are installed within the broad gully to collect and transport the run-on water to the formal stormwater system downstream of the site. In this regard, it is noted that there is an informal stormwater channel in the south-western corner of the site. The ability to place and compact filling within the gully will be highly dependent on prevailing weather conditions at the time of construction and prior drainage measures installed.

Site preparation will also depend on the type of foundations intended to be used to support the proposed buildings. If high level footings such as strip or pad footings are to be used, then the weak soils will need to be improved by means of over-excavation and replacement/recompaction under Level 1 inspection and testing conditions. Appropriate surface and subsurface drainage measures will also be required to prevent softening of the placed filling (refer Section 9.3).

Similarly, in areas which contain existing filling, if high level footings are to be used for support of structures, the existing filling should be removed to stockpiles for further assessment for possible re-use as engineered filling or adequately assessed for off-site removal.

Site preparation within the remaining higher areas of the site which are underlain by very stiff to hard residual clay are anticipated to be relatively straight forward.

Based on the results of the test bores and penetrometer tests, the weak material appears to extent to depths of up to 2 m within the broad gully (refer Drawing 1) and are likely to become thinner away from the central basal line of the gully.

9.3 Site Preparation

Site preparation for the construction of a building platform and internal roads should be carried out in general accordance with the following recommendations:

- Carry out further investigation within the central gully to delineate the area of weak soils which would require removal and/or recompaction;
- Install appropriate drainage/dewatering measures to allow earthworks within the central gully. This may require the construction of a drainage blanket comprising coarse sized durable gravel or cobbles encapsulated in a suitable geofabric along the base of the gully, which is appropriately sized to cater for the upslope catchment areas and connected to the formal downslope stormwater system. Surface drainage will also be required to direct overland flows to the downslope formal stormwater system;
- Remove the existing weak material and existing filling and stockpile for assessment for its suitability for reuse as an engineered filling by a geotechnical engineer. Based on the conditions encountered in the test bores, the gravelly clayey silt encountered in the central gully is anticipated to be suitable for re-use subject to removal of any oversized material and moisture adjustment. It is noted that soils with a high silt content can be difficult to work with depending on the moisture condition at the time and hence due consideration should be given to the space requirements and procedures required to render the material suitable for re-use;
- Present the stripped surface for inspection by a geotechnical engineer who should check for the presence of any remaining loose/unsuitable soils. The detection of unsuitable material may require proof rolling using a roller having a deadweight of at least 8 tonnes, and/or dynamic penetrometer testing across the exposed surface. Any unsuitable material identified during the inspection should also be removed;
- Compact the exposed material to a dry density ratio in the range 98% to 102% relative to Standard compaction (cohesive soils) or at least 80% Density Index (cohesionless soils);

- Place subsequent layers of homogenous filling in near horizontal layers having a loose thickness not greater than 250 mm. Each layer should also be compacted to a dry density ratio in the range 98% to 102% relative to Standard compaction (cohesive soils) or at least 80% Density Index (cohesionless soils);
- Moisture contents should be in the range OMC -3% (dry) to OMC +1% (wet) where OMC is the optimum content at standard compaction;
- All earthworks operations should be subject to Level 1 inspection and testing as defined in Section 8.3 of AS3798 – 2007: Guidelines on Earthworks for Commercial and Residential Developments (Ref 3). Level 1 testing requires full-time attendance of a geotechnician during the placement of filling with the frequency of density testing also based on AS3798 (Ref 3).

Care should be taken to avoid overcompaction of clayey soils. Overcompaction can result in higher than expected shrink-swell movements.

As the proposed development includes construction of structures (retail and sales outlet, canopies) surrounded by internal pavements, it will not be feasible to delineate areas of the site for different preparation measures. Therefore, it is recommended that the above procedure is undertaken for all areas of the site.

It is reiterated that difficulties may be encountered during earthworks due to the presence of shallow groundwater within the central gully and it will be of paramount importance to implement effective drainage and dewatering measures prior to commencement of earthworks. The installation of temporary drainage trenches well in advance of construction would assist in this regard.

9.4 Excavation Conditions

Based on the results of the investigation, it is considered that excavation of the filling, topsoil, gravelly clayey silt, and residual clays (Units 1 to 3) would be generally achievable using conventional machinery such as a hydraulic excavator.

Contractors should be responsible for selection of excavation equipment based on the proposed excavation depths and equipment capabilities, together with the anticipated conditions.

9.5 Site Classification

Site classification of foundation soil reactivity provides an indication of the propensity of the ground surface to move with seasonal variation in moisture. The site classification is based on procedures presented in AS 2870-2011 (Ref 2), the typical soil profiles revealed in the bores, and the results of laboratory testing.

The results of shrink-swell testing returned I_{ss} values of 1.5% and 2.6% per ΔpF.

The site in its current condition would be Class P owing to the presence of existing filling which was not placed in accordance with the requirements for Level 1 inspection and testing regime as outlined in AS3798 (Ref 3) and the presence of weak soils in the broad gully. An indication of the characteristic surface movements for the natural soil profile can be obtained from the results of the laboratory testing, and characteristic surface movements, y_s, were estimated to range from approximately 30 mm to 40 mm under normal seasonal moisture fluctuations, primarily depending on the depth of bedrock across the site. The presence of trees may increase the seasonal movement by another 20 mm to 30 mm.

Articulation joints should be provided within masonry walls in accordance with TN61 (Ref 4) in order to reduce the effects of differential movement.

It should be noted that this classification is dependent on proper site maintenance, which should be carried out in accordance with CSIRO Sheet BTF 18 attached in Appendix A and Appendix B of AS 2870-2011 (Ref 2).

9.6 Foundations

Subsurface conditions within the bores in and around the proposed footprint of the retail building and canopy (Bores 1, 2, 4, 5 and 9) as follows:

- Stiff or stronger residual clay (Bores 4, 5, 8 and 9); and
- Soft to firm alluvial gravelly clayey silt (Bores 1, 2 and 4).

Based on the results of the bores, it appears that the subsurface profile in this area of the site includes soft to firm alluvial soils within the existing gully, possibly to depths exceeding 2.5 m and underlain by very stiff to hard clay. Beyond the gully, stiff to very stiff residual soils appear to be present within the upper 1 m of the soil profile.

The proposed structure should be founded within the very stiff or stronger residual clay soils or the underlying bedrock. Tungsten carbide (TC) auger refusal was encountered in the bores at depths ranging from 2.5 m to 3.95 m depths in Bores 1, 2, 4 and 5 respectively. Although coring of the bedrock has not been undertaken, TC auger refusal is likely to indicate bedrock of at least very low strength.

The recommended maximum allowable bearing pressures for the encountered soil types are presented in Table 6 below:

Table 6: Allowable Bearing Pressure

Founding Strata	Maximum Allowable Bearing Pressure (kPa)
Very stiff to hard clay	350
Very low strength rock or stronger	1000

Note to Table 6:

The values above are based on the piles being embedded at least 4 pile diameters into the design strata

Groundwater was encountered at shallow depth in several of the bores within the broad gully. No free groundwater was observed in the remainder of the bores during drilling. Groundwater seepage should be anticipated during drilling of the piles. Hence, provision should be made for dewatering of the pile excavation and the need for casting of concrete by tremmie techniques.

Bored piles should be poured immediately after excavation to reduce the risk of hole collapse or softening from rain events or groundwater. Care should be taken to ensure the base of the bored pile holes are cleaned and free of all loose debris and water at the time of placing concrete. Accordingly, pier hole inspections are recommended during construction to confirm the above design parameters.

9.7 Pavements

9.7.1 Subgrade Conditions

Based on the drawings provided by the client, and the topography at the site, it is likely that the broad gully will need to be filled during bulk earthworks. Drainage works will be required to redirect upslope stormwater through the site, which may require the provision of subsurface drainage or culverts.

Therefore, the subgrade conditions in the lower areas of the site will be dependent on the filling used during bulk earthworks.

In areas of the site which are near design finished surface level, such as the south-eastern and northern areas of the site, it is anticipated that the subgrade conditions will comprise the Unit 3 residual clay. Results of laboratory testing on the residual clay (Unit 3) soil returned four-day soaked CBRs of 6% and 7%, however it is noted that soils with a high silt content can soften appreciably with increases in moisture.

Therefore, a design CBR of 5% is suggested for the internal pavements based on the presence of the residual soils or re-use of the residual soils as engineering filling.

A select subgrade layer may be required depending on the condition of the subgrade at the time of construction. Similarly, the weaker soils within the broad gully (i.e. clayey silt) are anticipated to have a significantly lower soaked CBR, and if such materials are exposed at subgrade level, a select layer may be required.

9.7.2 Pavement Drainage

It is important that adequate drainage to maintain the subgrade soils as close to the optimum moisture content as possible and to ensure that the pavement layers do not become saturated.

9.8 Stormwater Infiltration

It is understood that consideration is being given to disposal of stormwater collected from the site into infiltration basins.

Based on the results of the in-situ permeameter testing, and the conditions encountered in the bores, the subsurface strata is estimated to have a low characteristic infiltration rate of less than 5 x 10^{-7} m/s. It is therefore considered that on-site disposal of stormwater is not suitable at this site.

It should be further noted that groundwater was measured at depths in the order of 0.3 m to 0.7 m depth in the bores drilled within the existing gully. Therefore, depending on the depth of excavation for any future infiltration basins, the effectiveness of the infiltration basins may be affected by groundwater levels. Further assessment of groundwater depths across the site is recommended, particularly in areas of possible infiltration basins and stormwater detention tanks.

9.9 Material Reuse for Engineered Filling

The details of the bulk earthworks are not known at this stage. Given the topography of the site, it is likely that filling will need to be imported to the site to raise the site to design levels. However, some excavation may be required in the higher areas of the site.

The material anticipated to be excavated during pavement subgrade preparation and possible minor site regrading includes predominantly Units 1 to 3 (filling, alluvial soil or the residual clay).

These soils and rock are considered geotechnically suitable for re-use as engineered fill provided that they are free of deleterious inclusions such as organics and can be produced in suitable particle sizes (generally with a maximum particle size of less than 100 mm and well-graded distribution). The re-use of soils with high silt content will require careful control of moisture content.

All proposed fill materials should be screened / sieved or particles broken down by excavation / handling / compaction methods, thus removing / crushing oversized particles greater than 100 mm prior to use as engineered filling.

The clay soils returned shrink-swell values of 1.5% and 2.6%, which is indicative of moderately reactive material and hence consideration should be given to the effect on final soil reactivity and subgrade behaviour should this material be re-used as filling.

10. Recommended Additional Geotechnical Investigation

Further investigation will be required prior to and during construction. Specific investigation would include (but not be limited to):

- Detailed geotechnical investigation once the final layout of the development has been established, including site regrading, to provide additional advice on footings, safe batter slopes, excavation conditions, pavement subgrade preparation measures and pavement thickness design;
- Additional investigation in the area of the central gully to delineate the extent and depth of the weak material;
- Additional investigation in the northern area of the site to assess the depth of existing filling, particularly around the existing water body and presence of weak soils;

- Further assessment of groundwater depths across the site is recommended, particularly in areas of possible infiltration basins, and
- Routine inspections and earthworks monitoring during construction.

11. References

1. Douglas Partners Pty Ltd, “Report on Preliminary Site Investigation for Contamination, 37 – 41 Bengal Street, Coolongolook”, Project 91401.00, dated November 2018.
2. Australian Standard AS 2870-2011, “Residential Slabs and Footings”, Standard Association of Australia.
3. Australian Standard AS 3798-2007: “Guidelines on Earthworks for Commercial and Residential Development”.
4. Cement Concrete & Aggregates Australia, Technical Note 61 “Articulated Walling”, August 2008.
5. Austroads AGPT02-12 “Guide to Pavement Technology, Part 2: Pavement Structural Design”, 2012.
6. Australian Standard AS 1289.5.2.1-2003, “Methods of testing soils for engineering purposes”, Standards Australia.
7. Australian Standard AS 1289.5.1.1-2003, “Methods of testing soils for engineering purposes”, Standards Australia.
8. Australian Standard AS1547:2012, "On-site Domestic Wastewater Management", Standards Australia.

12. Limitations

Douglas Partners (DP) has prepared this report for this project at 37 – 41 Bengal Street, Coolongolook in accordance with DP’s proposal NCL180321 dated 8 August 2018 and acceptance received from Galen Property Pty Ltd dated 6 September 2018. The work was carried out under DP’s Conditions of Engagement. This report is provided for the exclusive use of Galen Property Pty Ltd and Turnbull Planning International Pty Ltd 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.

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.

Asbestos has not been detected by observation or by laboratory analysis, either on the surface of the site, or in filling materials at the test locations sampled and analysed. Building demolition materials, such as concrete, brick, metal, were, however, visible on the surface at the site, and these are considered as indicative of the possible presence of hazardous building materials (HBM), including asbestos.

Although the sampling plan adopted for this investigation is considered appropriate to achieve the stated project objectives, there are necessarily parts of the site that have not been sampled and analysed. This is either due to undetected variations in ground conditions or to budget constraints (as discussed above), or to parts of the site being inaccessible and not available for inspection/sampling. It is therefore considered possible that HBM, including asbestos, may be present in unobserved or untested parts of the site, between and beyond sampling locations, and hence no warranty can be given that asbestos is not present.

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

Douglas Partners Pty Ltd

Appendix A

About This Report
Sampling Methods
Soil Descriptions
Symbols and Abbreviations

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

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.

Sampling Methods

Douglas Partners

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

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).

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

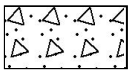
Symbols & Abbreviations

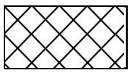
Graphic Symbols for Soil and Rock

General

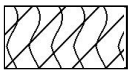

Asphalt

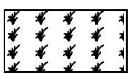

Road base

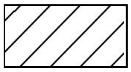

Concrete

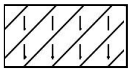

Filling

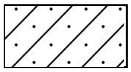
Soils


Topsoil

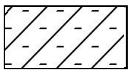

Peat

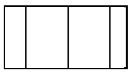

Clay

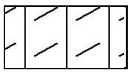

Silty clay

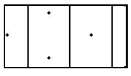

Sandy clay

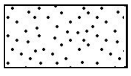

Gravelly clay

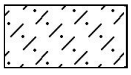

Shaly clay

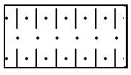

Silt


Clayey silt


Sandy silt

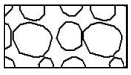

Sand

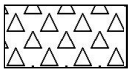

Clayey sand


Silty sand


Gravel

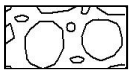

Sandy gravel


Cobbles, boulders

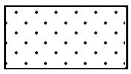

Talus

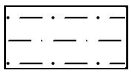
Sedimentary Rocks

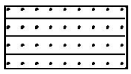

Boulder conglomerate

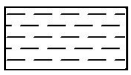

Conglomerate


Conglomeratic sandstone

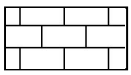

Sandstone


Siltstone

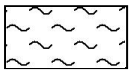

Laminite

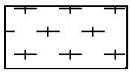

Mudstone, claystone, shale

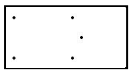

Coal


Limestone

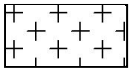
Metamorphic Rocks

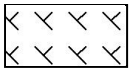

Slate, phyllite, schist

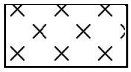

Gneiss

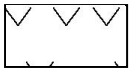

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Appendix B

Borehole Logs – Bores 1 to 10
Dynamic Penetrometer Test Results

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

SURFACE LEVEL: --
EASTING: 436137
NORTHING: 6435466
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 91401.00
DATE: 6/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.0	GRAVELLY CLAYEY SILT - Soft, dark brown gravelly clayey silt with some fine to medium grained sand (gravels predominantly 5mm - 30mm, rounded to subrounded, smooth), alluvium, (grass covered), M>Wp		D/E	0.1			▼	
				D/E	0.5				
	1				1.0				1
				S			1,1,2 N = 3		
					1.45				
	2								2
	2.3	GRAVELLY CLAY - Hard, light grey mottled brown gravelly clay with trace silt (10mm-20mm, rounded, smooth), M~Wp							
					2.5				
				S			14,22,17 N = 39		
	3				2.95				3
	3.0	Bore discontinued at 3.0m, TC bit refusal							
	4								4

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.3m

REMARKS: Bulk samples taken using a 300 mm solid flight auger

☐ 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_x	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
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

SURFACE LEVEL: --
EASTING: 436122
NORTHING: 6435439
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 91401.00
DATE: 6/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.25	TOPSOIL - Dark brown clayey silt topsoil, alluvium, M>Wp		D/E	0.1				
		SILTY CLAY - Dark brown with trace fine gravel (5mm - 15mm, smooth, rounded) alluvium, M>Wp		D/E	0.5			▼	
	0.8	CLAY - Firm to stiff, light grey mottled orange brown clay with trace silt, M>Wp							
1		From 1.0m - 1.1m, trace fine gravel (5mm - 20mm, rounded, smooth), M~Wp		S	1.0		pp = 170 2,2,4 N = 6		1
					1.45				
2				S	2.5		pp = 220 9,9,18 N = 27		2
					2.95				
3	3.0	SILTY CLAY - Hard, light grey silty clay with rock structure visible (weathered siltstone), M<Wp		S	3.5		pp >400 9,15,23 N = 38		3
4	3.95	Bore discontinued at 3.95m, TC bit refusal			3.95				4

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.7m

REMARKS: Bulk samples taken using a 300 mm solid flight auger

☐ 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_x	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
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

SURFACE LEVEL: --
EASTING: 436142
NORTHING: 6435416
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 91401.00
DATE: 7/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - Brown silty clay topsoil with trace fine rootlets, M~Wp		D/E	0.05				
		SILTY CLAY - Stiff, dark brown silty clay, M~Wp							
	0.4	CLAY - Stiff, light grey mottled brown clay with trace silt, M~Wp		D/E	0.5				
					0.51				
				B U50					
					0.8				
					0.9				
	1				1.0				
				S			pp = 250 2,5,6 N = 11		
					1.45				
		From 1.8m, becoming light grey							
	2								
	2.3	SILTY CLAY - Hard, light grey silty clay, M<Wp							
		From 2.5m, rock structure visible with trace very low strength weathered rock inclusions			2.5				
				S			pp >400 13,16,20/60 refusal		
	2.85	Bore discontinued at 2.85m, SPT refusal on weathered rock			2.85				
	3								
	4								

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Bulk samples taken using a 300 mm solid flight auger

☐ 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_x	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
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

SURFACE LEVEL: --
EASTING: 436104
NORTHING: 6435419
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 91401.00
DATE: 7/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
		CLAYEY SILT - Firm, dark brown clayey silt with trace gravel (5mm - 10mm, subrounded, smooth), alluvium, M>Wp		D/E	0.05				
				D/E	0.5				
					0.51				
				U50				▼	
	0.9				0.9				
1		GRAVELLY CLAYEY SILT - Firm, brown gravelly clayey silt (5mm - 20mm subrounded, smooth), alluvium, M>Wp		D/E	1.0				1
				S			pp = 150 3,4,3 N = 7		
					1.45				
2	2.0	SILTY CLAY - Very stiff, light grey mottled brown silty clay with some gravel (10mm - 30mm, rounded, smooth), M>Wp							2
					2.5				
				S			13,14,13 N = 27		
3					2.95				3
	3.1	Bore discontinued at 3.1m, TC bit refusal							
4									4

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.7m

REMARKS: Bulk samples taken using a 300 mm solid flight auger

☐ 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_x	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
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

SURFACE LEVEL: --
EASTING: 436115
NORTHING: 6435463
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 91401.00
DATE: 6/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.15	TOPSOIL - Brown silty clay with trace fine gravel and rootlets, M~Wp		D/E	0.1				
	0.5	CLAY - Stiff to very stiff, orange brown clay with trace silt and fine gravel (5mm - 10mm, rounded, smooth), M~Wp		D/E	0.5				
	1	CLAY - Stiff to very stiff, grey mottled red brown clay with some gravel (10mm - 30mm, subrounded, smooth), M~Wp		S	1.0 1.45		pp = 280-300 5,6,8 N = 14		
	2.5	METASILTSTONE - Medium to high strength, slightly weathered, grey metasiltstone		S	2.5 2.58		25/80,-,- refusal		
	2.7	Bore discontinued at 2.7m, TC bit refusal							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: Solid flight auger to 2.0m then wash bore to 2.7m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Bulk samples taken using a 300 mm solid flight auger

☐ 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_x	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
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

SURFACE LEVEL: --
EASTING: 436134
NORTHING: 6435505
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 91401.00
DATE: 7/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.2	FILLING (TOPSOIL) - Brown silty clay/clayey silt topsoil with trace fine rootlets, M<Wp		D/E	0.1				
	0.4	SILTY CLAY - Stiff, brown silty clay, M<Wp		D/E	0.5				
		CLAY - Stiff, light grey mottled brown clay with trace silt and gravel (20mm - 40mm, subangular, rough), M~Wp		B	0.8				
	1			D/E	1.0		pp = 250 5,20/80,- refusal		
				S	1.27				
		From 1.55m, some gravel		D	1.55				
	2 2.0	SILTY CLAY - Hard, light grey silty clay, rock structure visible, M<Wp		D	2.0				
	2.4	SILTSTONE - Low strength, moderately weathered, light grey and brown siltstone		S	2.5				
	2.55	Bore discontinued at 2.55m, TC bit refusal			2.53				
	3								
	4								

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Bulk samples taken using a 300 mm solid flight auger

☐ 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_x	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
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

SURFACE LEVEL: --
EASTING: 436137
NORTHING: 6435446
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 91401.00
DATE: 7/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.4	FILLING - Generally consisting of brown gravelly silty clay with trace cobbles (up to 300mm), M<Wp		D/E	0.01				
	0.8	CLAY - Very stiff, grey mottled brown clay with trace silt (possible filling), M~Wp		D/E	0.5 0.51 0.6				
	1	CLAY - Very stiff, grey mottled brown clay with trace silt and gravel (10mm - 30mm, rounded, smooth), M~Wp		U50 B	0.9				
				D/E	1.0				
				S			pp = 300 4,9,11 N = 20		
					1.45				
	2				2.5				
				S			pp = 180 7,8,11 N = 19		
	3				2.95				
	3.05	METASILTSTONE - Low to medium strength, highly weathered, grey metasiltstone		S	3.2		25/70,-,- refusal		
	3.27	Bore discontinued at 3.27m, TC bit refusal							
	4								

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Bulk samples taken using a 300 mm solid flight auger

☐ 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_x	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
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

SURFACE LEVEL: --
EASTING: 436141
NORTHING: 6435494
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 91401.00
DATE: 7/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - Brown silty clay with trace fine rootlets (possible filling), M<Wp		D/E	0.01		QA1		
	0.3	SILTY CLAY - Firm brown silty clay, M<Wp							
		CLAY - Stiff, orange brown clay with trace fine gravel (5mm - 10mm, subrounded, smooth), M~Wp		D/E	0.5		QA2		
					0.51				
				U50					
					0.8				
	0.9	CLAY - Very stiff, light grey mottled brown clay with trace silt and gravel (5mm - 15mm, subrounded, smooth), M~WP							
	1				1.0				1
				S			pp = 300 5,10,11 N = 21		
					1.45				
		From 1.8m, becoming light grey							
	2			D	2.0				2
	2.2	SILTY CLAY - Hard, light grey silty clay with rock structure visible, M<Wp							
		From 2.5m, trace low strength rock inclusions			2.5				
				S			pp >400 18,27,- refusal		
	2.8	Bore discontinued at 2.8m, limit of investigation			2.8				
	3								3
	4								4

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Bulk samples taken using a 300 mm solid flight auger

☐ 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_x	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
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

SURFACE LEVEL: --
EASTING: 436119
NORTHING: 6435422
DIP/AZIMUTH: 90°/--

BORE No: 9
PROJECT No: 91401.00
DATE: 7/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.1	TOPSOIL - Brown clayey silt with trace fine rootlets, M<Wp		D/E	0.05				
		CLAYEY SILT - Stiff, brown clayey silt, M<Wp							
	0.35	CLAY - Stiff, orange brown clay with trace silt, M>Wp			0.4				
				D/E	0.5				
				B	0.51				
				U50					
					0.8				
					0.9				
1	1.0	CLAY - Very stiff, light grey mottled red brown clay with trace silt, M~Wp		D/E	1.0				1
				S			pp = 280 5,8,13 N = 21		
					1.45				
		From 1.5m, trace gravel (10mm - 20mm, subrounded, smooth)							
2	2.0	SILTY CLAY - Very stiff, light grey silty clay with trace gravel (10mm - 20mm, subrounded, smooth), M~Wp							2
					2.5				
				S			pp = 350 9,13,14 N = 27		
3					2.95				3
	3.3	SILTSTONE - Very low strength, highly weathered light grey siltstone							
4					4.0				4
				S			25,20/30,- refusal		
	4.18	Bore discontinued at 4.18m, limit of investigation			4.18				

RIG: DT100 **DRILLER:** Hennessey **LOGGED:** Hickman **CASING:**

TYPE OF BORING: Solid flight auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Bulk samples taken using a 300 mm solid flight auger

☐ 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_x	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
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Turnbull Planning International Pty Ltd
PROJECT: Proposed Service Centre
LOCATION: 37-41 Bengal Street, Coolongolook

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

BORE No: 10
PROJECT No: 91401.00
DATE: 23/11/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
	0.15	TOPSOIL - Dark brown clayey silt with trace fine gravel and rootlets (grass covered), M<Wp		D	0.1				
		SILTY CLAY - Light brown silty clay with trace fine gravel, M<Wp		D	0.3				
	0.5	CLAY - Light brown clay with trace fine gravel, M<Wp		D	0.6				
		From 0.8m, some ironstained gravel (10mm - 30mm subrounded, rough), M~Wp		D	0.8				
	1	From 1.2m, becoming light grey and brown		D	1.2				
	1.6	Bore discontinued at 1.6m, refusal on gravel		D	1.6				

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: Hand Tools **DRILLER:** Hickman **LOGGED:** Hickman **CASING:**
TYPE OF BORING: 70 mm diameter hand auger
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

☐ 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_x	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
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
Unit 2, 32 Geebung Drive
Port Macquarie NSW 2444
PO Box 5463
Port Macquarie NSW 2444
Phone (02) 6581 5992
Fax (02) 6581 5669

Results of Dynamic Penetrometer Tests

Client Turnbull Planning International Pty Ltd

Project Proposed Service Centre

Location 37-41 Bengal Street, Coolongolook

Project No. 91401.00

Date 06/11/18

Page No. 1 of 1

Test Location	1	2	3	4	5	6	7	8	9	
RL of Test (AHD)										
Depth (m)	**Penetration Resistance** Blows/150 mm									
0 - 0.15	1	2	4	2	4	2	3	2	4	
0.15 - 0.30	4	3	3	2	8	4	9	3	3	
0.30 - 0.45	2	3	2	1	10	6	9	5	4	
0.45 - 0.60	2	1	5	3	14	6	7	6	4	
0.60 - 0.75	1	2	7	4	19	8	7	8	6	
0.75 - 0.90	3	1	7	5		8	8	8	5	
0.90 - 1.05	2	2	7	5		9	7	9	9	
1.05 - 1.20										
1.20 - 1.35										
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										
3.00 - 3.15										
3.15 - 3.30										
3.30 - 3.45										
3.45 - 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑

AS 1289.6.3.3, Sand Penetrometer ☐

Tested By MVH

Checked By

Remarks Ref = Refusal, 24/110 indicates 25 blows for 110 mm penetration

Appendix C

Results of Laboratory Testing

Material Test Report

Report Number: **91401.00-1**
Issue Number: 1
Date Issued: 27/11/2018
Client: Turnbull Planning International Pty Ltd
Suite 2301, Quattro Bldg 2, Level 3, 4 Daydream St, Warriewood NSW 2102
Contact: Sophie Litherland
Project Number: 91401.00
Project Name: Proposed Service Centre
Project Location: 37 - 41 Bengal Street, Coolongolook
Work Request: 7346
Sample Number: 18-7346A
Date Sampled: 07/11/2018
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **Bore 3 (0.5-0.8)**
Material: Clay

Douglas CMG
Geotechnics / Environment / Groundwater
Chandler Morrison Geotechnical Pty Ltd
Trading as Douglas CMG
Port Macquarie Laboratory
Unit 2, 32 Geebung Drive Port Macquarie NSW 2444
Phone: (02) 6581 5992
Fax: (02) 6581 5669
Email: adam.albury@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Adam Albury
Branch Manager

NATA Accredited Laboratory Number: 17255

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	RMS T111 & T120		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.53		
Optimum Moisture Content (%)	26.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	101.0		
Dry Density after Soaking (t/m^3)	1.51		
Field Moisture Content (%)	28.9		
Moisture Content at Placement (%)	26.3		
Moisture Content Top 30mm (%)	30.0		
Moisture Content Rest of Sample (%)	27.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours			
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Material Test Report

Report Number: **91401.00-1**
Issue Number: 1
Date Issued: 27/11/2018
Client: Turnbull Planning International Pty Ltd
Suite 2301, Quattro Bldg 2, Level 3, 4 Daydream St, Warriewood NSW 2102
Contact: Sophie Litherland
Project Number: 91401.00
Project Name: Proposed Service Centre
Project Location: 37 - 41 Bengal Street, Coolongolook
Work Request: 7346
Sample Number: 18-7346B
Date Sampled: 07/11/2018
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **Bore 6 (0.5-0.8)**
Material: Clay

Douglas CMG
Geotechnics / Environment / Groundwater
Chandler Morrison Geotechnical Pty Ltd
Trading as Douglas CMG
Port Macquarie Laboratory
Unit 2, 32 Geebung Drive Port Macquarie NSW 2444
Phone: (02) 6581 5992
Fax: (02) 6581 5669
Email: adam.albury@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Adam Albury
Branch Manager
NATA Accredited Laboratory Number: 17255

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**6**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	RMS T111 & T120		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.67		
Optimum Moisture Content (%)	20.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	101.5		
Dry Density after Soaking (t/m^3)	1.65		
Field Moisture Content (%)	22.1		
Moisture Content at Placement (%)	20.6		
Moisture Content Top 30mm (%)	23.2		
Moisture Content Rest of Sample (%)	21.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours			
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		

Material Test Report

Report Number:	**91401.00-1**
Issue Number:	1
Date Issued:	27/11/2018
Client:	Turnbull Planning International Pty Ltd Suite 2301, Quattro Bldg 2, Level 3, 4 Daydream St, Warriewood NSW 2102
Contact:	Sophie Litherland
Project Number:	91401.00
Project Name:	Proposed Service Centre
Project Location:	37 - 41 Bengal Street, Coolongolook
Work Request:	7346
Sample Number:	18-7346C
Date Sampled:	07/11/2018
Sampling Method:	AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location:	**Bore 8 (0.5-0.8)**
Material:	Clay

Douglas CMG
Geotechnics / Environment / Groundwater
Chandler Morrison Geotechnical Pty Ltd
Trading as Douglas CMG
Port Macquarie Laboratory
Unit 2, 32 Geebung Drive Port Macquarie NSW 2444
Phone: (02) 6581 5992
Fax: (02) 6581 5669
Email: adam.albury@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

Approved Signatory: Adam Albury
Branch Manager

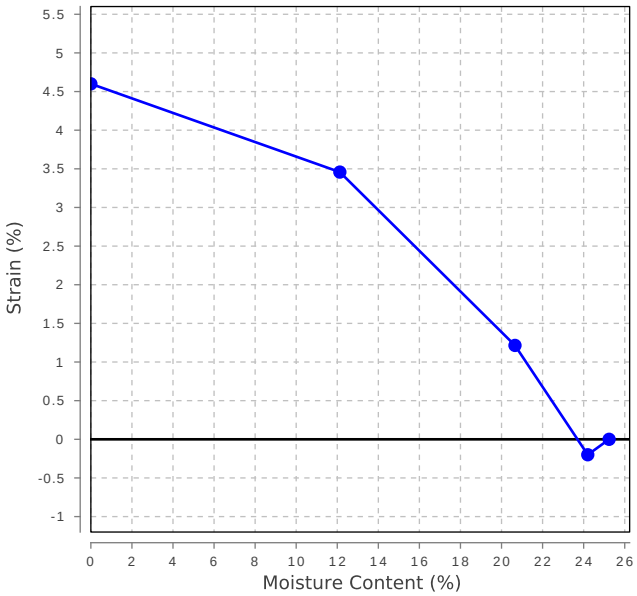
NATA Accredited Laboratory Number: 17255

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.6**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**4.6**
Estimated % by volume of significant inert inclusions	
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	25.2

Swell Test	
Initial Pocket Penetrometer (kPa)	340
Final Pocket Penetrometer (kPa)	290
Initial Moisture Content (%)	21.7
Final Moisture Content (%)	24.2
Swell (%)	**0.2**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	

Shrink Swell



Material Test Report

Report Number: **91401.00-1**
Issue Number: 1
Date Issued: 27/11/2018
Client: Turnbull Planning International Pty Ltd
Suite 2301, Quattro Bldg 2, Level 3, 4 Daydream St, Warriewood NSW 2102
Contact: Sophie Litherland
Project Number: 91401.00
Project Name: Proposed Service Centre
Project Location: 37 - 41 Bengal Street, Coolongolook
Work Request: 7346
Sample Number: 18-7346D
Date Sampled: 07/11/2018
Sampling Method: AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location: **Bore 9 (0.5-0.9)**
Material: Clay

Douglas CMG
Geotechnics / Environment / Groundwater
Chandler Morrison Geotechnical Pty Ltd
Trading as Douglas CMG
Port Macquarie Laboratory
Unit 2, 32 Geebung Drive Port Macquarie NSW 2444
Phone: (02) 6581 5992
Fax: (02) 6581 5669
Email: adam.albury@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA WORLD RECOGNISED ACCREDITATION

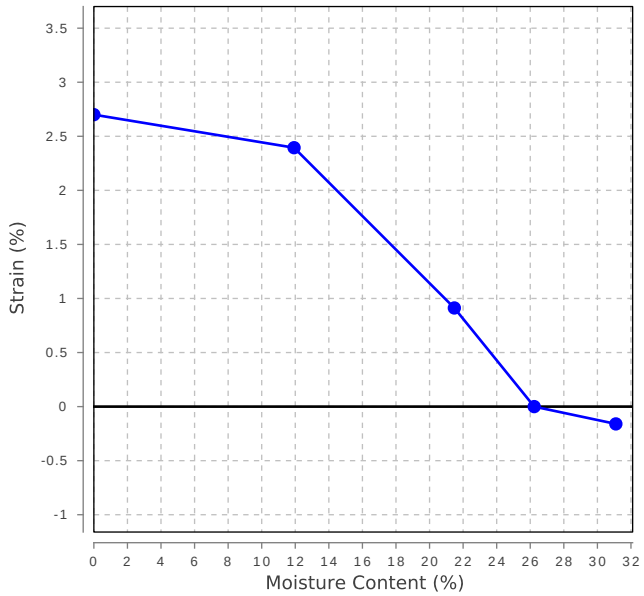
Approved Signatory: Adam Albury
Branch Manager
NATA Accredited Laboratory Number: 17255

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**1.5**
Visual Description	Clay
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**2.7**
Estimated % by volume of significant inert inclusions	
Cracking	Moderately Cracked
Crumbling	No
Moisture Content (%)	26.2

Swell Test	
Initial Pocket Penetrometer (kPa)	270
Final Pocket Penetrometer (kPa)	230
Initial Moisture Content (%)	26.0
Final Moisture Content (%)	31.1
Swell (%)	**0.2**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	

Shrink Swell



Material Test Report

Report Number:	**91401.00-1**
Issue Number:	1
Date Issued:	27/11/2018
Client:	Turnbull Planning International Pty Ltd Suite 2301, Quattro Bldg 2, Level 3, 4 Daydream St, Warriewood NSW 2102
Contact:	Sophie Litherland
Project Number:	91401.00
Project Name:	Proposed Service Centre
Project Location:	37 - 41 Bengal Street, Coolongolook
Work Request:	7346
Sample Number:	18-7346E
Date Sampled:	07/11/2018
Sampling Method:	AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location:	**Bore 1 (1.0-1.45)**
Material:	Gravelly Clayey Silt

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	35		
Plastic Limit (%)	20		
Plasticity Index (%)	**15**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	5.0		
Cracking Crumbling Curling	Cracking		

Douglas CMG
Geotechnics / Environment / Groundwater
Chandler Morrison Geotechnical Pty Ltd
Trading as Douglas CMG
Port Macquarie Laboratory
Unit 2, 32 Geebung Drive Port Macquarie NSW 2444
Phone: (02) 6581 5992
Fax: (02) 6581 5669
Email: adam.albury@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Adam Albury
Branch Manager

NATA Accredited Laboratory Number: 17255

Material Test Report

Report Number:	**91401.00-1**
Issue Number:	1
Date Issued:	27/11/2018
Client:	Turnbull Planning International Pty Ltd
	Suite 2301, Quattro Bldg 2, Level 3, 4 Daydream St, Warriewood NSW 2102
Contact:	Sophie Litherland
Project Number:	91401.00
Project Name:	Proposed Service Centre
Project Location:	37 - 41 Bengal Street, Coolongolook
Work Request:	7346
Sample Number:	18-7346F
Date Sampled:	07/11/2018
Sampling Method:	AS1289 1.2.1 6.5.3 - Power auger drilling
Sample Location:	**Bore 4 (0.5-0.9)**
Material:	Gravelly Clayey Silt

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	31		
Plastic Limit (%)	18		
Plasticity Index (%)	**13**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	4.0		
Cracking Crumbling Curling	None		

Douglas CMG
Geotechnics / Environment / Groundwater
Chandler Morrison Geotechnical Pty Ltd
Trading as Douglas CMG
Port Macquarie Laboratory
Unit 2, 32 Geebung Drive Port Macquarie NSW 2444
Phone: (02) 6581 5992
Fax: (02) 6581 5669
Email: adam.albury@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Adam Albury
Branch Manager

NATA Accredited Laboratory Number: 17255

Appendix D

Drawing 1 – Test Location Plan

Locality Plan

Legend

- Approximate Bore Location
- Approximate extent of gully and water body
- Identified Areas of Environmental Concern
- Location and Orientation of figures in report

Drawing adapted from plan by client and NearMap image

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT:	Galen Property Pty Ltd		
OFFICE:	Newcastle	DRAWN BY:	MPG
SCALE:	1:750 @ A3	DATE:	28.11.2018

TITLE: **Test Location Plan**
Proposed Service Centre
37 - 41 Bengal Street, Coolongolook

PROJECT No:	91401.00
DRAWING No:	1
REVISION:	0