Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Yeronga Priority Development Area
Park Road, Yeronga

Prepared for
Economic Development Queensland

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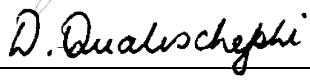
Reviewer		7 February 2022

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Table of Contents

Report on Geotechnical Investigation
Yeronga Priority Development Area
Park Road, Yeronga

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a Yeronga at Park Road, Yeronga. The investigation was commissioned in an email dated 1 March 2021 by Mr John Marshall of Economic Development Queensland, and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal BNE200443 dated 25 February 2020 and proposal BNE200443.01 dated 6 October 2021.

It is understood that the proposed development includes residential, commercial and community buildings, roads and associated services. It is further understood that the scope of this investigation includes:

- trench alignments, both within the development and on adjacent roads;
- bulk earthworks across the allotments;
- community centre building (Lot 11), single storey with undercroft; and
- commercial centre building (Lot 1), six storeys with two basement levels.

The aim of the investigation was to assess the subsurface soil and groundwater conditions across the site to provide comments on:

- subsurface conditions including groundwater;
- site classification in accordance with AS2870-2011;
- excavation conditions;
- suitable temporary and permanent batter slopes;
- suitable foundation types (high level, raft or piles), bearing pressures and estimated settlements;
- site preparation and earthworks, including compaction and reuse of excavated materials;
- trenching and trenchless construction methods for in-ground services;
- lateral bearing pressure and thrust block design parameters;
- suitable basement retention options and basement type;
- suitable geotechnical retaining/basement wall design parameters;
- slab-on-ground subgrade design parameters (California bearing ratio (CBR) and modulus of subgrade reaction) for pavement design by others;
- site sub-soil class in accordance with AS1170.4-2007; and
- dispersion potential of near surface soils.

The investigation included the drilling of twenty-four boreholes, followed by laboratory testing, engineering analysis and reporting. The details of the field work and laboratory testing are presented in this report, together with comments and recommendations on the items listed above.

This report must be read in conjunction with the notes entitled 'About This Report' in Appendix A and other explanatory notes, and should be kept in its entirety without separation of individual pages or sections.

2. Site Description

The site is located on the eastern side of Park Road, Yeronga (refer to Drawing 1 in Appendix B), and is bounded by Park Road to the west, Villa Street to the south, the Ferny Grove and Beenleigh railway lines to the north and Yeronga State High School to the east. At the time of the investigation, the site was vacant with all previous buildings/developments having been demolished.

The ground surface at the site was sparsely covered by poorly-maintained grass with the remaining areas exposed fill subgrade and small to large sized trees were observed scattered along the northern, western and eastern boundaries. Furthermore, localised rock outcrops were also observed in various areas of the site. The topography within the majority of the site was relatively flat, however, generally sloped gently down from the southern and south-western boundary towards the north, north-eastern boundary. With reference to recorded bore levels and Brisbane City Council Interactive Mapping, the site levels are approximately RL 20 mAHD near the southern boundary, and approximately between RL10 mAHD and RL7 mAHD near the northern boundary of the site. Photographs of the site are indicated in Figures 1 to 3.

Figure 1: Looking east towards the rig set up on Bore 2.

Figure 2: Looking north-west towards the rig set up on Bore 2.

Figure 3: Looking west towards the rig set up on Bore 24.

3. Regional Geology

The Geological Survey of Queensland's 1:100,000 digital geological series 'South East Queensland' map, indicates that the site is underlain by three geological formations. Majority of the site is underlain by Triassic aged Arenite Rudite of the Aspley formation, typically comprising "Sandstone, conglomerate, minor shale." Two localised areas along the northern boundary are underlain by Quaternary aged Alluvium, typically comprising "Clay, silt, sand, gravel; flood plain alluvium" and by Holocene aged Anthropogenic deposits, typically comprising "land fill, mine tailings and rubble".

The subsurface conditions encountered during the field work comprised localised fill overlying residual soils then weathered sandstone to their termination depth. The residual soil is generally consistent with the weathering of sandstone from the Aspley Formation.

4. Field Work Methods

The field work was undertaken on 10 and 11 March 2021, 24 November 2021 and 13 December 2021 and comprised the drilling of 24 boreholes (designated Bores 1 to 8,10,12 to 26) to between 0.60 m and 10.05 m depth, at accessible locations across the site (refer Drawing1 in Appendix B).

Boreholes 1 to 6 were drilled using a truck mounted drilling rig (Scout 3) and Boreholes 23 and 24 were drilled using a track rig (Hanjin 8D) and were commenced using 110 mm diameter solid flight augers and continued using rotary washbore techniques, whilst Boreholes 23 and 24 were further advanced using NMLC rock coring techniques. The remaining boreholes were drilled using a utility mounted drilling rig with 110 mm diameter solid flight augers. Standard penetration tests (SPTs), 'undisturbed' (U_{50}) tube samples, and disturbed samples were undertaken at regular depth intervals within the bores for visual identification and laboratory testing. Dynamic cone penetrometer (DCP) testing was carried out adjacent to Boreholes 1 to 20 and 25 and 26 only to a maximum of 1 m depth (or prior refusal) with reference to test method AS 1289.6.3.2 (1997). The purpose of the DCP is to provide additional information on the strength consistency and relative density of the subsurface profile.

On completion of sampling and after checking for groundwater, the boreholes were backfilled with drilling spoil.

The test locations were set out by a geotechnical engineer and the UTM coordinates and ground surface levels at the test locations were recorded using a differential GPS accurate to approximately up to 5 m and are presented on Drawing 1 in Appendix B. Bores 1 to 6 were completed by an experienced engineer who logged the bores, collected samples for laboratory testing. The remaining bores were then completed by a geotechnician who prepared field logs of the subsurface conditions, collected samples for visual and tactile assessment, and laboratory testing. Upon receipt of the samples at DP's laboratory, the samples and field logs were checked by a geotechnical engineer.

5. Field Work Results

The subsurface conditions encountered in the bores are described in detail on the borehole logs in Appendix C. Notes defining the classification methods and descriptive terms used in their preparation are given in Appendix A.

In summary, the subsurface conditions encountered generally comprised **fill** overlying **residual soil** then **weathered sandstone / siltstone** to the limit of the investigation. The subsurface conditions are further described below:

- **Fill:** generally medium dense to dense granular fill was encountered in Bores 5 to 7, 10, 12 to 15, 19 and 21 from surface to between 0.1 m and 1.2 m depth. Generally stiff to hard clayey fill with some localised firm zones was encountered in all bores except Bores 8, 13, 14, 21, 23 to 26 from surface and beneath the granular fill and continued between 0.2 m and 2.7 m depth. The fill had some localised brick rubble, cobbles and boulders in Bores 4, 6, 15 to18, 21 and 22 from surface up to 2.4 m depth. It should be noted that fill was not encountered in Bore 8 only.

  In the absence of documentation to confirm the fill was placed and compacted in a controlled manner under engineering supervision and testing, it should be considered as 'uncontrolled'.

- **Residual Soil:** was encountered from the surface in Bore 8 and beneath the fill in Bores 1 to 5, and 19 to 26 down to 0.3 m and 6.8 m depth. The residual soils were also encountered in Bores 6, 10, 12 to 17 and 22 down between 1 m and 4 m depth where these boreholes were terminated. The residual soils were generally stiff to very stiff locally grading to hard with depth with some localised firm zones in Bores 5, 6 and 12, grey mottled orange and red and orange and yellow-brown and dark grey, low to high plasticity, residual gravelly sandy / sandy / silty / clay with some localised relict rock structure bands and fine to coarse sands and gravel. A localised layer of loose to medium dense, fine to medium grained, residual silty / clayey sand was encountered in Bores 5, 6 and 12 between 1.3 m and 2 m depth.

- **Sandstone / Siltstone:** very low strength, highly weathered, pale grey and orange-brown and red-brown and yellow-brown, sandstone was encountered locally in Bores 1 to 5, 7 and 8, 18 to 21, 23, 24 and 26 beneath the fill and residual soil and continued to the borehole termination depths of between 0.6 m and 10.05 m. The sandstone locally graded to medium strength, moderately weathered, highly to slightly fractured below 7 m in Bore 23 and below 5.5 m in Bore 24. A localised layer of very low strength, highly weathered, highly fractured siltstone was also encountered interbedded in weathered sandstone in Bore 24 between 6.12 m and 7.05 m depth and beneath the residual soils in Bore 25 and continued to bore termination depth of 2.4 m. Bores 7, 8, 18 to 21. 25 and 26 were terminated on auger refusal which is indicative of possible very low to medium strength (or stronger) rock.

Free groundwater seepage was not encountered during the auger drilling of the bores, however, was measured at 2.96 m depth in Bore 1 on the 6 April 2021 after the standpipe was purged on the 11 March 2021. Standpipes installed in Bores 12 and 22 were measured at 1.53 m and 0.46 m depth respectively on the 6 April 2021. It should be noted that the standpipes were measured after some recent heavy rainfall. It should be noted, however, that groundwater depths are affected by climatic conditions and soil permeability and will therefore vary with time.

6. Laboratory Testing

Successful collection of "undisturbed" samples intended for two shrink-swell tests was not possible due to the types and strengths of the materials encountered. Consequently, an Atterberg limits and linear shrinkage test was adopted for the laboratory testing.

Geotechnical laboratory testing comprised:

- two Atterberg limits, linear shrinkage and natural moisture content tests;
- two shrink-swell tests;
- ten Emerson class tests; and
- four dispersiveness suite which included pH, electrical conductivity (EC), cation-exchange capacity (CEC) exchangeable sodium percentage (ESP) (soil sodicity) and calcium (Ca) to exchangeable magnesium (Mg) ratio.

The laboratory test results are summarised in Tables 1 to 3, and detailed test report sheets are given in Appendix D.

Table 1: Results of Moisture Content, Linear Shrinkage & Plasticity Tests

Bore	Depth (m)	Material	M (%)	W_L (%)	W_P (%)	PI (%)	LS (%)
3	1.00 – 1.45	Silty Clay	14.7	39	23	16	9.0
13	0.70	Silty Clay	21.2	62	22	40	14.0

Legend: M – moisture content; W_L – liquid limit; W_P – plastic limit; PI – plasticity index; LS – linear shrinkage;

Table 2: Results of Shrink-Swell Index (I_{ss}) Testing

Bore	Depth (m)	Material	Shrinkage (%)	Swell (%)	I_{ss} (% per ΔpF)
14	0.50 – 0.80	Clay	4.7	0.5	2.8
17	1.20 – 1.70	Silty Clay	2.6	-0.0	1.4

Table 3: Summary of Laboratory Test Results – Dispersiveness Assessment

Bore	Depth (m)	Material	Emerson Class No.	pH	EC (µS/cm)	CEC (meq/100)	ESP (%)	Ca:Mg Ratio
2	0.50	Gravelly Sandy Clay Fill	1	Not Applicable				
7	0.50 – 0.95	Sandy Gravel Fill	1					
14	0.50 – 0.80	Clay	6					
16	0.50 – 0.95	Gravelly Clay Fill	3					
19	0.50	Sandy Clay Fill	3					
21	0.50 – 0.95	Silty Clay	6					
23	0.50	Silty Clay	2	3.9	272	6.4	46.7	<0.2
24	0.50	Silty Clay	3	3.7	701	3.2	42.4	<0.2
25	0.50	Sandy Clay Fill	6	6.1	698	16.3	20.5	2.6
26	0.50	Clay	2	3.8	158	6.7	33.1	0.8
Note:		Non-sodic and/or low potential for erosion		Marginally sodic to sodic and/or medium potential for erosion		Strongly sodic and/or high potential for erosion		Very high potential for erosion and dispersion

Note: Potential for erosion is detailed in Brisbane City Council's Erosion Hazard Assessment Technical Notes (2006)

7. Dispersive/Erosion Assessment Criteria

Assessment of the dispersive/erosive nature of the soils is based on the following references and tables.

Soil sodicity ratings from Amec Foster Wheeler (2014) – Section 3 are presented in Table 4.

Table 4: Sodicity and Exchangeable Sodium Percentage (ESP)

ESP (%)	Sodicity Rating
0 - 6	Non-sodic
6 - 15	Marginally sodic to sodic
> 15	Strongly sodic

Interpretation of Emerson Class test results based on BCC (2006) are presented in Table 5.

Table 5: Emerson Class Interpretation from BCC

Emerson Class	Erosion Potential
1 or 2	Very high potential for erosion
3	High potential for erosion
4	Medium potential for erosion
5	
6	
7 or 8	Low potential for erosion by dispersion process

The Ca:Mg ratio rating from Amec Foster Wheeler (2014) – Section 3 are presented in Table 6.

Table 6: Ca:Mg Ratio

Ca:Mg Ratio	Ratio Rating
<0.1	Very low
0.1 - 1	Low
1 - 2	Medium
>2	High

Calcium (Ca) to exchangeable magnesium (Mg) ratios of less than 0.1 (i.e. very low ratio rating) are often associated with highly dispersive soils.

Review of Best Practice Erosion and Sediment Control by International Erosion Control Association (IECA 2008) found that soils with an electrical conductivity (EC) greater than 0.5 mS/cm (500 µS/cm) are considered saline and may have a reduced risk of dispersion.

8. Proposed Development

It is understood that the proposed development includes residential, commercial community buildings, roads and associated services. It is further understood that the scope of this investigation includes:

- trench alignments, both within the development and on adjacent roads;
- bulk earthworks across the allotments;
- community centre building (Lot 11), single storey with undercroft; and
- commercial centre building (Lot 1), six storeys with two basement levels.

The nature of building construction was not known at the time of reporting, however, it is envisaged that the buildings will probably be of reinforced masonry block and / or concrete construction with a slab on ground and steel roof probably supported on either a raft slab or high level footings. Basement retention will probably be supported by piled walls.

Structural working loads and bulk earthworks levels were not provided prior to the preparation of this report, however, based of the client drawings, it is anticipated that column working loads of up to 5,000 kN and approximately up to 7 m depth of excavation would be required for the development.

9. Appreciation of Ground Conditions

The subsurface conditions encountered during the field work generally comprised fill up to 2.7 m depth, underlain generally by stiff to very stiff grading to hard (with some localised firm zones) residual gravelly sandy / sandy / silty clays to borehole termination depths of 1 m and 6.8 m with a localised layer of loose grading to medium dense residual silty / clayey sand between 1.3 m and 2 m depth. The fill and residual soils were locally underlain by very low grading to medium strength, highly weathered grading to moderately weathered sandstone / siltstone to borehole termination depths of between 0.6 m and the 10.05 m. Groundwater seepage was not encountered during the augering of the bores.

Historically imagery from QImagery mapping services indicate the site was natural bushland until early 1967 where the site was stripped for proposed TAFE development. The fill encountered in the bores suggests that the site was filled to construct a levelled building pad which may have potentially been won during the stripping and bulk excavation works for the proposed development.

The stiff (or stronger) residual clayey soils and weathered sandstone / siltstone encountered at shallow depths would generally be suitable for lightly loaded, settlement tolerant structures founded on high level footings, otherwise the alternative is by supporting the structure on pile foundations. It is also recommended that all structures be founded into similar strength strata to reduce the potential for differential settlement.

The ‘uncontrolled’ fill and loose / firm natural soils encountered in Bores 6 and 12 and 23 to 26 is assessed as unsuitable to support the structural loads for the development due to potentially large total and differential settlements which can damage movement sensitive structures. High level spread footings founding in controlled fill may only be suitable if the existing ‘uncontrolled’ fill is removed, screened, and replaced under controlled conditions.

Transferring the building loads below the fill and loose sandy / firm clayey soils via deep footings which are founded in the stiff (or stronger) residual clayey soils or via piles founded into the weathered sandstone / siltstone is probably a more economical solution.

Due to the subsurface conditions encountered and the need to excavate relatively close to the western and southern boundaries of the site and within the site, there will be implications for the design and construction of the basement, structure and installation of the underground pipelines, as follows:

- excavatability;
- stability of adjoining buildings, footpaths, roadways and in-ground services during construction;
- stability of excavated faces during construction; and
- potential groundwater seepage (if any) at basement and trench level.

It would be prudent to commission a dilapidation survey of nearby structures and in-ground services prior to construction.

Further comments on design and construction practice are given in the following sections of this report.

10. Comments

10.1 Groundwater Control

Groundwater was not encountered during the auger drilling of the bores, however, was measured at 2.96 m depth in the standpipe in Bore 1, 1.53 m depth in Bore 12 and 0.46 m depth in Bore 22. Given the ground conditions encountered which mainly comprise residual clays and weathered sandstone / siltstone, and proposed basement excavation depth of up to 7 m and some anticipated seepage inflow into the excavation, it is recommended that an allowance for sumps and pumping methods should be used during construction with localised temporary lowering of the groundwater table.

A ‘drained’ basement should generally be suitable and would require full height drainage to be installed behind all basement walls and beneath the basement floor slabs. All drainage would then need to be connected to sumps with pumps to remove water as required. The design of extraction pumps would require a detailed groundwater investigation to determine inflow rates. DP can assist with such an investigation. The alternate to a drained basement is a ‘tanked’ basement which requires design for full hydrostatic uplift and lateral pressures.

10.2 Basement Design and Construction

10.2.1 General

Excavations of up to 7 m depth will generally be required to achieve the basement excavation level (BEL) in the south-western corner of the site for the proposed commercial building. Partial and / or full height benching and/or battering of the excavation face may be possible on the north and eastern boundaries where there is space, and the risk of collapse can be accepted and where the cut batter excavations are limited to maximum of 3 m vertical height. If a temporary cut batter is being considered for the 7 m deep cut, then specific stability assessment should be undertaken. Where the line of the

excavation extends close to the site boundaries such as the southern and western boundary, ground retention will be required. The extent of retention will depend upon the depth of excavation which is anticipated to decrease towards the north in line with falling ground levels.

The close proximity of the basement walls on the southern and western site boundary effectively negates the option of battering to maintain short term stability of excavation faces. Battering or benching may be possible for internal central excavations at the basement level, such as for spread footings, service trenches and lift pit overruns etc.

The excavation faces will require the use of a stiff retention system, such as cantilevered and/or anchored or propped pile wall, to minimise lateral and vertical ground movements behind the basement walls.

10.2.2 Excavatability

Based on the conditions encountered in the bores, the material cut from excavations to approximately 7m depth will generally comprise topsoil, fill, residual clays / sands and weathered sandstone / siltstone. Excavations in the soils and very low strength sandstone / siltstone should be achievable using conventional medium sized earthmoving plant (i.e. 30 tonne hydraulic excavator or larger) with rock teeth fitted buckets assisted with a ripping tyne. Confined excavations and excavation in very low to low strength (or stronger) sandstone / siltstone will require the use of a ripping tyne and a rock breaker. Any concrete if encountered would require the use of a rock breaker.

It should be recognised that the excavatability estimates are based on materials encountered at the test locations only and that conditions may prove more difficult (or easier) for excavatability beyond these test locations.

10.2.3 Temporary Slope Batters

For excavations up to 7 m in depth, full or partial height battering and / or benching of excavation faces may only be suitable provided they are excavated to a maximum of 3 m high stages with a minimum 3 m wide bench between each stage and a specific stability assessment is undertaken. This would only be suitable along the northern and eastern boundary where there is adequate space available during construction, and the potential risk of any collapse can be accepted.

Unsurcharged batter slopes cut up to 3 m vertical height into the ‘uncontrolled’ fill, residual soils and weathered sandstone / siltstone encountered during the field work may be preliminarily designed for temporary conditions as presented in Table 7.

Table 7: Cut Batter Slopes (up to 3 m in height)

Material	Safe Batter Slope (H:V)
	Short Term
Existing ‘uncontrolled’ fill and /or loose to medium dense residual sands	2:1
Stiff residual clays	1.5:1
Very stiff (or stronger) residual clays	1:1
Very low strength (or stronger) sandstone / siltstone	0.75:1[(1)]

Notes:
(1) Subject to geotechnical inspection during construction to confirm the absence of adverse joints.

The above temporary batter slopes are suggested with respect to slope stability only and do not allow for lateral stress relaxation which may result in movement of nearby in-ground services or shallow footings. If such services or footings are settlement-sensitive and are located such that a linear spread at 1H:1V outwards, down and away from the base of the service or footing, intersects the cut face, then the excavation may have to be positively supported.

10.2.4 'Hit and Miss' Panel Construction

For lower height cut slopes up to 2.5m the use of a 'hit and miss' panel sequence could be considered for excavations along parts of the eastern and northern boundaries, with an 'a,b,c, a,b,c' sequence adopted with panel widths of 3 m to 3.5 m. Panel widths might be able to be increased where ground conditions are favourable and the risks associated with a slump can be accepted and controlled. It is recommended that this methodology be limited to slopes of maximum height of 2.5 m vertical comprising stiff (or stronger) residual clays and weathered sandstone / siltstone.

A typical construction sequence would involve excavating the 'hit' panels (ie. 'a') whilst leaving the next two 'miss' panels (ie. 'b,c') temporarily battered. Installation and backfilling of the concrete tilt panels or cast insitu wall to full height of the excavation (ie. up to 2.5 m maximum) at the 'hit' panel locations would occur prior to excavation of the next series of 'hit' panels (either 'b' or 'c'), and the same process followed. If required, the wall panels could be temporarily propped back to temporary footings or to the basement floor slab prior to installation of the first suspended floor.

If fissures are encountered during excavation, then it is recommended that 'hit and miss' panels not be used due to the risk of potential failure and risk of damage to adjoining structures, public roads and in-ground services. Prior to considering 'hit and miss' panel construction, it is recommended that trial excavations/trenches be undertaken to confirm the presence or otherwise of fissures.

10.2.5 Positive Support

If the options above are not suitable in order to achieve the proposed basement dimensions, the installation of positive ground support prior to excavation will be necessary along parts of the site boundaries. The ground retention system selected will need to minimise ground movements behind the excavation faces to ensure adjacent structures, pavements, and in-ground services are not affected as a result of basement construction.

Cantilevered soldier piles with shotcrete infill panels are commonly used to support the faces in basement excavations. The advantage of a piled wall is that it could be incorporated into the final basement structure.

Where significant loads surcharge the excavation faces, the piled wall can be made stiffer by decreasing the pile spacing to form a contiguous pile wall or incorporating anchors or props for support.

Driven sheet piles would not be practical due to the presence of rock at close to the basement level.

10.2.5.1 Pile Walls

Based on previous experience with similar subsurface conditions, it is envisaged that a soldier pile wall with shotcrete infill panels would be suitable. Soldier piles are typically spaced at up to approximately three pile diameters around the basement excavation with mesh and shotcrete infill panels. It is envisaged that uncased bored piles would be a suitable construction method. Provision for temporary steel liners and a cleaning bucket should also be allowed.

If anchors are required, they could be designed using the following working bond stresses:

- 50 kPa in very stiff (or stronger) residual clay; and
- 100 kPa in the very low strength (or stronger) sandstone / siltstone.

Anchor bond stresses are largely reliant upon drilling and cleaning techniques, and hence the amount of smear around the sides of the hole. It would be appropriate for checks of bond stress to be made by the contractor installing anchors at the time of construction, by way of pull out testing and proof load testing. It is possible that adopted bond stresses could be 50% higher than the above very low strength rock value if appropriate drilling and cleaning techniques are used, in conjunction with regular and favourable load testing.

Anchors need only be of temporary construction since it is assumed that long term earth loads will be supported by the permanent basement structure and ground level slab. After installation, all temporary anchors should be check stressed to 130% of the nominal working load then locked off at 100% of the working load. Checks should also be made at regular intervals to ensure that load is maintained in anchors and not lost due to creep effects.

The conditions indicated by the investigation suggest that the preparation of temporary anchors at the site should also include:

- a free length equal to their height above the base of the excavation;
- a minimum bond length of 3 m; and
- a maximum bond length of 10 m (unless specialist single bore multi-anchored systems are adopted).

Internal bracing systems are an alternative to anchored support, however, braces can restrict access which must be maintained during building construction. Approval from neighbours and *Council* will be required prior to construction of temporary/permanent anchors.

Determination of pile or wall depths, anchor spacing and lengths is a matter for detailed design. DP could assist in this design if required.

10.2.5.2 Basement Wall Design Pressures

The design of flexible or rigid retaining walls either cantilevered with a single row of anchors or props could be designed by a triangular pressure distribution and the earth pressure coefficients in Table 8 can be adopted.

Table 8: Earth Pressure Coefficients (non-sloping crest backfill)

Material	Unit Weight (kN/m^3)	K_O (braced structure)	Ka (cantilever structure)	Kp (passive)
Existing 'uncontrolled' fill	18	0.70	0.55	1.8
'Controlled' fill(1) and /or stiff residual clays and / or loose to medium dense (or denser) residual sands	20	0.60	0.44	2.2
Very stiff (or stronger) residual clays	20	0.55	0.40	2.5
Very low strength (or stronger) sandstone / siltstone	22	0.35	0.25	(300 kPa)

Notes:
(1) Assuming controlled fill is undertaken in accordance with the recommendations of this report.

It is recommended that all permanent basement walls be drained for full height in order to minimise hydrostatic pressure build-up behind the walls. Tanked basements would need to be designed for full height hydrostatic pressure.

For design of basement and retaining walls:

- Due allowance should be made for surcharge loadings (over and above the lateral earth pressure coefficients presented above) where the finished ground level above retaining walls is above horizontal and where additional loading is likely to be applied from existing or future upslope structures, or from traffic. The effects of surcharge can be estimated by multiplying the vertical pressure by the appropriate lateral earth pressure coefficient presented above.
- An allowance of 10 kPa should be made for lateral stress induced by compaction plant operating behind any walls (if appropriate).
- Drainage material should be installed for the full height of the wall, for a width of at least 0.3 m. The material must be free draining and granular and have a perforated or slotted drainage pipe at the heel of the wall to rapidly remove the water into the stormwater system.
- Where not fully drained, the walls will need to be designed for full hydrostatic pressure.

It is recommended that a factor of safety of 2 be adopted for overturning and sliding stability, and 1.5 for global stability of all basement and retaining wall designs.

For limit state design methods, the ultimate parameters provided above in Table 8 will need to be factored in accordance with AS 4678 (2002). Guidance on the selection of material strength partial factors is provided in Section 5.2 of AS 4678 and is dependent upon the nature and state of the natural insitu soil.

10.3 Basement Preparation and Localised Fill Placement

Following excavation to BEL, the exposed subgrade is anticipated to comprise very low strength (or stronger) sandstone / siltstone. Where the exposed subgrade is subjected to increases in moisture

content from rainfall and/or overland flow, there is potential for the weathered sandstone / siltstone to soften.

A working platform will probably be required to prevent softening of the subgrade and may be required for the support of a piling rig if pile foundations are adopted. Temporary piling platform design can only be definitively carried out once the size and loading of the piling rig(s) are known. However, at this stage a nominal construction trafficking platform in the order of (say) 0.3 m thick well graded crushed rock may be required to support the anticipated large piling rigs given the presence of very low strength sandstone / siltstone and potential for softening following increases in moisture content from rainfall and/or overland flow.

It is important that suitable grades be maintained to allow drainage and to minimise the potential for ponding of surface water, which can be collected in screened sumps and pumped from the excavation.

Trafficability across the weathered sandstone subgrade at BEL, if water softened, will be relatively poor. Placement of the abovementioned construction trafficking platform would also assist trafficability of rubber tyred vehicles.

Any new fill required up to 0.5 m depth to achieve design levels beneath on-ground basement slabs should be undertaken under 'Level 2' sampling and testing as detailed in AS 3798 (2007). Greater fill depths would require 'Level 1' inspection and testing where the fill is required for structural support. Any new fill required beneath floor slabs should also be compacted to a minimum dry density ratio of 98% relative to standard dry density at ±2% OMC.

The above procedures will require geotechnical inspection and testing services to be employed during construction. DP is suitably qualified to conduct earthworks testing and supervision services, as well as engineering inspections of batters, footings and piled foundations, as may be required during the development.

10.4 Trench Construction

10.4.1 Batter Slopes

Where space is available, battering or benching of the trench side walls is recommended.

Based on the encountered natural strata profiles encountered, temporary excavations up to 1 m depth below existing ground level in stiff (or stronger) clays or medium dense (or denser) clayey sands or very low strength (or stronger) sandstone / siltstone may remain near vertical for short periods of time, provided that any loose or water-bearing granular soils are battered back from the crest, dry moisture conditions prevail at the time of construction and there are no loads, services, structures or traffic located within a distance from the crest of the batter equal to the slope height. It is recommended that geotechnical inspection of near vertical cuts be undertaken prior to personnel working in excavations to ensure conditions are as assumed in design.

All excavations greater than 1 m depth will need to be shored, benched or battered for stability prior to personnel entering the excavation. Unsurcharged batter slopes cut up to 3 m high into the various soil profiles encountered during the field work, may be designed for temporary and long term conditions as presented below in Table 9 below.

Table 9: Cut Batter Slopes (up to 3 m high)

Material	Safe Batter Slope (H:V)	
	Short Term	Long Term[2]
Existing 'uncontrolled' fill and /or loose to medium dense residual sands	2:1	Not Suitable
'Controlled' fill[1] and /or stiff residual clays	1.5:1	2:1
Very stiff (or stronger) residual clays	1:1	2:1
Very low strength (or stronger) sandstone / siltstone[3]	0.75:1	1:1

Notes:

(1) Assuming controlled fill is undertaken in accordance with the recommendations of this report.

(2) Long term slopes in engineered fill and residual clays would require surface protection to reduce the risk of erosion potential. Steeper values may be possible, subject to detailed stability analysis.

(3) Subject to geotechnical inspection during construction to confirm the absence of adverse joints.

It should be noted that the above slopes assume dry conditions, if groundwater is encountered during excavation of granular i.e. sandy soils it may be accompanied by 'running sand' conditions and ensuing sidewall instability. In such instances, excavations will need to be battered considerably flatter than those given in Table 9 possibly flatter than 4H:1V and/or require dewatering for stability or require support measures such as shoring boxes with pumping from screened sumps.

It is recommended that crest and toe drainage and surface protection (such as vegetation or similar) be incorporated in all permanent batters to assist in the removal of surface water from the batters.

The above temporary batter slopes are suggested with respect to slope stability only, and do not allow for lateral stress relaxation which may result in movement of nearby inground services. If such services are settlement-sensitive and are located near the crest of the cut face, then the excavation may have to be positively supported.

10.4.2 Shoring Design

Where space to batter or bench is not available in areas of open trench excavation, the temporary support of the excavations in soils could comprise shoring boxes. The design of cantilevered or single propped temporary excavation support could be undertaken using a triangular pressure distribution and the earth pressure parameters given in Table 8.

Flexible walls are those which are free to rotate or tilt (such as cantilevered walls) and should be designed using an active earth pressure coefficient (Ka). For support systems with more than one prop, a constant earth pressure of 6H (where H is the depth of excavation) could be used for design. Any retention system will require detailed design.

Allowance should be made for hydrostatic pressure build-up behind the temporary shoring. Also, allowance for surcharge loads and sloping crest should be made as appropriate. The effect of surcharge should be included by multiplying the vertical surcharge pressure by the appropriate short term lateral earth pressure coefficient as given in Table 8 above in Section 10.2.5.2.

10.4.3 Trench Backfill and Compaction

It is anticipated that following placement of a bedding layer at the base of the trench, the service pipe will be installed, and the trench progressively backfilled using predominantly granular material to a predetermined height above the pipe invert. Trench depths, bedding layer thickness and cover requirements may vary and will be provided on the relevant construction drawings. Backfilling is then understood to comprise materials won from trench excavation, provided it is suitable.

Compaction of trench backfill material should be carried out in a manner to prevent damage to the installed service pipes. Appropriate purpose selected equipment may be required to achieve compaction requirements to prevent damage occurring.

Any trench backfill should be placed in layers not exceeding 200 mm loose thickness, with each layer compacted to a minimum dry density ratio of 98% relative to standard compaction (for cohesive material) or a minimum density index of 75% (for cohesionless soils), or as directed by Project guidelines. Hand-operated compaction equipment, or other approved methods as directed by Project guidelines, should be used to compact the first 600 mm of trench backfill above the pipe. Heavy compaction equipment may be used to compact the trench backfill provided a minimum of 1.2 m of backfill has been initially placed above the pipe. At any road crossings, the final 600 mm of the finished surface should be compacted to 100% Standard compaction (or a density index of 80%). Moisture contents should be within -2% to +2% of OMC.

Field density testing should be carried out to check the standard of compaction achieved during backfilling and the moisture content during placement. The frequency and extent of testing should be carried out in accordance with AS 3798 (2007) or as directed by Project guidelines. The above procedures will require geotechnical inspection and testing services to be employed during construction.

Where the pipeline is bedded and/or backfilled with free-draining pea gravel, sand or gravel, and where any utility trench slopes more than 5%, DP recommend that backfill “check dams” be constructed to prevent movement of groundwater through the bedding or backfill material. These check dams consist of relatively impermeable soil extending from the base of the trench, surrounding the pipe and extending to the surface to impede movement of groundwater along the trench backfill. Check dams are typically spaced 10 m to 30 m apart and should have minimum widths of 0.5 m. Steep utility trench grades (i.e. more than 8% to 10%) would probably require the minimum spacing.

10.4.4 Trenchless Construction

Trenchless installation methods are a possibility for this alignment; however, no locations have been indicated to DP at the time of this report. Depending on the method and locations, launch or receival pits may be required at each end of proposed water pipelines. Sloped cuts or bracing/shoring could be used for the excavations, although this would depend on HDD transect depths and space requirements i.e. the excavation depth required which will be dependent upon the Contractor’s equipment and operations.

The ground conditions along the alignment generally comprise existing fill over stiff (or stronger) residual clays overlying very low strength (or stronger) sandstone / siltstone from surface from between 1 m and 6.1 m depth. In terms of issues for construction:

- Given the shallow very low strength (or stronger) sandstone / siltstone, there may be potential difficulties in drilling and will require provision for measures to accommodate for this issue.
- The stiff (or stronger) residual clays and very low strength sandstone / siltstone should be relatively stable, but any residual sands may present some issues for hole stability and require provision for measures to accommodate this issue. If a high groundwater table is present at the time of construction (not anticipated), special measures would likely be required.
- The presence of residual sands and weathered sandstone suggests that 'frac-out' may potentially be a risk at the site and may require provision for measures to accommodate this issue.

Positive ground support such as shoring boxes should be used for excavations up to approximately 6 m depth (if required). If battered excavation is preferred for launch or receival pits (if required), it is recommended that the excavation sides be sloped or benched as per Table 9 in Section 10.4.1. For excavations deeper than 3 m in vertical height case specific stability analysis is recommended.

It is recommended that experienced trenchless pipeline contractors be contacted to discuss the suitability of the above installation methods with respect to the onsite conditions.

If this option is to be considered for specific portions of the proposed water alignment, then DP could provide more location specific information.

10.5 Re-Use of Excavated Materials

The results of the field work indicate the majority of materials 'won' from onsite excavation are likely to comprise existing fill, residual clays / sands and weathered sandstone / siltstone. The existing fill, residual clays / sands and weathered sandstone / siltstone will generally be suitable for re-use as fill (i.e. for platform subgrade construction). Such re-use is contingent upon acceptance of reactive surface movements, and on particle size distribution being controlled along with moisture content, and upon minimum placement and compaction requirements being met, all as indicated in Section 10.7 below. Re-use of any sand will require blending with clay to improve workability and reduce the potential for 'slushy' conditions when wet and unravelling when dry.

10.6 Treatment of Existing Fill

Where site fill has been placed (prior to this investigation) without any supporting documentation to confirm that the fill was placed under engineering supervision and testing in a 'controlled' manner, then there may be some risk of incurring unacceptably high differential settlement of the 'uncontrolled' filling under future upper-level footing loads and during any rainwater ingress. The results of the bores indicate that the existing moderately to well compacted 'uncontrolled' fill is between 0.1 m and 2.7 m thick. Accordingly, the following options are suggested to manage the risks associated with "uncontrolled" fill:

- **Pile Support the Buildings** – The option with lesser additional earthworks work is to leave the existing "uncontrolled" fill in place. With this option the future building loads would need to be supported on piles penetrating into competent natural material below the fill and the floor slabs fully suspended. Any new pavements to be constructed on the existing fill would need to be designed to accept the risk of settlements.

- **Excavate and Recompact the Filling** – The option with significant earthworks is to remove all "uncontrolled" fill and test roll the underlying natural ground for soft or loose conditions. The existing fill can then be screened to remove all coarse, oversize or deleterious material prior to replacement in layers of maximum 0.3 m 'loose' thickness. Each layer should be compacted under 'Level 1' inspection and testing in accordance with the recommendations presented in Section 10.7 below. Adopting this low level of risk will enable high level foundations for structures with light to moderate loads.

The above procedures will require geotechnical inspection and testing services to be employed during construction. It is further noted that the first option will have a risk of potential movement in pavement areas requiring on-going maintenance where this option is adopted.

10.7 Site Preparation and Filling Placement

Based on the depth of fill encountered in the proposed development area which ranges between 0.1 m to 2.7 m, and where an excavate and replace option is adopted as discussed above in Section 10.6, the following site preparation measures and subsequent use of a slab-on-ground footing system founding in engineered fill and/or pavements and/or structural components. The placement of controlled fill over natural soils is detailed below:

- Remove any 'uncontrolled' or deleterious, soft, wet or highly compressible material or topsoil material rich in organics or root matter which should be initially stockpiled for screening and to be potentially reused as fill.

  Uncontrolled fill was encountered at the test locations to depths of between 0.2 m and 2.7 m.
- Reshape and grade the clay or sandy subgrade beneath proposed structures and pavements to drain towards the outside from a slightly domed centre. Any internal low spots should be prevented from developing as these may act as a drainage sink and subsequently lead to localised swelling and softening or unravelling.
- Assess moisture contents of the subgrade and adjust the moisture content (if required) to be within 2% of OMC, where OMC is the optimum moisture content at standard compaction.
- Roll the exposed surface with at least six passes of a minimum 8 tonne deadweight smooth drum roller, with a final test roll pass accompanied by careful visual inspection to ensure that any deleterious materials such as soft, wet or highly compressible soil and any organics are identified and removed;
- Compact the subgrade (including upper 0.5 m depth if in fill) to a minimum dry density ratio of 95% standard, but 100% standard for 1 m depth of a building platform subgrade where footings are to be founded in the fill. Clay fill should be limited to a maximum dry density ratio of 102% Standard to avoid over-compaction. Over-compacted clays (ie. minimum dry density ratio of >102%) which are dry of OMC, may swell significantly and lose strength if they are wetted after compaction, potentially changing the site classification and reducing subgrade strengths assumed in design, and therefore need to be avoided.
- Place fill in layers not exceeding 300 mm loose thickness, with each layer compacted to a minimum dry density ratio of 98% standard. It is recommended that the upper 1 m depth of fill for any fill which is required to support building footings and / or any pavements be compacted to a minimum dry density ratio of 100% standard. This higher dry density ratio should apply to all fill extending from a nominal horizontal distance of 2 m at the edge of each structural support footing with a

nominal zone of influence of 1H:1V down and away from the proposed engineered subgrade level. Where fill is clayey, moisture content within the fill should be maintained within 2% of OMC (where OMC is the optimum moisture content at standard compaction) during and after compaction.

- Seal or cover any compacted silty or sandy clay foundation soil at or close to footing formation level should be as soon as practicable, to reduce the opportunity for occurrence of desiccation and cracking. It is recommended that building platforms be overlaid with a working platform of nominal 200 mm thickness of well graded clayey granular fill of minimum CBR 20% with a minimum 15% fines (<75 µm) content to reduce moisture variation (and associated shrink-swell movements) in subgrade soils, and to improve trafficability for light vehicles. Where the surface is to be trafficked by heavy vehicles/machinery, then specific pavement thickness design should be undertaken.
- Undertake 'Level 1' inspection and testing as detailed in AS 3798 (2007) where any new fill is required to achieve design levels for support of any structural components including on-ground slabs and Level 2 for pavements.

The above procedures will require geotechnical inspection and testing services during construction.

Due to the high to low plasticity of the near surface clayey fill soils (if left in place) and residual clayey soils, it is expected that rubber tyred vehicles in particular will have trafficability problems during and after periods of rainfall or other increases in subgrade moisture content, and in some cases tracked plant will experience some difficulty. It will be essential to keep the site well drained during construction. As indicated previously, a granular working platform is recommended to reduce potential lost time during or following wet weather, and to reduce wetting or drying of the subgrade soils (with associated long-term movements).

Soils which become wet, 'slushy' and soft will need to be allowed to dry out or be replaced.

Where bulk fill is placed under controlled conditions, there is potential for 'creep' of the fill material as the fill settles over time under self-weight. Such settlement is expected to be in the order of approximately 0.5% to 1% of the fill thickness over a period of ten to twenty years for well compacted clay fill and less for granular fill.

The above procedures will require geotechnical inspection and testing services to be employed during construction.

10.8 Foundations

10.8.1 General

For proposed lightly loaded, settlement tolerant near surface structures, it is estimated that high level pad / strip footings founded into the stiff (or stronger) residual clays and / or medium dense (or denser) residual sands and / or very low strength (or stronger) sandstone / siltstone and /or where the existing 'uncontrolled' fill is removed, screened, and replaced under controlled conditions would be suitable. Given the anticipated column loads and the expected very low strength (or stronger) sandstone / siltstone at basement excavation level and potentially at pipe invert levels, it is estimated that pad footings and / or thrust blocks founded into the very low strength (or stronger) sandstone / siltstone would be suitable. Alternatively, the structures could be supported on the stronger underlying low strength (or stronger) sandstone / siltstone via piles.

It is also recommended that the proposed structures are be founded into similar strength strata to reduce the potential for differential settlement.

Where limit state methods are used to design the foundations, the ultimate geotechnical strength ($R_{d,ug}$) can be calculated by multiplying the allowable parameters by the adopted safety factor of 2.5, and then multiplied by a suitable geotechnical strength reduction factor (Φ_g) to obtain the design geotechnical strength ($R_{d,g}$). A nominal Φ_g value of 0.5 is recommended for high level footings. The Piling Code AS 2159 (2009) requires a Φ_g value of 0.45 to 0.65 where there is no testing of pile capacity, rising to 0.65 to 0.85 where a significant number of piles are tested after installation.

It is essential that foundation excavations be inspected by experienced geotechnical personnel to ensure the design parameters adopted are suitable for the ground conditions and to ensure that there is no soft or loose material remaining at the base of the excavations or smear on the side walls. Ground conditions can vary, and it is essential that adequate provision be made throughout the project to vary foundations to suit differing ground conditions.

10.8.2 Allowable Thrust Block Bearing Pressures

Table 10 below outlines the allowable bearing pressures for the materials encountered during the investigation for the design of thrust blocks.

Table 10: Vertical and Horizontal Bearing Pressures

Material	Allowable Vertical Bearing Pressure (kPa)	Allowable Horizontal Bearing Pressure (kPa)[(1)]
Stiff residual clay	100	50
Very stiff residual clay	200	100
Hard residual clay	400	200
Medium dense residual sand	100	50
Dense residual sand	400	100
Very low strength (or stronger) sandstone / siltstone	500	250

Note: [(1)] - based upon values outlined in the Water Supply Code of Australia (2002)

The above bearing pressures are contingent upon the centre of the thrust block being a minimum of 1 m depth below the existing ground surface. Furthermore, any vertical pressures are contingent upon the founding material extending at least two times the footing width below the footing or higher strength/density material at depth.

It is recommended that all thrust block excavations be inspected by an experienced geotechnical engineer to confirm bearing pressure prior to casting of concrete.

These allowable values are based on a factor of safety of 2.5. Ground movement of up to 10 mm could be expected for properly designed and constructed thrust blocks sized using the allowable horizontal

bearing pressures given above. Vertical settlements of up to 1% of the footing width can be expected for footings constructed and loaded as outlined above.

10.8.3 High Level Footings

High level strip footings to a maximum width of 1 m and pad footings to a maximum width of 2 m, may be preliminary sized using allowable bearing pressures given in Table 11.

Table 11: Allowable Bearing Pressures for Pad and Strip Footings

Material	Allowable Bearing Pressure (kPa)(1)
Existing 'Uncontrolled' fill and / or firm residual clays and /or loose residual sands	Not Suitable
Controlled fill(2) and / or stiff residual clays or medium dense (or denser) residual sands	100
Very stiff (or stronger) residual clays	200
Very low strength (or stronger) sandstone / siltstone	500(3)

Notes: (1) Subject to confirmation through visual and tactile assessment of the material during inspection.

(2) Assuming engineered fill is undertaken in accordance with the recommendations of this report and AS3798.

(3) Provided no weaker foundation material exists within two footing widths below the base of the footing; else the value for very stiff (or stronger) residual clays should be adopted for design.

For upper level footings (loaded as above), it is considered that settlements under such applied loading will be less than 1% of footing width. Wider footings are possible but would be subject to specific settlement assessment in relation to footing size and founding depth.

The above allowable values are based on a factor of safety of 2.5 against bearing capacity failure.

10.8.4 Pile Foundations

Should the above maximum allowable bearing pressures prove too low for the development loads, then the structures will need to be supported on piles. Given the encountered ground conditions, auger bored piles would be suitable. Allowance should be made for the use of temporary steel liners and a cleaning bucket where water ingress is encountered and for base cleanliness

It is recommended that pile foundations be concreted promptly after excavation to reduce the potential for base softening caused by increases in moisture content and localised excavation relaxation.

Bored piles founded one pile diameter into sandstone/siltstone could be sized using the preliminary maximum allowable values given in Table 12.

Table 12: Allowable Bored Pile Design Pressures

Material	Allowable Shaft Adhesion (kPa)	Allowable End Bearing (kPa)[1]
Existing 'Uncontrolled' fill and / or firm residual clays and /or loose residual sands	Not Suitable	Not Suitable
Controlled fill[2] and / or stiff residual clays or medium dense (or denser) residual sands	20	Not Suitable
Very stiff (or stronger) residual clays	25	Not Suitable
Very low strength (or stronger) sandstone / siltstone	60	750[3]

Notes: (1) Subject to confirmation through visual and tactile assessment of the material during inspection.
(2) Assuming controlled filling is undertaken in accordance with the recommendations of this report.
(3) Provided no weaker foundation material exists within four pile diameters and below the base of the pile footing.

For bored pile foundations loaded as per the allowable bearing pressures in Table 12, it is considered that settlements under such applied loading will be less than 1% of the pile diameter. Bored piles should be socketed into similar strength strata to reduce the potential for differential settlement between adjacent piles.

It is recommended that the upper 0.9 m of soil be ignored or depth of fill (whichever is greater) in pile shaft adhesion calculations due to the effects of seasonal moisture variation and shaft load development effects.

10.9 Presumptive Pavement and Slab-on-Ground Parameters

If site preparation is carried out as detailed in Sections 10.3 and 10.7, the subgrade conditions are expected to comprise clay-bound engineered fill, residual clays / sands and / or weathered sandstone / siltstone.

Based on experience with similar subgrades and allowing for minor variations in subgrade type and strength, it is recommended that a

- presumptive CBR value of 3% (or a modulus of subgrade reaction (k) of 20 kPa/mm for rigid pavements) be adopted for clay-bound engineered fill and residual clay material;
- a presumptive CBR value of 4% (or a modulus of subgrade reaction (k) of 23 kPa/mm for rigid pavements) be adopted for residual sands; and
- a presumptive CBR value of 6% (or a modulus of subgrade reaction (k) of 30 kPa/mm for rigid pavements) be adopted for weathered sandstone / siltstone.

In the design of either flexible sealed, unsealed granular or rigid concrete pavements, subjected to highway type vehicular trafficking. These values are based on the assumption that the earthworks will be undertaken in accordance with the recommendations in Section 10.3 and 10.7 and additional onsite CBR tests should be carried out to confirm the above presumptive CBR values.

For controlled fill depths of less than 1 m, the Japan Road Association method of assessing weighted subgrade strength can be used:

$$CBR_W = (D_F \times CBR_F^{0.33} + (1-D_F) \times CBR_S^{0.33})^3$$

where: CBR_W = weighted subgrade CBR (%)
D_F = depth of fill (m)
CBR_F = CBR of fill material
CBR_S = CBR of subgrade

For loaded areas of different proportion or different load intensity to standard highway type wheel loads, DP should be contacted for further advice.

The satisfactory on-going performance of pavements is dependent on the subgrade not being allowed to become 'over-wet'. To ensure the required subgrade performance, sufficient drainage should be installed in areas where there is potential for water to enter the subgrade (i.e. adjacent to garden beds, etc).

10.10 Site Classification

Site classification of foundation soil reactivity strictly only applies to residential buildings up to two-storeys and to other buildings of similar size, loading and flexibility as defined in accordance with AS 2870 (2011), and would not apply to this development. Such classification, as well as the results of the laboratory testing, provide an indication of the propensity of the ground surface to move with seasonal variation in moisture content, and has been used (along with general climatic zoning and general experience) to assess the potential depth of seasonal cracking and potential for softening under soaked conditions. The following is provided for information purposes.

Due to the presence of fill of unknown compaction history (which must be considered as 'uncontrolled' fill) up to 2.7 m depth, the site would strictly be given a "Class P" classification, in accordance with AS 2870 (2011), requiring design by engineering principles.

The shrink-swell index tests reported I_{ss} values of 1.4% and 2.8 % per ∆pF for the residual silty clay samples tested.

To provide an indication of the reactive surface movements of the residual silty clay, the highest result of the Atterberg limits and linear shrinkage tests were compared with an in-house database of plasticity and shrink-swell index (I_{ss}) values, to estimate a presumptive I_{ss} value of 3 % per ∆pF for the residual silty clay sample testeds. Therefore, we have adopted the higher I_{ss} value for this assessment.

The presumptive I_{ss} value was input into DP's in-house program *REACTIVE*, to calculate the characteristic surface movement (y_s) values in general accordance with AS 2870 (2011) which provides recommended values of change in suction (Δu) and depth of suction (Hs) for major and regional centres throughout Australia. More detailed published data by Fox (2000) relating climatic conditions to suction was used for this report. A value of 1.2 pF was adopted for Δu and 1.8 m for H_s in the *REACTIVE* calculations. This is based on a "wet temperate" climatic zone. A cracking depth of 0.9 m was used in the analysis, based on $0.5H_s$.

The analysis indicates that the y_s values of a full depth soil profile tested in response to seasonal moisture variation, are in the order of up to 40 mm consistent with a “Class M” (moderately reactive) classification.

Where existing site soils (i.e. natural clay) of similar reactivity won from excavation are reused as controlled fill, y_s values of up to 60 mm consistent with a “Class H1” (highly reactive) classification would result. This is due to the need to consider uncracked conditions for a five-year period following fill placement and two years following excavation.

It should be noted that for the proposed commercial building with a basement level up to 7 m depth, this will be well below the depth of seasonal moisture change of 1.8 m depth. However the site classification will be of particular importance to high level footings for any at ground structures or inground services founded close to existing ground surface levels.

It should be noted that no assessment of the effect of soil moisture change by trees has been made in this site classification (either with respect to the removal of established trees prior to development of building pads, or the proximity of established or new trees to proposed buildings). Reference to the requirements in AS2870 (2011) should be made by the building designer in this regard. It should be further noted that the presence or removal of trees can result in additional surface movement, due to tree-induced suction changes and tree-induced centre heave. Such tree-induced movement is not included in the characteristic surface movement calculations used to classify the site.

If “abnormal” soil moisture conditions are experienced, the site would be classified as “Class P” (problem site) which would require more extensive foundation works to avoid adverse foundation performance. Abnormal soil moisture conditions are defined in AS 2870 (2011) (Clause 1.3.3) and, in summary, comprise:

- Recent removal of buildings or structures likely to have affected soil moisture conditions;
- Unusual moisture caused by drains, channels, ponds, dams or tanks;
- Recent removal of large trees;
- Growth of trees planted too close to a structure;
- Excessive or irregular watering of gardens adjacent to a structure;
- Lack of maintenance of site drainage; and
- Failure to repair plumbing leaks.

10.11 Site Earthquake Sub- Soil Class

Following excavation to basement level, the subgrade is anticipated to comprise weathered sandstone/siltstone. In accordance with AS1170.4 (2007), it is recommended that a site sub-soil classification of “Class B_e – Rock” be adopted for parts of the structure founded in rock, in accordance with the definitions presented in *Section 4.2 – Class Definitions*. This is based on a sub-soil profile of no more than 3 m of soil underlain by rock with a compressive strength of between 1 MPa and 50 MPa over the top 30 m.

For components of the structure founded close to existing ground surface levels, a site sub-soil classification of “Class C_e – Shallow Soil Site” is recommended.

10.12 Site Erosion Potential

Fine grained and granular soils are prevalent at the site, and the Emerson class tests (Class 1, 2, 3 and 6) indicate that the near surface granular / cohesive fill, residual clayey soils are moderately to very highly dispersive. Based on the assessment, a **dispersive management plan (DSMP)** will be required for the site.

Erosion control measures at the surface will require detailed design; however, it is expected that, as a minimum, measures will need to include silt fences, hay bales and measures to limit water runoff velocity (such as swales or benches) at the downslope boundaries of the site, and prompt installation of topsoiling and grassing or hydro mulching in completed areas. A sedimentation dam may also be required where bulk earthworks operations requiring large volumes of soil disturbance at the site.

It is recommended that adequate lined collector drainage be installed at the top/crest of all batters and that all clean drainage be discharged off-site via pipes or lined channels.

11. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for the proposed Yeronga Priority development at Park Road, Yeronga in accordance with DP's proposal BNE200443.P.002.Rev0 dated 25 February 2021 and proposal BNE200443.01.P.001.Rev0 dated 6 October 2021 in which acceptance was received from Mr John Marshall of Economic Development Queensland dated 3 March 2021 and 5 November 2021 respectively. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Economic Development Queensland for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

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

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

12. References

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

AS 1289.6.3.2:1997, "Methods of testing soils for engineering purposes", Standards Australia.

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AS 2870:2011, "Residential slabs and footings"; Standards Australia.

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Fox E, 2000, "A Climate-Based Design Depth of Moisture Change Map of Queensland and the Use of Such Maps to Classify Sites Under AS 2870:1996", Australian Geomechanics, Vol 35, No 4.

Water Services Association (WSAA) (2002), "Water Supply Code of Australia", Water Services Association

Douglas Partners Pty Ltd

Appendix A

About This Report
Soil Descriptions
Rock Descriptions
Sampling Methods
Symbols and Abbreviations

About this Report

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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

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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).

Rock Strength

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

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

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

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

Degree of Weathering

The degree of weathering of rock is classified as follows:

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

Rock Descriptions

Degree of Fracturing

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

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

Rock Quality Designation

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

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

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

Stratification Spacing

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

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

Symbols & Abbreviations

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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

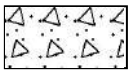
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

General


Asphalt


Road base


Concrete


Filling

Soils


Topsoil

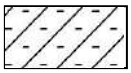

Peat


Clay

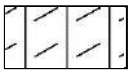

Silty clay

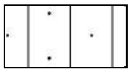

Sandy clay

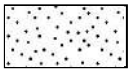

Gravelly clay


Shaly clay

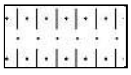

Silt

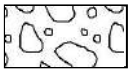

Clayey silt


Sandy silt

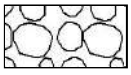

Sand

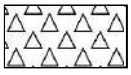

Clayey sand


Silty sand


Gravel

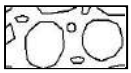

Sandy gravel


Cobbles, boulders

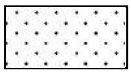

Talus

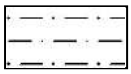
Sedimentary Rocks

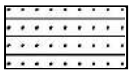

Boulder conglomerate

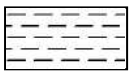

Conglomerate


Conglomeratic sandstone

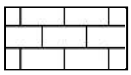

Sandstone


Siltstone

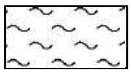

Laminite

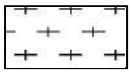

Mudstone, claystone, shale

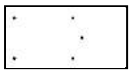

Coal


Limestone

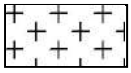
Metamorphic Rocks


Slate, phyllite, schist

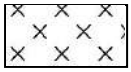

Gneiss


Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite

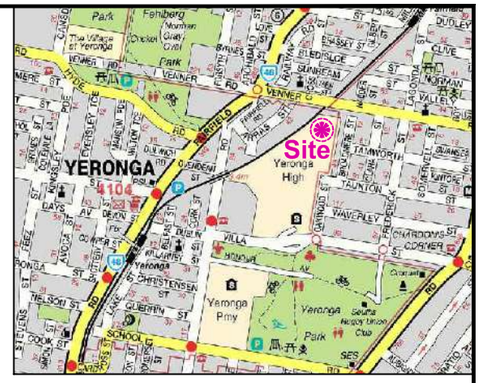

Dacite, epidote


Tuff, breccia


Porphyry

Appendix B

Drawing 1 - Site and Test Location Plan



Location Plan

N

0 10 20 30 40m

SCALE 1: 1,000 (A3)

LEGEND:-

Borehole Location and Number

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Image obtained from Metromap. Date of imagery 27-09-2020.

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Economic Development Queensland		TITLE: **Site and Test Location Plan** **Yeronga Priority Development Area** **Park Road, Yeronga**
OFFICE: Brisbane	DRAWN BY: JST	
SCALE: As shown	DATE: 30 March 2021	

PROJECT No:	200443.00
DRAWING No:	1
REVISION:	0

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Location Plan

N

0 5 10 15 m

SCALE 1: 400 (A3)

LEGEND:-

- Borehole Location and Number
- Approximate Site Boundary

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Image obtained from Metromap. Date of imagery 24-09-2021.

Douglas Partners
Geotechnics | Environment | Groundwater

CLIENT: Turner & Townsend Pty Ltd		
OFFICE: Brisbane	DRAWN BY: JST	
SCALE: As shown	DATE: 30 November 2021	

TITLE: **Site and Test Location Plan**
Proposed PDA Civil Works - Additional Investigation
701 Park Road, Yeronga

PROJECT No:	200443.01
DRAWING No:	1
REVISION:	0

P:\200443.01 - YERONGA, Prop PDA Civil Works Add Inv\7.0 Drawings\7.2 Out\200443.01.D.001.Rev0.dwg

Appendix C

Field Work Results

BOREHOLE LOG

CLIENT: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 17.8 mAHD
EASTING: 502043
NORTHING: 6956295
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
17	0	FILL Gravelly Sandy CLAY (CI): medium plasticity, brown, fine to coarse sand, fine to medium gravel, w>PL, very stiff		D	0.1				
				D	0.5		5,9,10 N = 19		
				S					
	1	- becoming hard			0.95				
16	1.8	Sandy CLAY (CI): medium plasticity, grey, fine to medium sand, w<PL, hard (Residual)			2.0				
	2			S			15,17,17 N = 34		
					2.45				
15	3	- becoming grey mottled orange-brown							
				S	3.5		30/140mm		
14	3.6	SANDSTONE: fine to medium, grey with red and orange-brown, very low strength, highly weathered (Aspley Formation)			3.64				
	4								
13									
	5			S	5.0		30/100mm		
					5.1				
12	6								
				S	6.0		30/50mm		
	6.1	Bore discontinued at 6.1m depth - Limit of investigation			6.05				
11	7								
10	8								
9	9								
8	10								

RIG: Hydrapower Scout 3 **DRILLER:** Ground Test **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit. Well installed to 6m

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 19.1 mAHD
EASTING: 502050
NORTHING: 6956267
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
19	0	FILL Gravelly Sandy CLAY (CL): low plasticity, brown, fine to coarse sand, trace fine to medium gravel, w~PL, hard		D	0.1				
				D	0.5				
		- becoming very stiff to hard		S	0.9		6, 11, 30/100mm		
18	1								1
17	2	Silty CLAY (CI): medium plasticity, pale grey mottled red and orange-brown, trace fine sand, w<PL, very stiff (Residual)		S	2.0		7,10,9 N = 19		2
	2.0				2.45				
16	3	Sandy CLAY (CI): medium plasticity, pale grey with red and orange, fine to coarse sand, trace fine to medium gravel, w~PL, very stiff (Residual)		S	3.5		10,15,22 N = 37		3
15	4				3.95				4
14	5			S	5.0		15,24,30 N = 54		5
		- becoming grey mottled red-brown, hard			5.45				
13	6								6
	6.8			S	6.5		12, 20, 30/120mm		
12	7	SANDSTONE: fine to medium, grey with red and orange-brown, very low strength, highly weathered (Aspley Formation)			6.92				7
				S	7.5		9, 30/110mm		
	7.8				7.76				
11	8	Bore discontinued at 7.8m depth - Limit of investigation							8
10	9								9
9	10								10

RIG: Hydrapower Scout 3 **DRILLER:** Ground Test **LOGGED:** NS **CASING:** HQ to 2.5m

TYPE OF BORING: Auger to 2.5m, washbore to depth of termination

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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)

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BOREHOLE LOG

CLIENT: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 18.4 mAHD
EASTING: 502021
NORTHING: 6956279
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
18	0.1	FILL Gravelly Sandy CLAY (CI): medium plasticity, fine to coarse sand, trace fine to medium gravel, w~PL, hard		D	0.1				
	0.2			D	0.2				
	0.5				0.5				
17	1.0	Silty CLAY (CI): medium plasticity, grey mottled red and orange-brown, w~PL, hard (Residual)		S	1.0		12,21,20 N = 41		
	1.45				1.45				
16	2.5			S	2.5		9,19,25 N = 44		
	2.95				2.95				
15	4.0			S	4.0		14,20,28 N = 48		
14	4.45				4.45				
	4.7	Sandy CLAY (CL): low plasticity, grey mottled red-brown, fine to medium sand, w~PL, hard (Residual)							
13	5.5			S	5.5		10,20,29 N = 49		
12	5.95				5.95				
	6.5	SANDSTONE: fine to medium, grey with red and orange-brown, very low strength, highly weathered (Aspley Formation)							
11	7.0			S	7.0		30/55mm		
	7.06				7.06				
10	8.5			S	8.5		30/80mm		
	8.58				8.58				
9	10.0			S	10.0		30/30mm		
	10.03				10.03				
8	10.05	- very low to low strength Bore discontinued at 10.05m depth - Limit of investigation							

RIG: Hydrapower Scout 3 **DRILLER:** Ground Test **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger to 3m, washbore to depth of termination

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 18.4 mAHD
EASTING: 501992
NORTHING: 6956288
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 200443.00
DATE: 11/3/2021
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 100mm)
18.4	0.0	FILL Sandy CLAY (CI-CH): medium to high plasticity, brown, fine to coarse sand, trace fine to medium gravel, w~PL, very stiff to hard		D	0.0				
	0.2			D	0.2				
	0.5	- trees, cobbles (possible old fill/foundation)		S	0.5 0.58		30/75mm		
17.4	1.0	Silty CLAY (CI): medium plasticity, grey with orange and pale red-brown, w~PL, hard (Residual)							
		- becoming grey mottled pale red-brown							
	2.0	- hard		S	2.0 2.15		3, 30/148mm		
16.1	2.3	Gravelly Sandy CLAY (CL): low plasticity, grey mottled red and orange-brown, fine to coarse sand, fine to medium gravel, w~PL, hard (Residual)							
		- becoming grey							
15.4	3.5	SANDSTONE: fine to medium, grey with red and orange-brown, very low strength, highly weathered (Aspley Formation)		S	3.5 3.58		30/30mm		
	5.0			S	5.0 5.09		30/90mm		
	6.5			S	6.5 6.57		30/70mm		
	8.0			S	8.0 8.06		30/80mm		
	9.5	- becoming low strength		S	9.5 9.53		30/30mm		
8.4	10.0	Bore discontinued at 10.0m depth - Limit of investigation							

RIG: Hydrapower Scout 3 **DRILLER:** Ground Test **LOGGED:** NS **CASING:** HQ to 2.5m

TYPE OF BORING: Auger to 2.5m, washbore to depth of termination

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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)

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BOREHOLE LOG

CLIENT: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 10.1 mAHD
EASTING: 502123
NORTHING: 6956405
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
10	0	FILL Gravelly SAND (SM): fine to coarse, brown, fine to coarse gravel, with clay, moist, medium dense to dense		S	0.5		7,10,8 N = 18		
					0.95				
9	1			D	1.2			▽	
	1.2	FILL Gravelly CLAY (CI): medium plasticity, brown with grey, fine to coarse gravel, with fine to coarse sand, w>PL, estimated firm							
	1.5								
	1.9	Silty SAND (SM): fine, dark grey, moist, loose - grey, with clay							
8	2			S	2.0		2,2,5 N = 7		
		Sandy CLAY (CH): high plasticity, grey with red and orange, fine to medium sand, w>PL, firm to stiff (Residual)			2.45				
	2.7								
7	3	Silty CLAY (CH): high plasticity, grey mottled orange-brown, w~PL, estimated stiff (Residual)							
	3.3								
	3.5	Sandy CLAY (CI): medium plasticity, pale grey, fine to medium sand, w<PL, estimated stiff to very stiff (Residual)		S	3.5 3.61		30/110mm		
	3.8	SANDSTONE: fine to medium grained, pale grey, very low strength, highly weathered (Aspley Formation)							
6	4	Bore discontinued at 3.8m depth - Limit of investigation							
5	5								
4	6								
3	7								
2	8								
1	9								
0	10								

RIG: Hydrapower Scout 3 **DRILLER:** Ground Test **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: Groundwater seepage observed at 1.2m

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 9.6 mAHD
EASTING: 502094
NORTHING: 6956413
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
	0.0	FILL Gravelly SAND (SM): fine to coarse, brown, fine to coarse gravel, trace cobbles, dry, medium dense to dense							
	0.5	FILL Gravelly CLAY (CL): low plasticity, brown with grey, fine to coarse gravel, with fine to coarse sand and gravels, with cobbles, w<PL, very stiff		S	0.5		8,9,15 N = 24		
	0.95				0.95				
	1.4	Silty SAND (SM): fine, dark grey, moist, estimated medium dense (Residual)							
	1.8	- grey, with clay, trace medium gravel							
	2.0	Clayey SAND (SC): fine, grey, trace medium gravel, moist, loose (Residual)		S	2.0		2,3,4 N = 7		
	2.45	Sandy CLAY (CH): high plasticity, pale grey mottled orange-brown, fine to medium sand, w>PL, firm (Residual)			2.45				
		- medium plasticity, pale grey with red and orange-brown, w~PL, stiff							
		- very stiff							
	3.5			S	3.5		5,8,13 N = 21		
	3.95	Bore discontinued at 3.95m depth - Limit of investigation			3.95				

RIG: Hydrapower Scout 3 **DRILLER:** Ground Test **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 13.4 mAHD
EASTING: 502050
NORTHING: 6956365
DIP/AZIMUTH: 90°/--

BORE No: 7
PROJECT No: 200443.00
DATE: 11/3/2021
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 100mm)
13	0	FILL Sandy GRAVEL (GM): fine to coarse, brown-grey, fine to coarse sand, moist, dense to very dense							
		- medium dense		S	0.5		6,7,15 N = 22		
					0.95				
12	1.1	SANDSTONE: fine to medium, grey with orange and red-brown, very low strength, highly weathered (Aspley Formation)		S	1.2		30/70mm		
	1.3	Bore discontinued at 1.3m depth - Refusal on very low strength or stronger sandstone			1.27				
11	2								
10	3								
9	4								
8	5								
7	6								
6	7								
5	8								
4	9								
3	10								

Dynamic Penetrometer Test (blows per 100mm): 5, 10, 15, 20

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:** Uncased

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 12.1 mAHD
EASTING: 502019
NORTHING: 6956408
DIP/AZIMUTH: 90°/--

BORE No: 8
PROJECT No: 200443.00
DATE: 11/3/2021
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 100mm)
12		Sandy CLAY (CL): low plasticity, brown mottled grey, fine to coarse sand, with relict rock structure, w>PL, hard (Residual)			0.5				
				S			18, 28, 30/130mm		
11	0.8 1	SANDSTONE: fine to medium, grey and orange-brown, very low strength, highly weathered (Aspley Formation)			0.93				
	1.4			S	1.3 1.4		30/100mm		
10	2	Bore discontinued at 1.4m depth - Refusal on very low strength or stronger sandstone							
9	3								
8	4								
7	5								
6	6								
5	7								
4	8								
3	9								
2	10								

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:** Uncased

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 18.3 mAHD
EASTING: 502010
NORTHING: 6956303
DIP/AZIMUTH: 90°/--

BORE No: 10
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
18	0.2	FILL Sandy CLAY (CL): low plasticity, brown, fine to coarse sand, w>PL, stiff to very stiff							
	0.7	FILL Silty SAND (SM): fine to coarse, brown-orange, moist, loose		S	0.5		6,4,7 N = 11		
17	1.0	Silty CLAY (CH): high plasticity, grey mottled red-brown, w~PL, stiff to very stiff (Residual)			0.95				
		Bore discontinued at 1.0m depth - Limit of investigation							

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:** Uncased

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 8.5 mAHD
EASTING: 502098
NORTHING: 6956427
DIP/AZIMUTH: 90°/--

BORE No: 12
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
8.5	0.0	FILL Sandy GRAVEL (GM): fine to coarse, grey, with clay, dry, dense to very dense		D	0.1				
7.9	0.6	FILL Sandy CLAY (CL): low plasticity, brown-orange with grey, fine to medium sand, trace fine to coarse gravel, w<PL, stiff			1.0				
				S			2,4,4 N = 8		
7.2	1.3	Clayey SAND (SC): fine to medium, grey, very moist, loose (Residual)			1.45				
6.9	1.6	Sandy CLAY (CH): high plasticity, grey with orange, w>PL, firm to stiff (Residual)							
6.5	2.0	Silty CLAY (CH): high plasticity, pale grey mottled orange-brown, trace fine sand, w>PL, firm to stiff (Residual)			2.5				
		- w~PL, stiff		S			3,5,7 N = 12		
					2.95				
					3.5				
				S			4,6,7 N = 13		
4.5	4.0	Bore discontinued at 4.0m depth - Limit of investigation			3.95				

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit. Well installed to 3m

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 10.0 mAHD
EASTING: 502083
NORTHING: 6956398
DIP/AZIMUTH: 90°/--

BORE No: 13
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
10		FILL Sandy GRAVEL (GM): fine to coarse, brown, fine to coarse sand, dry, dense							
	0.6			D	0.7				
	0.8	Silty CLAY (CH): high plasticity, grey mottled orange-brown, with fine to coarse sand, w~PL, stiff (Residual)			1.0				
9	1	Sandy CLAY (CL): low plasticity, orange with grey, fine to medium sand, w<PL, very stiff (Residual)		S	1.2		10, 30/50mm		
		- grey mottled orange-brown, hard							
8	2	- with some interbedded very low strength, highly weathered sandstone layers							
		- very stiff			2.5				
				S			4,11,15 N = 26		
7	3	- hard			2.95				
		- becoming red-brown			3.5				
				S			22,25,23 N = 48		
6	4	4.0 Bore discontinued at 4.0m depth - Limit of investigation			3.95				
5	5								
4	6								
3	7								
2	8								
1	9								
0	10								

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:** Uncased

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 8.5 mAHD
EASTING: 502077
NORTHING: 6956432
DIP/AZIMUTH: 90°/--

BORE No: 14
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
8.5	0.0	FILL Silty SAND (SM): fine, dark grey-brown, dry, dense		D	0.1				
		- grey-brown							
8	0.4	CLAY (CH): high plasticity, grey mottled orange-brown, trace fine to coarse sand, w~PL, stiff (Residual)		D	0.5		pp >350		
				U_{50}	0.7–0.8				
7	1.0	- with trace fine gravel			1.0				
	1.2	Sandy CLAY (CI): medium plasticity, grey mottled orange-brown, fine to coarse sand, trace fine to medium gravel, w<PL, hard (Residual)		S	1.45		7,15,22 N = 37		
6	2.0			S	2.5		14, 24, 30/30mm		
		- pale grey, with relict rock structure (extremely weathered sandstone)			2.83				
5	3.0			S	3.5		12,17,25 N = 42		
4	4.0	Bore discontinued at 4.0m depth - Limit of investigation			3.95				

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 13.7 mAHD
EASTING: 502079
NORTHING: 6956321
DIP/AZIMUTH: 90°/--

BORE No: 15
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
13	0.1	FILL Sandy GRAVEL (GM): fine to coarse, brown-grey, fine to coarse sand, moist, medium dense							
		FILL Sandy CLAY (CL): low plasticity, brown, fine to coarse sand, with fine to coarse gravel and cobbles, w>PL, stiff		S	0.5		3,7,8 N = 15		
12	1				0.95				
		- with clay, firm		S	2.0		2,3,3 N = 6		
11	2.4	Silty CLAY (CH): high plasticity, dark grey, w>PL, firm to soft (Residual)			2.45				
	3	- grey							
	3.3	- stiff							
10		Sandy CLAY (CL): low plasticity, pale grey mottled orange-brown, fine to medium sand, w<PL, very stiff (Residual)		S	3.5		5,7,9 N = 16		
	4				3.95				
9	4.0	Bore discontinued at 4.0m depth - Limit of investigation							
8	5								
7	6								
6	7								
5	8								
4	9								
	10								

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 16.4 mAHD
EASTING: 502098
NORTHING: 6956291
DIP/AZIMUTH: 90°/--

BORE No: 16
PROJECT No: 200443.00
DATE: 11/3/2021
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 100mm)
16	0.0	FILL Gravelly CLAY (/CL): low plasticity, grey, fine to coarse gravel, with fine to coarse sand and cobbles, w<PL, hard		S	0.5		10,12,24 N = 36		
					0.95				
15	1.3	FILL CLAY (CH): high plasticity, grey with brown-orange and red-brown, trace fine to coarse sand and gravel, w~PL, stiff		S	2.0		2,4,5 N = 9		
					2.45				
13	2.7	Silty CLAY (CH): high plasticity, grey mottled orange-brown, w>PL, stiff (Residual) - pale grey mottled orange-brown - stiff		S	3.5		3,6,5 N = 11		
					3.95				
12	4.0	Bore discontinued at 4.0m depth - Limit of investigation							

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 17.0 mAHD
EASTING: 502071
NORTHING: 6956268
DIP/AZIMUTH: 90°/--

BORE No: 17
PROJECT No: 200443.00
DATE: 11/3/2021
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 100mm)
17									5 10 15 20
	0.4	FILL Gravelly CLAY (CL): low plasticity, grey, fine to coarse gravel, with fine to coarse sand and cobbles, w<PL, very stiff to hard		D	0.2				
		FILL CLAY (CH): high plasticity, grey with brown-orange and red-brown, trace fine to coarse sand and gravel, w~PL, stiff		S	0.5		4,7,6 N = 13		
16	1				0.95				1
	1.1	Silty CLAY (CH): high plasticity, dark grey, w>PL, firm (Residual)			1.2				
		- grey mottled red-brown		D U_{50}	1.7		pp >210		
15	2	- stiff			2.0				2
				S	2.45		2,2,4 N = 6		
14	3								3
		- pale grey mottled red-brown, w<PL, very stiff			3.5				
				S	3.95		6,9,13 N = 22		
13	4	4.0 Bore discontinued at 4.0m depth - Limit of investigation							4
12	5								5
11	6								6
10	7								7
9	8								8
8	9								9
7	10								10

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 9.3 mAHD
EASTING: 502037
NORTHING: 6956435
DIP/AZIMUTH: 90°/--

BORE No: 18
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
9.3	0.2	FILL Sandy CLAY (CL): low plasticity, brown with grey, fine to medium sand, trace fine to coarse gravel and cobbles, w<PL, stiff to very stiff		D	0.1				
		SANDSTONE: fine to medium, pale grey and orange-brown, very low strength (Aspley Formation)		D	0.5				
8.3	1	- very low to low strength		S	1.0		30/30mm		
8.1	1.2	Bore discontinued at 1.2m depth - Refusal on very low to low strength or stronger sandstone			1.03				

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 11.8 mAHD
EASTING: 502017
NORTHING: 6956418
DIP/AZIMUTH: 90°/--

BORE No: 19
PROJECT No: 200443.00
DATE: 11/3/2021
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 100mm)
11	0.2	FILL Gravelly SAND (SM): fine to coarse, brown, fine to coarse gravel, with cobbles, with clay, moist, medium dense							
	0.7	FILL Sandy CLAY (CL): low plasticity, brown with grey, fine to coarse sand, with fine to coarse gravel, w>PL, stiff		S	0.5		3,13,22 N = 35		
10	1	Sandy CLAY (CL): low plasticity, pale grey mottled orange-brown, fine to medium sand, trace fine to medium gravel, w<PL, hard (Residual) - with interbedded very low strength, highly weathered sandstone			0.95				
	2			S	2.0		21, 18, 30/110mm		
9	2.3	SANDSTONE: fine to medium, pale grey and orange-brown, very low strength, highly weathered (Aspley Formation)			2.41				
	3	3.01 - very low to low strength		S	3.0		30/10mm		
		Bore discontinued at 3.01m depth - Refusal on very low to low strength or stronger sandstone			3.01				
8	4								
7	5								
6	6								
5	7								
4	8								
3	9								
2	10								

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 14.0 mAHD
EASTING: 502027
NORTHING: 6956375
DIP/AZIMUTH: 90°/--

BORE No: 20
PROJECT No: 200443.00
DATE: 11/3/2021
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 100mm)
14	0.2	FILL Sandy CLAY (CL): low plasticity, brown with grey, fine to coarse sand, trace fine to coarse gravel, w<PL, very stiff		D	0.2				
	0.3			S	0.5		30/70mm		
	0.6	Sandy CLAY (CI): medium plasticity, pale grey mottled orange-brown, w<PL, Hard (Residual)			0.57				
13	1	SANDSTONE: fine to medium grained, pale grey and orange-brown, very low strength, highly weathered (Aspley Formation)							
		Bore discontinued at 0.6m depth - Refusal on very low to low strength or stronger sandstone							
12	2								
11	3								
10	4								
9	5								
8	6								
7	7								
6	8								
5	9								
4	10								

Dynamic Penetrometer Test (blows per 100mm): 5, 10, 15, 20

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 17.1 mAHD
EASTING: 502006
NORTHING: 6956336
DIP/AZIMUTH: 90°/--

BORE No: 21
PROJECT No: 200443.00
DATE: 11/3/2021
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 100mm)
17	0.0	FILL Silty SAND (SM): fine to coarse, brown, with fine to coarse gravel, trace cobble, building rubble, moist, dense		D	0.0				
	0.4	Silty CLAY (CH): high plasticity, grey mottled red-brown, with fine sand, w~PL, stiff (Residual)		D	0.1				
				S	0.5		3,4,4 N = 8		
16	1.0	Sandy CLAY (CL): low plasticity, grey mottled orange-brown, fine to medium sand, w<PL, hard (Residual)			0.95				
	1.3	SANDSTONE: fine to medium, grey with orange-brown, very low strength, highly weathered (Aspley Formation)		S	2.0		15, 30/120mm		
15	2				2.27				
		- pale grey with red-brown, with relict rock structure (extremely weathered sandstone) - very low to low strength							
14	3.14	Bore discontinued at 3.14m depth - Refusal on very low to low strength or stronger sandstone		S	3.1 3.14		30/40mm (hammer bounce)		
13	4								
12	5								
11	6								
10	7								
9	8								
8	9								
7	10								

Dynamic Penetrometer Test (blows per 100mm): 5, 10, 15, 20

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:**

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit.

☐ 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: Economic Development Queensland
PROJECT: Yeronga Priority Development Area
LOCATION: Park Road, Yeronga

SURFACE LEVEL: 12.1 mAHD
EASTING: 502119
NORTHING: 6956343
DIP/AZIMUTH: 90°/--

BORE No: 22
PROJECT No: 200443.00
DATE: 10/3/2021
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 100mm)
12	0.0	FILL Gravelly Sandy CLAY (CI): medium plasticity, brown, fine to coarse sand, fine to coarse gravel, with cobbles and boulders, w~PL, stiff to hard		D	0.0				
		- stiff		S	0.5		3,2,6 N = 8		
11	1				0.95				1
				D	1.3				
	1.5	Sandy CLAY (CI): medium plasticity, grey mottled red and orange-brown, fine to medium sand, w~PL, very stiff (Residual)		D	1.5				
10	2	- becoming grey		S	2.0		10,13,16 N = 29		2
					2.45				
9	3				3.5				3
				S			3,11,18 N = 29		
8	4.0	Bore discontinued at 4.0m depth - Limit of investigation			3.95				4
7	5								5
6	6								6
5	7								7
4	8								8
3	9								9
2	10								10

RIG: Christie **DRILLER:** Geoserve **LOGGED:** NS **CASING:** Uncased

TYPE OF BORING: Auger

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit. Well installed to 4m

☐ 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: Turner & Townsend Pty Ltd
PROJECT: Proposed PDA Civil Works - Additional Investigation
LOCATION: 701 Park Road, Yeronga

SURFACE LEVEL: 18.5 mAHD
EASTING: 501998.2
NORTHING: 6956277.3
DIP/AZIMUTH: 90°/--

BORE No: 23
PROJECT No: 200443.01
DATE: 13/12/2022
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering	Graphic Log	Rock Strength	Water	Fracture Spacing (m)	Discontinuities	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
			EW HW MW SW FS FR		Ex Low Very Low Low Medium High Very High Ex High		0.01 0.05 0.10 0.50 1.00	B - Bedding J - Joint S - Shear F - Fault				
18	0.0	FILL CLAY (CH): high plasticity, pale grey, w~PL, estimated firm							D			
									D			
	0.6	Silty CLAY (CI): medium plasticity, pale grey mottled orange and red-brown, w~PL, stiff (Residual)										
17	1								S			4,6,6 N = 12
	2	- trace fine sand, very stiff							S			9,10,16 N = 26
15	3											
14	4.0	SANDSTONE: fine to medium grained, pale grey and red-brown, very low to low strength, highly weathered weathered (Aspley Formation)							S			30/80mm
13	5								S			30/80mm
12	6											
	7								S			30/80mm
11	7.1	SANDSTONE: fine grained, light grey to dark grey, orange-red-brown, medium strength, moderately weathered, fractured to slightly fractured (Aspley Formation)						7.46m: J, 5°, ir, ro 7.76m: J, 5°, ir, ro 7.87m: J, 5°, ir, ro	C			PL(A) = 0.64 PL(D) = 0.43
10	8							8.3m: J, 5°, ir, ro	C	99	48	PL(A) = 0.69
								8.59m: J, 5°, ir, ro 8.83m: J, 5°, ir, ro 8.97m: J, 5°, ir, ro	C			PL(D) = 0.51
	9											
9	9.33 9.41	CONGLOMERATE: coarse grained, grey and orange-brown, medium to high strength, slightly weathered (Band)						9.3m: Cs, v, ir, 10mm thick	C			PL(A) = 0.39 PL(D) = 0.41
	10.0											

RIG:
DRILLER: MK Drilling
LOGGED: SP/JB
CASING: Uncased

TYPE OF BORING: Auger to 7m depth, then NMLC to 10m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit

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: Turner & Townsend Pty Ltd
PROJECT: Proposed PDA Civil Works - Additional Investigation
LOCATION: 701 Park Road, Yeronga

SURFACE LEVEL: 18.5 mAHD
EASTING: 501998.2
NORTHING: 6956277.3
DIP/AZIMUTH: 90°/--

BORE No: 23
PROJECT No: 200443.01
DATE: 13/12/2022
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
8	11	SANDSTONE: fine to medium grained, orange-brown and grey, medium strength, moderately weathered, slightly fractured (Aspley Formation)										
7	12	Bore discontinued at 10.0m depth - Limit of investigation										
6	13											
5	14											
4	15											
3	16											
2	17											
1	18											
0	19											
-1												

RIG:
DRILLER: MK Drilling
LOGGED: SP/JB
CASING: Uncased

TYPE OF BORING: Auger to 7m depth, then NMLC to 10m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit

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: Turner & Townsend Pty Ltd
PROJECT: Proposed PDA Civil Works - Additional Investigation
LOCATION: 701 Park Road, Yeronga

SURFACE LEVEL: 18.3 mAHD
EASTING: 502016.1
NORTHING: 6956287.3
DIP/AZIMUTH: 90°/--

BORE No: 24
PROJECT No: 200443.01
DATE: 13/12/2022
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low / Very Low / Low / Medium / High / Very High / Ex High)	Water	Fracture Spacing (m) (0.01 / 0.05 / 0.10 / 0.50 / 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
18	0.0	FILL Sandy CLAY (CL): low plasticity, pale grey, fine to medium sand, w<PL. estimated firm							D			
									D			
	0.6	Silty CLAY (CI): medium plasticity, pale grey mottled yellow-brown, trace fine sand, w~PL, stiff to very stiff (Residual)										
17	1								S			7,15,14 N = 29
16	2	- pale grey mottled red and yellow-brown							S			8,9,13 N = 22
15	3											
14	4								S			5, 30/100
	4.15	SANDSTONE: fine grained, pale grey and red-brown, very low strength, highly weathered (Aspley Formation)										
13	5								C			PL(A) = 0.82
	5.5	SANDSTONE: fine grained, pale grey and yellow-brown, medium strength, highly to moderately weathered, highly fractured (Aspley Formation)						5.51m: J, 10°, ir, ro	S			PL(D) = 0.85 30/60
								5.82m: DB, 40mm				
12	6								C	100	45	
	6.12	SILTSTONE: fine grained, pale brown, red-brown and dark grey, very low strength, highly weathered, highly fractured, laminated (Aspley Formation)							C			PL(A) = 0.36 PL(D) = 0.16
	6.44							6.44m: J, 5°, ir, ro				
								6.59m: J, 10°, ir, ro				
	6.86							6.65m: DB				
11	7	SANDSTONE: fine grained, pale brown, medium strength, moderately weathered, fractured to slighly fractured (Aspley Formation)						6.8m: DB				
	7.05							7.26m: J, 5°, ir, ro				
								7.32m: J, 5°, ir, ro	C			PL(A) = 0.73 PL(D) = 0.62
		SILTSTONE: fine grained, pale brown, red-brown and dark grey, very low strength, highly weathered, highly fractured, laminated (Aspley Formation)						7.36m: J, 5°, ir, ro				
								7.4m: J, 5°, ir, ro				
								7.51m: J, 5°, ir, ro				
10	8							7.92m: DB				
								8.02m: J, 5°, ir, ro				
								8.06m: J, 5°, ir, ro	C	100	78	PL(A) = 0.51 PL(D) = 0.3
								8.31m: J, st, ro	C			
		SANDSTONE: fine grained, pale brown, medium strength, moderately weathered, fractured to slightly fractured (Aspley Formation) - light grey						8.56m: J, st, ro				
								8.85m: DB, 30mm				
9	9							9.02m: J, 5°, ir, ro				
								9.04m: J, 5°, ir, ro				
		- fractured						9.63m: J, 5°, ir, ro	C			PL(A) = 0.99 PL(D) = 0.83
	10.0							9.8m: DB	C	100	100	

Bore discontinued at 10.0m depth - Limit of investigation

RIG: **DRILLER:** MK Drilling **LOGGED:** SP/JB **CASING:** Uncased

TYPE OF BORING: Auger to 5.5m depth, then NMLC to 10m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit

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: Turner & Townsend Pty Ltd
PROJECT: Proposed PDA Civil Works - Additional Investigation
LOCATION: 701 Park Road, Yeronga

SURFACE LEVEL: 18.3 mAHD
EASTING: 502016.1
NORTHING: 6956287.3
DIP/AZIMUTH: 90°/--

BORE No: 24
PROJECT No: 200443.01
DATE: 13/12/2022
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW, HW, MW, SW, FS, FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, F - Fault)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
8	10											
7	11											
6	12											
5	13											
4	14											
3	15											
2	16											
1	17											
0	18							9.91m: DB				
-1	19											

RIG:
DRILLER: MK Drilling
LOGGED: SP/JB
CASING: Uncased

TYPE OF BORING: Auger to 5.5m depth, then NMLC to 10m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit

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: Turner & Townsend Pty Ltd
PROJECT: Proposed PDA Civil Works - Additional Investigation
LOCATION: 701 Park Road, Yeronga

SURFACE LEVEL: 18.3 mAHD
EASTING: 501997
NORTHING: 6956293.8
DIP/AZIMUTH: 90°/--

BORE No: 25
PROJECT No: 200443.01
DATE: 24/11/2021
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 100mm)
18	0.6	FILL Sandy CLAY (CI): medium plasticity, pale brown with orange-brown, fine to medium sand, trace fine to medium gravel, w<PL, stiff - very stiff		D	0.5				
		Silty CLAY (CI): medium plasticity, grey mottled orange-brown, trace fine sand, w<PL, very stiff (Residual)		D	0.6				
17	1	- very stiff		S	1.0		6,11,16 N = 27		
		- hard			1.45				
16	1.9	SILTSTONE: fine grained, pale brown and orange-brown, very low strength, highly weathered, with interbedded relict rock structure (Aspley Formation)							
	2	- very low to low strength							
	2.4	Bore discontinued at 2.4m depth - Refusal on probable low to medium strength siltstone		S	2.4 2.43		30/30mm		
15	3								
14	4								
13	5								
12	6								

RIG: **DRILLER:** Geoserve **LOGGED:** Geoserve/SP **CASING:** Uncased

TYPE OF BORING: Auger to 2.4m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit

☐ 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: Turner & Townsend Pty Ltd
PROJECT: Proposed PDA Civil Works - Additional Investigation
LOCATION: 701 Park Road, Yeronga

SURFACE LEVEL: 18.8 mAHD
EASTING: 502012.6
NORTHING: 6956274.9
DIP/AZIMUTH: 90°/--

BORE No: 26
PROJECT No: 200443.01
DATE: 24/11/2021
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 100mm)
18	0.2	TOPSOIL FILL Sandy CLAY (CL): low plasticity, dark brown and grey, fine to medium sand, trace fine to coarse gravel, with some organics, w>PL, soft		D	0.2				
	0.5	FILL Gravelly CLAY (CI): medium plasticity, light grey with orange-brown, fine to coarse gravel, with fine to coarse sand, w>PL, hard		D	0.5				
18	1	Silty CLAY (CL): low plasticity, pale grey mottled red-brown, trace fine sand, with relict rock strcuture, w<PL, hard (Residual)			1.0				
		- hard		S			14,20,25 N = 45		
					1.45				
17	2								
					2.5				
				S			5, 30/140mm		
16					2.79				
	3								
15		- grey mottled orange-brown							
	4				4.0				
	4.15	SANDSTONE: fine to medium grained, red-brown and orange-brown, very low strength, highly weathered, with interbedded relict rock structure (Aspley Formation)		S			22, 30/120mm		
					4.27				
14	5								
					5.5				
				S			8, 30/120mm		
13					5.77				
	6	- very low to low strength							
					6.4				
	6.48			S	6.48		30/70mm		
12		Bore discontinued at 6.48m depth - Refusal on probable low to medium strength sandstone							

RIG: **DRILLER:** Geoserve **LOGGED:** Geoserve/SP **CASING:** Uncased

TYPE OF BORING: Auger to 6.4m depth

WATER OBSERVATIONS: No free groundwater observed

REMARKS: w = moisture content, PL = plastic limit

☐ 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

Appendix D

Laboratory Results

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Brisbane Laboratory
439 Montague Road West End QLD 4101
Phone: (07) 3237 8900
Fax: (07) 3237 8999
Email: aimee.cartwright@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Aimee Cartwright
Laboratory Technician
Laboratory Accreditation Number: 828

Report Number: **200443.00-1**
Issue Number: 1
Date Issued: 23/03/2021
Client: Economic Development Queensland
GPO Box 2202, Brisbane QLD 4001
Contact: John Marshall
Project Number: 200443.00
Project Name: Yeronga Priority Development Area
Project Location: Park Road, Yeronga
Work Request: 10260
Sample Number: BN-10260A
Date Sampled: 10/03/2021
Dates Tested: 15/03/2021 - 17/03/2021
Sampling Method: Sampled by Others
The results apply to the sample as received
Sample Location: **Bore 16, Depth: 0.50 - 0.95 m**
Material: Fill /Gravelly CLAY

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	As per material description		
Nature of Water	De-ionized		
Temperature of Water (^{o}C)	22.6		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Brisbane Laboratory
439 Montague Road West End QLD 4101
Phone: (07) 3237 8900
Fax: (07) 3237 8999
Email: aimee.cartwright@douglaspartners.com.au

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Approved Signatory: Aimee Cartwright
Laboratory Technician
Laboratory Accreditation Number: 828

Report Number: **200443.00-1**
Issue Number: 1
Date Issued: 23/03/2021
Client: Economic Development Queensland
GPO Box 2202, Brisbane QLD 4001
Contact: John Marshall
Project Number: 200443.00
Project Name: Yeronga Priority Development Area
Project Location: Park Road, Yeronga
Work Request: 10260
Sample Number: BN-10260B
Date Sampled: 10/03/2021
Dates Tested: 15/03/2021 - 17/03/2021
Sampling Method: Sampled by Others
The results apply to the sample as received
Sample Location: **Bore 7, Depth: 0.50 - 0.95 m**
Material: Fill/ Sandy GRAVEL

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**1**		
Soil Description	As per material description		
Nature of Water	De-ionized		
Temperature of Water (^{o}C)	22.6		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
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Brisbane Laboratory
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Approved Signatory: Aimee Cartwright
Laboratory Technician
Laboratory Accreditation Number: 828

Report Number: **200443.00-1**
Issue Number: 1
Date Issued: 23/03/2021
Client: Economic Development Queensland
GPO Box 2202, Brisbane QLD 4001
Contact: John Marshall
Project Number: 200443.00
Project Name: Yeronga Priority Development Area
Project Location: Park Road, Yeronga
Work Request: 10260
Sample Number: BN-10260C
Date Sampled: 10/03/2021
Dates Tested: 15/03/2021 - 17/03/2021
Sampling Method: Sampled by Others
The results apply to the sample as received
Sample Location: **Bore 2, Depth: 0.50 m**
Material: Fill/ Gravelly Sandy CLAY

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**1**		
Soil Description	As per material description		
Nature of Water	De-ionized		
Temperature of Water (^{o}C)	22.6		

Material Test Report

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Approved Signatory: Aimee Cartwright
Laboratory Technician
Laboratory Accreditation Number: 828

Report Number: **200443.00-1**
Issue Number: 1
Date Issued: 23/03/2021
Client: Economic Development Queensland
GPO Box 2202, Brisbane QLD 4001
Contact: John Marshall
Project Number: 200443.00
Project Name: Yeronga Priority Development Area
Project Location: Park Road, Yeronga
Work Request: 10260
Sample Number: BN-10260D
Date Sampled: 10/03/2021
Dates Tested: 15/03/2021 - 17/03/2021
Sampling Method: Sampled by Others
The results apply to the sample as received
Sample Location: **Bore 19, Depth: 0.50 m**
Material: Fill/ Sandy CLAY

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	As per material description		
Nature of Water	De-ionized		
Temperature of Water (^{o}C)	22.6		

Material Test Report

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Approved Signatory: Aimee Cartwright
Laboratory Technician
Laboratory Accreditation Number: 828

Report Number: **200443.00-1**
Issue Number: 1
Date Issued: 23/03/2021
Client: Economic Development Queensland
GPO Box 2202, Brisbane QLD 4001
Contact: John Marshall
Project Number: 200443.00
Project Name: Yeronga Priority Development Area
Project Location: Park Road, Yeronga
Work Request: 10260
Sample Number: BN-10260E
Date Sampled: 10/03/2021
Dates Tested: 15/03/2021 - 17/03/2021
Sampling Method: Sampled by Others
The results apply to the sample as received
Sample Location: **Bore 21, Depth: 0.50 - 0.95 m**
Material: Silty CLAY

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	As per material description		
Nature of Water	De-ionized		
Temperature of Water (^{o}C)	22.6		

Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Brisbane Laboratory
439 Montague Road West End QLD 4101
Phone: (07) 3237 8900
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Email: aimee.cartwright@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Aimee Cartwright
Laboratory Technician
Laboratory Accreditation Number: 828

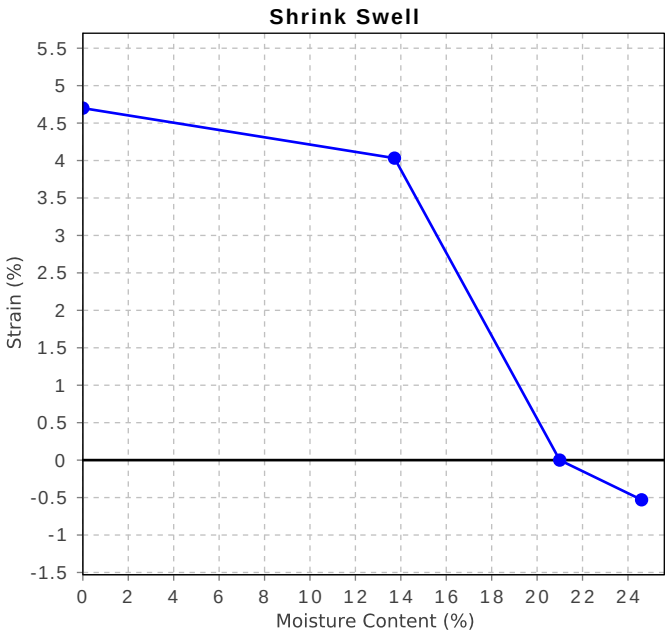
Report Number: **200443.00-1**
Issue Number: 1
Date Issued: 23/03/2021
Client: Economic Development Queensland
GPO Box 2202, Brisbane QLD 4001
Contact: John Marshall
Project Number: 200443.00
Project Name: Yeronga Priority Development Area
Project Location: Park Road, Yeronga
Work Request: 10260
Sample Number: BN-10260F
Date Sampled: 10/03/2021
Dates Tested: 15/03/2021 - 17/03/2021
Sampling Method: Sampled by Others
The results apply to the sample as received
Sample Location: **Bore 14, Depth: 0.50 - 0.80 m**
Material: CLAY

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	As per material description		
Nature of Water	De-ionized		
Temperature of Water (^{o}C)	22.6		

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.8**
Visual Description	Silty CLAY
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**4.7**
Estimated % by volume of significant inert inclusions	10
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	21.0

Swell Test	
Initial Pocket Penetrometer (kPa)	460
Final Pocket Penetrometer (kPa)	320
Initial Moisture Content (%)	24.2
Final Moisture Content (%)	24.6
Swell (%)	**0.5**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Brisbane Laboratory
439 Montague Road West End QLD 4101
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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Aimee Cartwright
Laboratory Technician
Laboratory Accreditation Number: 828

Report Number:	**200443.00-1**
Issue Number:	1
Date Issued:	23/03/2021
Client:	Economic Development Queensland GPO Box 2202, Brisbane QLD 4001
Contact:	John Marshall
Project Number:	200443.00
Project Name:	Yeronga Priority Development Area
Project Location:	Park Road, Yeronga
Work Request:	10260
Sample Number:	BN-10260G
Date Sampled:	10/03/2021
Dates Tested:	15/03/2021 - 15/03/2021
Sampling Method:	Sampled by Others *The results apply to the sample as received*
Sample Location:	**Bore 17, Depth: 1.20 - 1.70 m**
Material:	Silty CLAY

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**1.4**
Visual Description	Silty CLAY
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**2.6**
Estimated % by volume of significant inert inclusions	20
Cracking	Slightly Cracked
Crumbling	No
Moisture Content (%)	18.8

Swell Test	
Initial Pocket Penetrometer (kPa)	200
Final Pocket Penetrometer (kPa)	240
Initial Moisture Content (%)	31.0
Final Moisture Content (%)	33.4
Swell (%)	**-0.0**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	

Material Test Report

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Report Number: **200443.00-1**
Issue Number: 1
Date Issued: 23/03/2021
Client: Economic Development Queensland
GPO Box 2202, Brisbane QLD 4001
Contact: John Marshall
Project Number: 200443.00
Project Name: Yeronga Priority Development Area
Project Location: Park Road, Yeronga
Work Request: 10260
Sample Number: BN-10260H
Date Sampled: 10/03/2021
Dates Tested: 15/03/2021 - 17/03/2021
Sampling Method: Sampled by Others
The results apply to the sample as received
Sample Location: **Bore 13, Depth: 0.70 m**
Material: Silty CLAY

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	62		
Plastic Limit (%)	22		
Plasticity Index (%)	**40**		
Weighted Plasticity Index (%)	2676		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	14.0		
Cracking Crumbling Curling	Curling		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	21.2

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Report Number: **200443.00-1**
Issue Number: 1
Date Issued: 23/03/2021
Client: Economic Development Queensland
GPO Box 2202, Brisbane QLD 4001
Contact: John Marshall
Project Number: 200443.00
Project Name: Yeronga Priority Development Area
Project Location: Park Road, Yeronga
Work Request: 10260
Sample Number: BN-10260I
Date Sampled: 10/03/2021
Dates Tested: 15/03/2021 - 17/03/2021
Sampling Method: Sampled by Others
The results apply to the sample as received
Sample Location: **Bore 3, Depth: 1.00 - 1.45 m**
Material: Silty CLAY

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	39		
Plastic Limit (%)	23		
Plasticity Index (%)	**16**		
Weighted Plasticity Index (%)	1269		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	9.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	14.7

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Report Number:	**200443.01-2**
Issue Number:	1
Date Issued:	16/12/2021
Client:	Turner & Townsend Pty Ltd
	GPO Box 627, BRISBANE QLD 4001Q
Contact:	Lachlan Rigney
Project Number:	200443.01
Project Name:	Proposed PDA Civil Works - Additional Investigation
Project Location:	701 Park Road, Yeronga QLD
Work Request:	12115
Sample Number:	BN-12115A
Date Sampled:	13/12/2021
Dates Tested:	14/12/2021 - 16/12/2021
Sampling Method:	Sampled by DP Brisbane Engineering Department
	The results apply to the sample as received
Sample Location:	**BH 23 , Depth: 0.50m**
Material:	Fill CLAY

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	As per material description		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	23		

pH Value of Soil (AS 1289 4.3.1)	
Depth	0.50 m
pH	3.9
Electrical Conductivity (µS/cm)	

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Report Number:	**200443.01-2**
Issue Number:	1
Date Issued:	16/12/2021
Client:	Turner & Townsend Pty Ltd
	GPO Box 627, BRISBANE QLD 4001Q
Contact:	Lachlan Rigney
Project Number:	200443.01
Project Name:	Proposed PDA Civil Works - Additional Investigation
Project Location:	701 Park Road, Yeronga QLD
Work Request:	12115
Sample Number:	BN-12115B
Date Sampled:	13/12/2021
Dates Tested:	14/12/2021 - 16/12/2021
Sampling Method:	Sampled by DP Brisbane Engineering Department
	The results apply to the sample as received
Sample Location:	**BH 24 , Depth: 0.50m**
Material:	Fill Sandy CLAY

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**3**		
Soil Description	As per material description		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	23		

pH Value of Soil (AS 1289 4.3.1)	
Depth	0.50 m
pH	3.7
Electrical Conductivity (µS/cm)	

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Report Number:	**200443.01-1**
Issue Number:	1
Date Issued:	07/12/2021
Client:	Turner & Townsend Pty Ltd GPO Box 627, BRISBANE QLD 4001Q
Contact:	Lachlan Rigney
Project Number:	200443.01
Project Name:	Proposed PDA Civil Works - Additional Investigation
Project Location:	701 Park Road, Yeronga QLD
Work Request:	12043
Sample Number:	BN-12043A
Date Sampled:	24/11/2021
Dates Tested:	01/12/2021 - 06/12/2021
Sampling Method:	Sampled by DP Brisbane Engineering Department *The results apply to the sample as received*
Sample Location:	**BH 25 , Depth: 0.20 - 0.50 m**
Material:	Fill Sandy CLAY

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Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**6**		
Soil Description	As per material description		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	23		

pH Value of Soil (AS 1289 4.3.1)	
Depth	0.20-0.50m
pH	6.1
Electrical Conductivity (µS/cm)	

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Report Number:	**200443.01-1**
Issue Number:	1
Date Issued:	07/12/2021
Client:	Turner & Townsend Pty Ltd GPO Box 627, BRISBANE QLD 4001Q
Contact:	Lachlan Rigney
Project Number:	200443.01
Project Name:	Proposed PDA Civil Works - Additional Investigation
Project Location:	701 Park Road, Yeronga QLD
Work Request:	12043
Sample Number:	BN-12043B
Date Sampled:	24/11/2021
Dates Tested:	01/12/2021 - 06/12/2021
Sampling Method:	Sampled by DP Brisbane Engineering Department *The results apply to the sample as received*
Sample Location:	**BH 26 , Depth: 0.50 m**
Material:	Silty CLAY

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Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	**2**		
Soil Description	As per material description		
Nature of Water	Distilled		
Temperature of Water (^{o}C)	23		

pH Value of Soil (AS 1289 4.3.1)	
Depth	0.50m
pH	3.8
Electrical Conductivity (µS/cm)	

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2136417**	Page	: 1 of 3
Client	: **DOUGLAS PARTNERS PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR MARC SALCOR	Contact	: John Pickering
Address	: 439 MONTAGUE ROAD WEST END QLD, AUSTRALIA 4101	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3237 8900	Telephone	: +61 7 3552 8634
Project	: Proposed Heart Commercial Building	Date Samples Received	: 14-Dec-2021 11:57
Order number	: 200443.01	Date Analysis Commenced	: 17-Dec-2021
C-O-C number	: ----	Issue Date	: 24-Dec-2021 12:26
Sampler	: Shebin		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 4		
No. of samples analysed	: 4		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ALS is not NATA accredited for the analysis of Exchangeable Aluminium and Exchange Acidity in soils when performed under ALS Method ED005.
- ALS is not NATA accredited for the analysis of Exchangeable Cations on Alkaline Soils when performed under ALS Method ED006.
- ED006 (Exchangeable Cations on Alkaline Soils): Unable to calculate Magnesium/Potassium Ratio result as required Exchangeable Potassium results are less than the limit of reporting.
- ED007 and ED008: When Exchangeable Al is reported from these methods, it should be noted that Rayment & Lyons (2011) suggests Exchange Acidity by 1M KCl - Method 15G1 (ED005) is a more suitable method for the determination of exchange acidity (H+ + Al3+).

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)			*Sample ID*	**BH23-0.5**	**BH24-0.5**	**BH25-0.5**	**BH26-0.5**	**----**
			Sampling date / time	13-Dec-2021 00:00	13-Dec-2021 00:00	13-Dec-2021 00:00	13-Dec-2021 00:00	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB2136417-001**	**EB2136417-002**	**EB2136417-003**	**EB2136417-004**	**--------**
				Result	Result	Result	Result	----
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**9.2**	**9.3**	**9.3**	**8.6**	**----**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**272**	**701**	**698**	**158**	**----**
ED006: Exchangeable Cations on Alkaline Soils								
ø Exchangeable Calcium	----	0.2	meq/100g	**0.3**	<0.2	**9.2**	**1.9**	**----**
ø Exchangeable Magnesium	----	0.2	meq/100g	**2.9**	**1.8**	**3.6**	**2.4**	**----**
ø Exchangeable Potassium	----	0.2	meq/100g	<0.2	<0.2	<0.2	**0.2**	**----**
ø Exchangeable Sodium	----	0.2	meq/100g	**3.0**	**1.4**	**3.3**	**2.2**	**----**
ø Cation Exchange Capacity	----	0.2	meq/100g	**6.4**	**3.2**	**16.3**	**6.7**	**----**
ø Exchangeable Sodium Percent	----	0.2	%	**46.7**	**42.4**	**20.5**	**33.1**	**----**
ø Calcium/Magnesium Ratio	----	0.2	-	<0.2	<0.2	**2.6**	**0.8**	**----**
ø Magnesium/Potassium Ratio	----	0.2	-	**----**	**----**	**----**	**9.8**	**----**