appendix f

engineering services report

(Cossill & Webley)

Cossill & Webley
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Lot 703 Armadale Road, Treeby
Engineering Servicing Report

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1. INTRODUCTION

The following report has been prepared by Cossill & Webley Pty Ltd (CW) and summarises the engineering aspects of the proposed urban development of Lot 703 Armadale Road, Treeby (referred to herein as the Site).

The Site is identified by the red boundary presented below in Figure 1 and is bound by Armadale Road to the south, Ghostgum Avenue to the west, Bush Forever to the north and land currently zoned Rural under the Metropolitan Region Scheme to the east.



Figure 1: Site Plan (Nearmap July 2019)

2. SITE DESCRIPTION

2.1 Planning Background

The Site is currently zoned 'Urban' under the Metropolitan Region Scheme and is zoned 'Resource' under the City of Cockburn's Town Planning Scheme No. 3.

2.2 Previous Land Uses

The Site was previously encompassed by an existing 'dead' Western Australian Mining Exploration (WAMEX) tenement previously used to mine sand for the neighbouring Midland Brick quarry. It is not anticipated this previous tenement will pose any restrictions on urban development of the Site.

Nearmap aerial data dating back to January 2008 shows Site was completely cleared during sand mining apart from the strip of retained bushland along the south and western boundaries. Only sparse vegetation has regrown in the last eleven years, as depicted in the latest aerial photo presented in Appendix A.

2.3 Geology

The Geological Survey of Western Australia Armadale Region Soils Map indicates the Site is generally characterised by Bassendean Sand. This soil type is generally free draining and is suitable for urbanisation. Figure 2 below presents the geology across the Site.

Douglas Partners have undertaken a preliminary geotechnical investigation across the site as presented in Appendix B. Douglas Partners have confirmed that from a geotechnical standpoint, the land is physically capable of development for the proposed residential development, subject to the recommendations of their geotechnical report being adhered to.

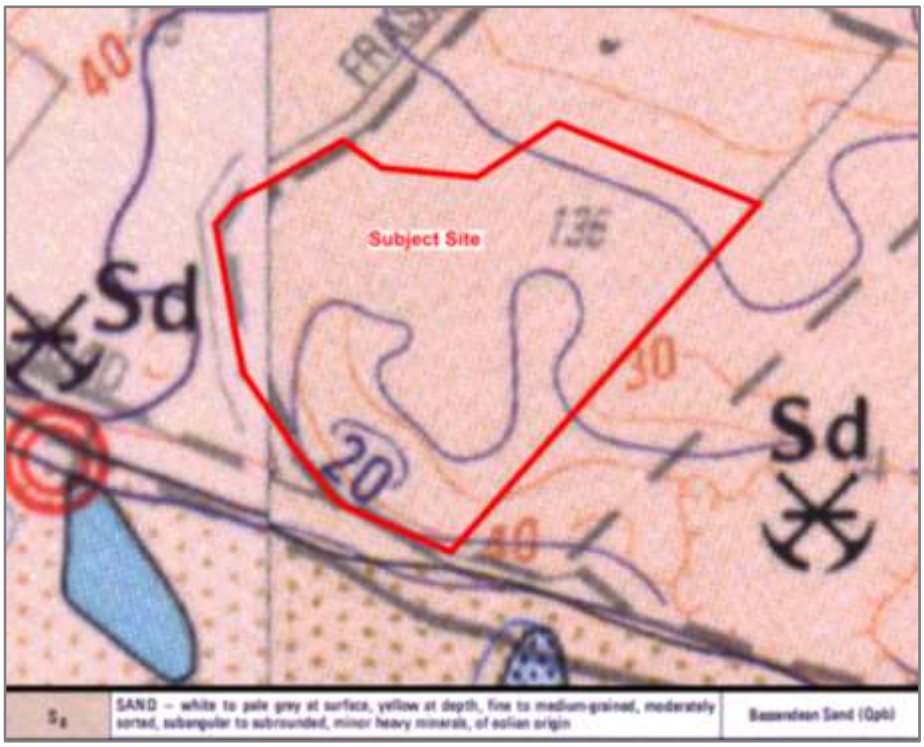


Figure 2: Geotechnical Information (Geological Survey of WA)

2.4 Surface Elevation

Based on topographical data provided by MNG, the Site has a long ridgeline along the south west boundary that rises up steeply from the adjacent road reserve to a maximum level of approximately RL 40m AHD and is in the order of 6.0-10.0m higher than the balance of the Site. The ridge along the southern boundary of the Site batters down to the Armadale Road duplication works, which at the time of writing (September 2019), were being completed by MRWA. The balance of the Site is relatively flat at a level of approximately RL 30m AHD through the base of the former quarry.

2.5 Groundwater

The Maximum Recorded Groundwater Level varies from approximately 26.9m AHD in the south west of the Site to 28.0m AHD in the north east according to the Department of Water's (DoW) Perth Groundwater Atlas, as presented below in Figure 3.

RPS in July 2019 calculated that the AAMGL contours for the Site range from 27.0m AHD along the northern boundary to 26.4m AHD at the south-eastern corner of the Site. Further information is available in RPS's Local Water Management Strategy.

The separation from the existing surface to the ground water table is typically two meters or more throughout the Site, and as such, groundwater management will need to be considered during development.

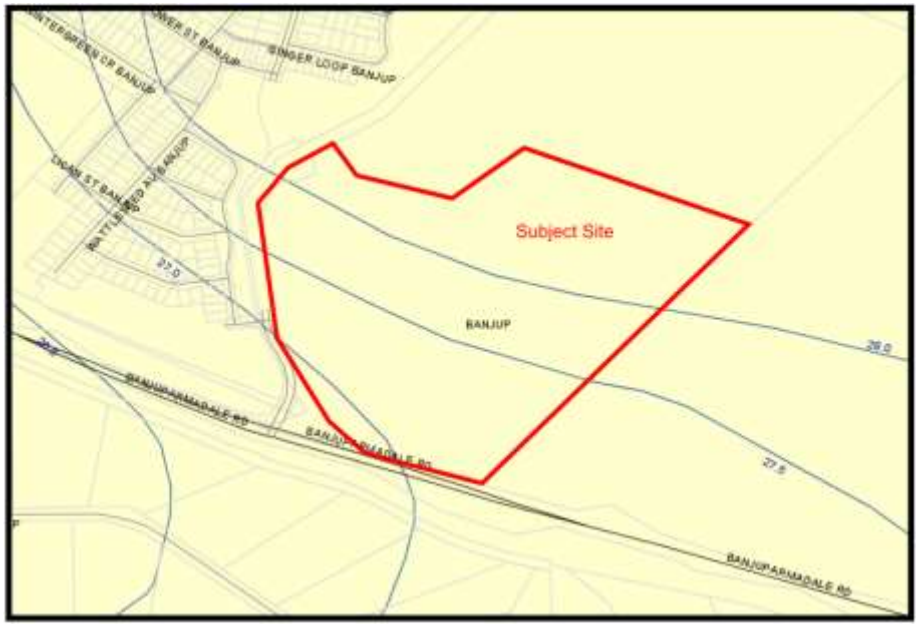


Figure 3: Historical Maximum Groundwater Contours (Department of Water 2016)

2.6 Public Drinking Water Source Area (PDWSA)

When the Site was re-zoned from "Rural – Water Protection" to "Urban" the Department of Water (DoW) reclassified the site from a P2 to a P3 protection status. This is deemed compatible with urban development.

2.7 Acid Sulphate Soils

A desk top review of the Department of Environment and Conservation's ASS Risk Map for the South Metropolitan Region for potential for Acid Sulphate Soils (ASS) indicates the Site is generally classified as having moderate to low risk of ASS occurring within 3m of the natural soil surface. The risk map is presented below in Figure 4.



Figure 4: Acid Sulphate Soils Risk Mapping (Department of Environment and Conservation)

Given the risk rating, it is recommended further testing is undertaken to determine the presence of ASS on the Site and the likely impact on development costs. Further information regarding Acid Sulphate Soils within the Site is presented in RPS's Environmental Assessment Report.

3. ROADWORKS

Access to the Site will be via the roundabout that has been constructed at the intersection of Ghostgum Avenue and Clementine Boulevard to the west of the Site. The intersection of Ghostgum Avenue with Armadale Road has been constructed as a signalised full movement tee intersection. Main Roads Western Australia (MRWA) is currently reconfiguring this intersection as part of the duplication of Armadale Road. In addition to the duplication of Armadale Road, MRWA awarded the Armadale Road to North Lake Road Bridge project in July 2019. As part of these works the Ghostgum Avenue intersection with Armadale Road will be upgraded to improve traffic flows; however, it is not anticipated that any revisions to this intersection will impact the development potential for the Site. The Armadale Road to North Lake Road Bridge project is projected to be completed by Late 2021.

The 25m road widening across the southern boundary of the site has occurred consistent with the WAPC's urban zone boundary.

The City of Cockburn has confirmed that the section Fraser Road between the intersection of Ghostgum Avenue/Clementine Boulevard and Solitaire Road has been closed. The engineering design for the section of Fraser Road from Solitaire Road to Jandakot Drive has been approved by the City of Cockburn and is currently under construction.

A secondary access location will be required as part of the initial stages of development to address emergency service requirements. This is currently proposed at the corner of Ghostgum Avenue and Armadale Road, and will be fenced off during normal operations.

All newly created roads, drainage and footpaths will need to be designed and constructed to the satisfaction of the City of Cockburn.

4. DRAINAGE

The Site is generally very flat, with clearance to groundwater as little as 2 metres to the existing surface at the northern half of the Site.

The proposed development will be required to retain stormwater runoff generated from newly created lots and roads on-site.

The 1 year 1 hour ARI event should be infiltrated within bio-filters as close to source as possible, with greater storm events retained within POS infiltration basins.

It is currently proposed that a subsoil drainage outlet be constructed to the Atwell Drain, directly south of the Site, south of Armadale Road. The Atwell Drain is a Council asset, which ultimately discharges into the Water Corporation's Bartram Road Branch Drain. The purpose of the subsoil drain would be to prevent a rise in the pre-development AAMGL which would assist with infiltration within the Central POS. With this proposal the subsoil drain would only be constructed underneath the central POS, with an outlet to the Atwell Drain as seen in Appendix C.

The feasibility of discharging the subsoil drain to the Atwell Drain, and ultimately the Bartram Road Brach Drain will require further modelling as part of a Local Water Management Strategy to confirm the capacity of this existing infrastructure.

5. SEWER RETICULATION

The Water Corporation has confirmed the Site is within their Banjup Catchment, with preliminary wastewater planning advice from the Water Corporation presented in Appendix D.

The Water Corporation planning confirms that the entire Site will be connected via gravity sewer to a 300mm diameter sewer that has been constructed as part of the Calleya development. This 300mm diameter sewer discharges to an existing Type 10 Waste Water Pumping Station (WWPS) located within the neighbouring Calleya development to the West of the Site. The Water Corporation has advised that the sizing of the sewer within the proposed site is subject to review following further investigation; however, their latest planning advice shows sewer to a maximum size of 225mm in diameter within the Site.

The Water Corporation has confirmed they are monitoring wastewater flows into the existing WWPS, and any upgrades required to accommodate increased flows from future development will be funded by the Water Corporation as part of their Capital Investment Program.

6. WATER RETICULATION

The Water Corporation has provided preliminary water reticulation planning advice as presented in Appendix E. The Water Corporation has however advised that approved water reticulation planning for the Site has not been undertaken as of yet.

The water reticulation planning advice that has been provided includes construction of a DN500 water main from

the South to the Site via Tapper and Armadale Roads. A DN375 water distribution main "loop" is proposed to be constructed as per Appendix E following extension of the DN500 main to Armadale Road. The Water Corporation has indicated that all water headworks items will need to be funded under the Capital Investment Program and brought on as demand increases progressively in the area.

The Water Corporation has advised that initial stages of development may be required to be serviced via a connection to the existing DN150 reticulation main in Clementine Boulevard.

7. EARTHWORKS

Cossill & Webley have prepared a preliminary earthworks strategy (attached as Appendix F) which demonstrates that a cut-to-fill balance can be achieved.

The preliminary earthworks strategy ties in with the existing levels of the Bush Forever along the northern boundary of the Site and allows for the retention of existing levels within the Conservation POS. The Site will be elevated along the southern boundary with earthworked levels around the Site to grade towards the central POS.

Consideration of the interface treatments with the existing vegetation abutting Ghostgum Avenue and at the proposed Public Access Way to Ghostgum Avenue will be required as part of the detailed earthworks design process.

8. UNDERGROUND POWER AND STREET LIGHTING

The Western Power Network Capacity Mapping Tool was used to determine future forecast remaining capacity in the electricity network. This showed that the network will have 10-15MVA remaining capacity in the future. If approximately 370 new dwellings are developed with a power draw of approximately 4.7kVA per dwelling, the total power requirement for the residential development is approximately 1.74 MVA, well within the network capacity. This will need to be confirmed formally with Western Power during detailed planning and design.

Armadale Road features underground LV street lighting cable in the median with overhead HV distribution lines in the northern verge. It is anticipated that this overhead HV will be undergrounded as part of the current Armadale Road widening works.

Underground HV cables are located within the western verge of Ghostgum Avenue where it has been upgraded adjacent the Site.

Subject to final yield, the Site will require a minimum of 3 transformers and 2 switchgears to service the Site, and all power within the proposed development will be underground. We do not anticipate any off-site headwork upgrades will be required.

9. GAS SUPPLY

There is an existing steel 1.9MPa high pressure distribution gas main in the southern verge of Armadale Road. ATCO gas has advised that the existing gas network has adequate capacity to service the ultimate demand of the Site.

Connecting to the existing high pressure gas main will require a high pressure regulator to be installed and boring underneath Armadale Road to facilitate servicing of the Site.

10. TELECOMMUNICATIONS

As per the New Developments Policy announced by the Minister for Communications & the Digital Economy, new developments with 100 premises or more will be prioritised by NBN Co to have optic fibre infrastructure installed. The subject area is within NBN Co's fibre footprint, and hence can be serviced with optic fibre under their NBN roll-out scheme for Greenfield developments.

Under the current scheme, the developer is required to enter into an agreement with NBN Co to provide design and pit and pipe infrastructure which is handed over free of charge to NBN upon completion. NBN has advised that the nearest connection point to their network is located within 650m and has adequate capacity to service the Site.

Furthermore, as the backhaul distance is within 1000m, there are no backhaul costs required to be paid by the developer and only the standard deployment charge of $600/lot will apply.

Alternative telecommunication providers could also be considered to service the Site.

11. CONCLUSION

From an engineering perspective the Site is suitable for urban development with service planning in place to extend infrastructure to the Site.

It is recommended that an environmental investigation be undertaken on the site to determine if previous land uses have resulted in any contaminated land, and if any remediation is required.

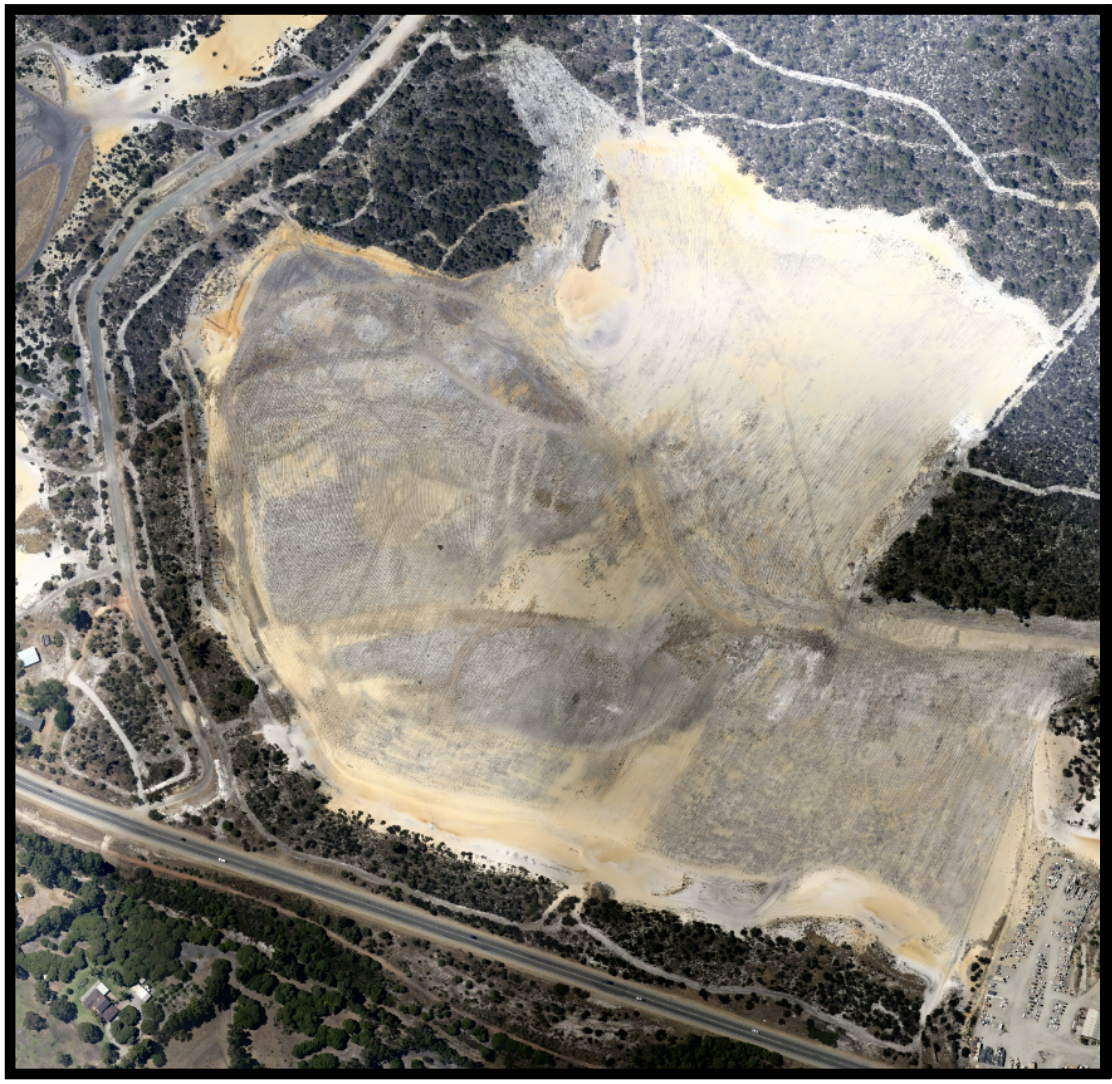
An overall drainage management strategy will need to be developed to allow urbanisation to proceed.

APPENDIX A

Nearmap Aerial Images 2008 vs 2019

Lot 703 Armadale Road, Treeby

Nearmap Aerial - January 2008



Nearmap Aerial - July 2019



APPENDIX B

Douglas Partners Geotechnical Report
96594.00.R.001.Rev0.BANJUP, Lot 821 Armadale Road

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Proposed Residential Development
Lot 821 Armadale Road, Banjup, WA

Prepared for
Anstey Road Developments

Project 96594
September 2019



Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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	1	-	Jordan Williams, Cossill & Webley Consulting Engineers

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

	Signature	Date
Author		13 SEPTEMBER 2019
Reviewer		13 September 2019

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Drawing

Douglas Partners
Geotechnics | Environment | Groundwater

Appendix B: Results of Field Work

Appendix C: Results of Laboratory Testing

Report on Geotechnical Investigation
Proposed Residential Development
Lot 821 Armadale Road, Banjup, WA

1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed residential development at Lot 821 Armadale Road, Banjup, WA. The investigation was commissioned on 15 July 2019 by Kelli Howell of Anstey Road Developments and was undertaken in accordance with Douglas Partners' proposal PER190281 dated 10 July 2019.

It is understood that the proposed development comprises a residential subdivision and associated internal access roads and public open space. Finished surface levels across the site, following earthworks, will range between approximately RL 29.5 m and RL 32 m AHD.

The aim of the geotechnical investigation is to assess the subsurface conditions at the site and provide comments on:

- The sub-soil conditions including identification of areas of problematic soils, loose zones and uncontrolled fill if encountered, with suitable earthworks remediation strategies provided.
- Topsoil condition and thickness and comments on suitable topsoil blending ratios to produce structural fill suitable for the proposed development.
- The geotechnical suitability of the south-west bund soils and stockpiled materials for re-use in cut to fill operations.
- Provide recommendations on re-use options of all materials encountered during the investigation, with the aim of minimising off-site disposal costs during earthworks.
- Site preparation, excavatability, compaction control criteria and other earthworks requirements to suitably prepare the ground for the proposed development.
- Appropriate site classification in accordance with the requirements of AS 2870-2011.
- Geotechnical parameters for soil retention (assuming limestone block mass-gravity retaining walls) and safe batter slopes.
- Pavement design parameters and any other comments pertinent to pavement subgrade preparation.
- The depth to groundwater, if encountered.
- The suitability of the in situ soils for stormwater disposal by soakage, particularly within the proposed central public open space.

The investigation included the excavation of 20 test pits, the supervision of eight cone penetration tests, six in situ infiltration tests and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the issues listed above.

2. Site Description

The site is located approximately 2.5 km east of Cockburn. It is bounded by Armadale Road to the south, by Ghostgum Avenue to the West and by undeveloped bushland elsewhere.

At the time of the investigation, the site comprised a generally open and flat area. It had previously been cleared of significant vegetation, although regrowth of grass, shrubs and bushes, which are thick in some areas, had occurred. The exposed soils indicated some evidence of prior disturbance, with some crushed brick and concrete materials of unknown thickness spread over the surface in some areas. A number of stockpiles of predominantly sand material, though incorporating some material assessed to be topsoil, were observed in the southern part of the site. Historical aerial photographs indicate that the first major disturbance of the site occurred around 2004 to 2005, with clearing, excavation and removal of sand, and possibly some placement of materials occurring until approximately 2009. In general, no further activity appears to have occurred within in the site since 2009, except for the placement of the stockpiles noted above in 2018.

A typical view of the site are presented in Figure 1 below, and a view of the stockpiles mentioned above in Figure 2 (next page).



Figure 1: General View of the Site Near Test Location 10



Figure 2: General View of Stockpiles on the Site

The site generally grades from approximately RL 36 m AHD on the western boundary to RL 30m AHD on the eastern boundary with a bund running along the southern boundary with a maximum height of RL 43 m AHD. A survey of the site provided by the client (6234-LWP-SK01 Rev a indicates two low points of approximately RL 26 m AHD in the southern part of the site and RL 27 m AHD in the north west. Both areas are shown to be several metres below the surrounding areas. Neither low point were visually apparent on site during the field work, nor on aerial photographs, nor in the publicly available LiDAR data. The LiDAR data has been used as it conforms more closely to observed site conditions.

The 1:50 000 Fremantle Environmental Geology map indicates that the soil beneath the site comprises Bassendean Sand.

The Perth Groundwater Atlas (2004) indicates that regional aquifer was between RL 25 m AHD and RL 26 m AHD in May 2003.

3. Field Work Methods

Field work was carried out on 30 August and 2 September 2019 and comprised:

- 20 test pits;
- Eight cone penetration tests;
- A Perth sand penetrometer (PSP) test at each test pit location; and
- Six infiltration tests.

The test pits (test locations1 to 20) were excavated using an 8 tonne excavator with a 800 mm wide bucket to depths of between approximately 1.7 m and 2.8 m, at which depths they collapsed.

The cone penetration tests (21 to 28) were carried out using a 36 mm diameter instrumented cone with a following 130 mm long friction sleeve attached to rods of the same diameter, pushed continuously at a rate of 20 mm/sec into the soil by hydraulic thrust from a ballasted 12 tonne tracked rig. Strain gauges in the cone and sleeve measure resistance to penetration and this data allows assessment of the type and condition of the materials penetrated. The cone penetration tests were undertaken to depths of between approximately 4 m and 10 m.

Ground conditions were logged in general accordance with AS1726-2017 by a suitably experienced geotechnical engineer from Douglas Partners. Soil samples were recovered for subsequent geotechnical laboratory testing.

Perth sand penetrometer testing was carried out in accordance with AS 1289.6.3.3 adjacent to each test pit to assess the in situ density of the shallow soils to depths of generally approximately 1 m, or prior refusal. The results of these Perth sand penetrometer tests are presented on the borehole log sheets in Appendix B.

The field infiltration tests were performed using the falling head method, at depths of between approximately 0.7 m and 0.95 m below the existing surface level at test locations 30 to 34.

Test locations were determined with reference to existing site features, and are presented on Drawing 1 in Appendix A. Surface elevations at each test location were interpolated from publicly available LiDAR data.

4. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions are presented in Appendix B, and should be read in conjunction with the notes defining descriptive terms and classification methods provided in Appendix A.

The subsurface conditions encountered comprised:

- **FILL/SAND SP:** fine to medium grained, generally dark grey-brown, grey-brown and yellow-brown, trace silt and varying gravel content, occasionally trace organics, loose to medium dense, encountered all test pit locations except test location 11, to depths of up to 2.4 m (the extent of the test pit investigation), and interpreted at most cone penetration test locations, to depths of up to 3.2 m. Where encountered, the loose sand was from the existing surface level to depths of up to generally less than 0.6 m but locally up to 1.4 m.
- **SAND SP:** fine to medium grained, pale yellow, yellow-brown, and pale white, trace silt, generally medium dense to dense, from the surface or underlying the fill at all test locations where natural sand was encountered (i.e. except at test pit locations where the test pit terminated in fill) to the extent of the investigation of up to 10 m.

4.2 Groundwater

Groundwater was encountered at test locations 24 and 27 at depths of 3.2 m and 6.9 m below existing ground level (approximately RL 26.8 m AHD and RL 26.9 m AHD) respectively during the field work undertaken on 2 September 2019. Groundwater was not observed at the other test locations, though collapse of the cone penetration test holes prior to dipping for groundwater may have prevented measurement of groundwater level at other test locations.

The boreholes were immediately backfilled following the investigation, which precluded longer-term monitoring of groundwater levels at those locations.

The Perth Groundwater Atlas (2004) indicates that the level of the regional aquifer was between RL 25 m AHD and RL 26 m AHD in May 2003.

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

4.3 Results of Infiltration Testing

Six in situ infiltration tests were carried out using the falling head method at test locations 29 to 34 at depths of between approximately 0.7 m and 0.95 m below existing ground level. An estimated permeability value has been derived from the in situ permeability test data using Hvorslev (1951).

Permeability can also be estimated from particle size distribution test results from samples taken from the same depths at infiltration test locations, using Hazen's formula. Hazen's formula provides an indication of the permeability for clean sand in loose conditions, and thus the result derived using this approach should be considered with caution.

Table 1 below summarises the permeability results.

Table 1: Summary of Permeability Analysis

Test Location	Depth (m)	Measured Permeability[1]		Derived Permeability (m/s) [2]		In situ Conditions of Tested Material
		(m/s)	(m/day)	(m/s)	(m/day)	
29	0.95	1.8×10^{-3}	>50	-	-	Loose Sand, trace silt
30	0.70	1.0×10^{-3}	50			Loose Sand, trace silt
31	0.75	1.8×10^{-3}	>50	0.7×10^{-3}	>50	Loose Sand, trace silt
32	0.70	1.5×10^{-3}	>50			Medium Dense Sand, trace silt
33	0.705	0.7×10^{-3}	>50			Medium Dense Sand, trace silt
34	0.70	1.8×10^{-3}	>50	0.6×10^{-3}	>50	Medium Dense Sand, trace silt

Notes: [1]: In situ permeability (Hvorslev).
[2]: Hazen's formula (assumes sand in loose condition).

5. Laboratory Testing

A geotechnical laboratory testing programme has been scheduled with a NATA registered laboratory and comprises the determination of:

- the particle size distribution of six samples; and
- the organic content of four samples.

The detailed test certificates are be presented in Appendix C, with the results summarised in Table 2 (next page).

Table 2: Summary of Laboratory Testing Results

Test Location	Depth (m)	Fines (%)	Sand (%)	Gravel (%)	Organic (%)	Material
2	1.9-1.2	1	99	0	0.3	FILL/SAND, trace silt
12	0.6-0.7	0	100	0	0.1	SAND
14	0.2-0.3	3	68	29	-	FILL/SAND, with gravel
31	0.6-0.7	1	98	1	-	SAND, trace silt
34	0.6-0.7	0	100	0	1.7	SAND
Topsoil Stockpile – Sample 1	-	-	-	-	3.1	SAND, trace silt, trace organics
Topsoil Stockpile – Sample 2	-	3	97	0	1.5	SAND, trace silt, trace organics

Notes on Table : The % fines is the amount of particles smaller than 75 µm.
The % sand is the amount of particles smaller than 2.36 mm and larger than 75 µm.
The % gravel is the amount of particles smaller than 63 mm and larger than 2.36 mm.
See Drawing 1 for location of topsoil stockpile

6. Proposed Development

It is understood that the proposed development comprises a residential subdivision and associated internal access roads and public open space. Finished surface levels across the site, following earthworks, will range between approximately RL 29.5 m and RL 32 m AHD.

7. Comments

7.1 Site Suitability

Results of the investigation indicate that the site is underlain by generally loose to medium dense sand fill overlying medium dense to dense natural sand. The loose fill is near the existing surface, generally to depths of less than 0.6 m, though locally encountered up to 1.4 m deep. Stockpiles of material placed in the southern part of the site (see Drawing 1, Appendix A) contain sand and topsoil materials, comprising sand with a trace of silt and organics.

Groundwater was encountered at two test locations during the field work on 30 August and 2 September 2019, at depths of 3.2 m and 6.9 m (approximately RL 26.8 m AHD and RL 26.9 m AHD). Desktop information indicates that the level of the regional aquifer was between RL 25 m AHD and RL 26 m AHD in May 2003, when groundwater was near its low seasonal level.

From a geotechnical standpoint, the land is physically capable of development for the proposed development, provided that the provisions outlined in the subsequent subsections of the report are taken into consideration, and recommendations are implemented.

7.2 Site Classification

The site is generally underlain by loose to medium dense sand fill overlying medium dense to dense natural sand.

Fill was encountered at most test locations across the site. A surface layer of loose fill was present in many test locations. In the absence of documentation to confirm the fill on the site was controlled and placed under engineering supervision, it should be considered as "uncontrolled".

The site classification of the site in its current condition is "Class P" in accordance AS2870-2011 because of the presence of uncontrolled fill and the presence of loose sand in some locations.

However, based on encountered conditions, a site classification of "Class A" in accordance AS2870-2011 can be achieved provided the site preparation recommendations in Section 7.5 are carried out.

It should be noted that AS 2870-2011 applies to single houses, townhouses and the like classified as Class 1 and 10a under the Building Code of Australia. It also applies to light industrial and commercial buildings if they are similar in size, loading and superstructure flexibility to those designs included in AS 2870-2011.

7.3 Excavation Conditions

The encountered ground conditions comprise medium dense to dense sand, with a layer of near surface loose sand, to the extent of the investigation.

Conventional earthmoving equipment should be generally suitable for excavations across the site within the surficial sand.

As discussed in Section 4.2, groundwater was encountered at two test locations at approximately RL 26.8 m AHD and RL 26.9 m AHD, though collapse to the cone penetration test hole prior to dipping for groundwater may have prevented identification of groundwater at other test locations. Higher groundwater levels may be anticipated following particularly wet periods. Desktop information indicates that the level of the regional aquifer was between RL 25 m AHD and RL 26 m AHD in May 2003. Therefore, excavations below, say, RL 27.5 m AHD may be affected by groundwater, particularly in the winter months. It is recommended that monitoring wells are installed during detailed investigations to allow monitoring of groundwater levels at the site.

7.4 Geotechnical Suitability for Re-Use of In Situ Materials

7.4.1 Re-Use of Stockpiles

An area of stockpiles is located in the southern part of the site, as indicated on Drawing 1, Appendix A. Inspection of the stockpiles indicated that they are partly composed of clean sand, particularly around the perimeter of the stockpile area, and partly by sandy topsoil material. Laboratory testing indicates that the organic content of the topsoil material is below 5%, though the possible presence of material with higher organic content within the stockpile cannot be precluded.

The sand stockpiles are geotechnically suitable for reuse as structural fill material provided it is free from organic matter and particles greater than 150 mm in size.

The topsoil stockpiles are considered generally suitable for re-use as structural fill and particles greater than 150 mm in size. However, as a precaution against possible variability in the organic content of this material, it is recommended that it is blended with clean sand on a ratio of 2 (clean sand):1 (topsoil stockpile). Further testing of the stockpile material during detailed investigations or during construction should be undertaken to refine this suggested blending ratio.

It should be noted that this study has not assessed whether unacceptable levels of contaminants exist within the filling material as this was outside the scope of the investigation. Such levels, if they occur, may limit or prevent the use of this material. Douglas Partners would be pleased to assist with this matter if required.

7.4.2 Re-Use of Existing Fill

The encountered existing fill on the site comprised sand with a trace of silt and various gravel content.

The encountered fill across the site is considered geotechnically suitable for reuse as structural fill material provided it is free from organic matter and particles greater than 150 mm in size.

As noted above, this study has not assessed whether unacceptable levels of contaminants exist within the filling material as this was outside the scope of the investigation. Such levels, if they occur, may limit or prevent the use of this material.

7.4.3 Re-Use of Natural Sand

The fill across the site is underlain by natural sand with a trace of silt.

The encountered natural sand is considered geotechnically suitable for reuse as structural fill material provided it is free from organic matter and particles greater than 150 mm in size.

7.4.4 Topsoil

The investigation did not encounter topsoil, which historical aerial photographs indicate has been previously stripped from the site.

7.5 Site Preparation

7.5.1 Site Stripping

As noted above, the investigation did not encounter topsoil. However, revegetation of the site has occurred since then. All deleterious material, including (if encountered) waste, debris, unsuitable fill and vegetation should be stripped from the proposed development areas of the site.

Any tree roots remaining from clearing operations within the proposed development area should be completely removed to a depth of 0.6 m, and the excavation backfilled with material of similar geotechnical properties to the surrounding ground and suitably compacted.

The granular fill encountered during the investigation is considered likely suitable to be left in place. It should be noted that areas of unsuitable fill not encountered by this investigation cannot be entirely precluded, therefore inspections of the site following clearing and stripping should be conducted by a geotechnical engineer, to identify any possible areas which required further treatment.

7.5.2 Proof Rolling and Compaction

A surface layer of loose fill was encountered across much of the site. The thickness of the encountered loose layer was generally less than 0.6 m, though it was locally up to 1.4 m thick. Some of the loose material may be removed during earthworks in part of the site, but may remain in place in other areas.

Therefore, following removal of unsuitable material, if any, and excavation to formation level (in areas of cut) it is recommended that the exposed ground beneath be proof rolled with a heavy smooth drum roller (say minimum 18 tonnes deadweight) in vibrating mode.

Any areas that show signs of excessive deformation during compaction should be compacted until deformation ceases or, alternatively, the poor quality material should be excavated and replaced with suitable structural filling and compacted.

Following proof rolling to confirm suitable foundation material, footing locations should be tested to a depth of 1.0 m below footing formation level, or shallower refusal, by a suitably experienced geotechnical engineer.

The above measure should generally be sufficient. However, if loose material remains after proof rolling, which may occur in areas of thicker loose material, it is recommended that some surface material be excavated to allow compaction of the underlying material, and subsequently replaced and compacted.

Compaction control of sand could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3. All areas within the proposed building envelope should be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration to a depth of not less than 0.5 m below foundation level.

Earthworks should be supervised by a Geotechnical Engineer.

7.5.3 Imported Filling

If required, imported filling should comprise free draining, cohesionless, well graded sand that:

- contains less than 5% by weight of particles less than 75 microns in size;
- contains no particles greater than 150 mm in size; and
- is free of organic and other deleterious materials.

It is recommended that test certificates are reviewed and approved by the geotechnical engineer prior to importing material to site.

Other materials could be considered, provided they are granular and non-reactive, and following review by a geotechnical engineer.

7.5.4 Fill Placement

Any fill should be placed in layers not exceeding 300 mm loose thickness and compacted near optimum moisture content with a roller of say 12 tonne deadweight. It is recommended that earthworks be carried out with regular inspections by a geotechnical engineer.

7.5.5 Compaction Testing

Compaction control of the sand filling could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3. All areas within the proposed building envelopes should be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration to a depth of not less than 1.0 m below foundation level.

The top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings. Inspection of footing excavations by a geotechnical engineer is also recommended.

7.5.6 Geotechnical Inspection

Owing to the presence of fill across the site, it is recommended that earthworks are inspected by a geotechnical engineer.

7.6 Design Parameters for Excavations and Retaining Systems

It is recommended that batter slopes not steeper than 1.5H:1V (horizontal : vertical) be adopted for temporary excavations not deeper than 3 m in sand material. For deeper excavations, average batter slopes not steeper than 2H:1V should be adopted, with horizontal benches at least 1 m wide at 5 m intervals in height. These recommended batter angles should be re-assessed if loads are to be applied near the top of the batter or if there is a possibility of substantial overland water flow. Permanent batter slopes should not be steeper than 2H:1V.

Design of temporary and permanent retaining structures in sand can be based on the design parameters listed in Table 3 below. In addition, retaining structures should be designed to support lateral pressure from external loads such as such as live loads from the surrounding developments and construction activities.

Table 3: Suggested Soil Parameters for Retaining Wall Design

Soil Type	Unit Weight (kN/m^3)	Shear Strength		Pressure Coefficients		
		Φ ′ (°)	c’ (kPa)	Ka	Kp	K0
Sand (natural and fill) – Loose	18	30	0	0.33	3.0	0.5
Sand (natural and fill) – Medium Dense or Denser	20	34	0	0.28	3.5	0.5

7.7 Pavement Design Parameters

Based on observation of the sandy soils underlying the site, and Douglas Partners’ experience, and assuming the recommendations in Section 7.4 are implemented, a subgrade California bearing ratio (CBR) of 12% is suggested for pavement design for subgrades in the natural sand, provided the subgrade is compacted to not less than 95% of modified maximum dry density to a depth of at least 0.5 m below subgrade level.

7.8 Stormwater Disposal and Drainage

The shallow ground conditions comprise generally medium dense sand, with a surface layer of loose fill. It is assumed that the density of the loose fill will be increased to at least medium dense during earthworks, or the loose material removed if in areas of cut. As discussed in Section 4.2, groundwater was encountered at two test locations at approximately RL 26.8 m AHD and RL 26.9 m AHD, though collapse to the cone penetration test hole prior to dipping for groundwater may have prevented identification of groundwater at other test locations. Higher groundwater levels may be anticipated following particularly wet periods.

Six in situ falling head infiltration tests were undertaken in loose or medium dense sand at depths of between approximately 0.7 m and 0.95 m at test locations 29 to 34, as described in Section 4.3 above. The estimated permeability values arising from the tests was greater than 50 m/day.

A further assessment of permeability at the test location was carried out by applying Hazen's formula to the particle size distribution result from samples taken from the test locations at the infiltration test depths. It should be noted that Hazen's formula applies to 'clean' sand in a loose state and that values derived using this approach should be considered with caution. The result of this assessment also suggests permeability values greater than 50 m/day. The permeability results reflect the low fines content of the sand at the test locations.

Given possible variability in situ permeability, the possible extensive earthworks and an anticipated reduction of permeability following compaction operations, a permeability value of 1×10^{-4} m/s (approximately 8 m/day) is suggested for the in situ sand in a dense condition.

On-site stormwater disposal using soakwells, sumps and drainage basins is considered suitable for this site. The infiltration capability commonly reduces over time due to silt build up at the base of soakwells and therefore the soakwells must be cleaned and maintained on a regular basis. Soakwells should preferably be positioned at a distance from all buildings, retaining walls and boundaries by not less than 2 m.

8. References

1. Australian Standard AS2870-2011, 'Residential Slabs and Footings', April 2011, Standards Australia
2. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
3. Australian Standard AS 1289.6.3.3-1999, Soil Strength and Consolidation Tests- Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test.
4. Australian Standard AS 1726-2017, Geotechnical Site Investigation.
5. Australian Standard AS 3798-2007, Guidelines on Earthworks for Commercial and Residential Developments.
6. Department of Environment, Perth Groundwater Atlas, Second Edition, December 2004
7. Hvorslev M. J., 1951, Time lag and soil permeability in groundwater observations, US Army Corps of Engineers Waterways Experiment Observation Station, Bulletin 36, Vicksburg, Mississippi
8. Hazen A, 1930, "Water Supply", in American Civil Engineers Handbook, Wiley, New York.

9. Limitations

Douglas Partners (DP) has prepared this report for this project at Lot 821 Armadale Road, Banjup, WA in accordance with DP's proposal dated 10 July 2019 and acceptance received from Kelli Howell of Anstey Road Developments dated 15 July 2019. The work was carried out under DP's Conditions of Engagement . This report is provided for the exclusive use of Anstey Road Developments for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

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

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

Douglas Partners Pty Ltd

Appendix A

About This Report
Drawing

About this Report

Douglas Partners

Introduction

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

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

Copyright

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

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

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

Site Inspection

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

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.

Cone Penetration Tests

Douglas Partners

Introduction

The Cone Penetration Test (CPT) is a sophisticated soil profiling test carried out in-situ. A special cone shaped probe is used which is connected to a digital data acquisition system. The cone and adjoining sleeve section contain a series of strain gauges and other transducers which continuously monitor and record various soil parameters as the cone penetrates the soils.

The soil parameters measured depend on the type of cone being used, however they always include the following basic measurements

- Cone tip resistance q_c
- Sleeve friction f_s
- Inclination (from vertical) i
- Depth below ground z

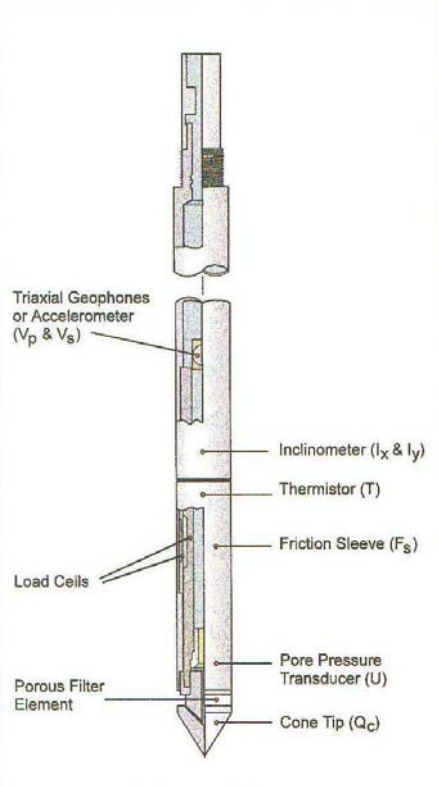


Figure 1: Cone Diagram

The inclinometer in the cone enables the verticality of the test to be confirmed and, if required, the vertical depth can be corrected.

The cone is thrust into the ground at a steady rate of about 20 mm/sec, usually using the hydraulic rams of a purpose built CPT rig, or a drilling rig. The testing is carried out in accordance with the Australian Standard AS1289 Test 6.5.1.



Figure 2: Purpose built CPT rig

The CPT can penetrate most soil types and is particularly suited to alluvial soils, being able to detect fine layering and strength variations. With sufficient thrust the cone can often penetrate a short distance into weathered rock. The cone will usually reach refusal in coarse filling, medium to coarse gravel and on very low strength or better rock. Tests have been successfully completed to more than 60 m.

Types of CPTs

Douglas Partners (and its subsidiary GroundTest) owns and operates the following types of CPT cones:

Type	Measures
Standard	Basic parameters (q_c, f_s, i & z)
Piezocone	Dynamic pore pressure (u) plus basic parameters. Dissipation tests estimate consolidation parameters
Conductivity	Bulk soil electrical conductivity (σ) plus basic parameters
Seismic	Shear wave velocity (V_s), compression wave velocity (V_p), plus basic parameters

Strata Interpretation

The CPT parameters can be used to infer the Soil Behaviour Type (SBT), based on normalised values of cone resistance (Qt) and friction ratio (Fr). These are used in conjunction with soil classification charts, such as the one below (after Robertson 1990)

Cone Penetration Tests

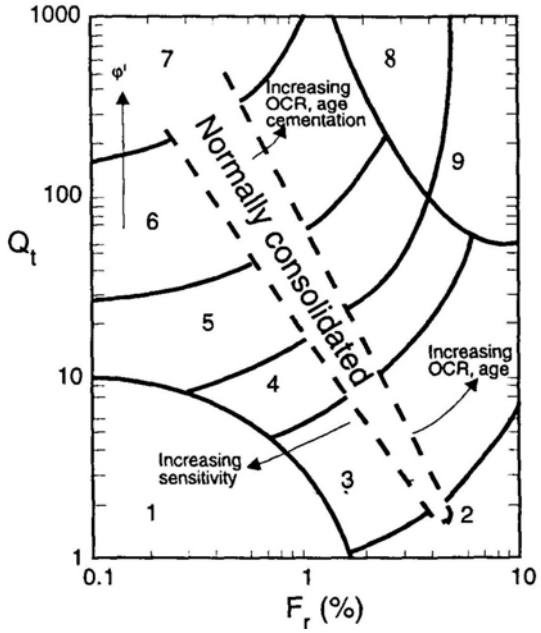


Figure 3: Soil Classification Chart

DP's in-house CPT software provides computer aided interpretation of soil strata, generating soil descriptions and strengths for each layer. The software can also produce plots of estimated soil parameters, including modulus, friction angle, relative density, shear strength and over consolidation ratio.

DP's CPT software helps our engineers quickly evaluate the critical soil layers and then focus on developing practical solutions for the client's project.

Engineering Applications

There are many uses for CPT data. The main applications are briefly introduced below:

Settlement

CPT provides a continuous profile of soil type and strength, providing an excellent basis for settlement analysis. Soil compressibility can be estimated from cone derived moduli, or known consolidation parameters for the critical layers (eg. from laboratory testing). Further, if pore pressure dissipation tests are undertaken using a piezocone, in-situ consolidation coefficients can be estimated to aid analysis.

Pile Capacity

The cone is, in effect, a small scale pile and, therefore, ideal for direct estimation of pile capacity. DP's in-house program ConePile can analyse most pile types and produces pile capacity versus depth plots. The analysis methods are based on proven static theory and empirical studies, taking account of scale effects, pile materials and method of installation. The results are expressed in limit state format, consistent with the Piling Code AS2159.

Dynamic or Earthquake Analysis

CPT and, in particular, Seismic CPT are suitable for dynamic foundation studies and earthquake response analyses, by profiling the low strain shear modulus G_0. Techniques have also been developed relating CPT results to the risk of soil liquefaction.

Other Applications

Other applications of CPT include ground improvement monitoring (testing before and after works), salinity and contaminant plume mapping (conductivity cone), preloading studies and verification of strength gain.

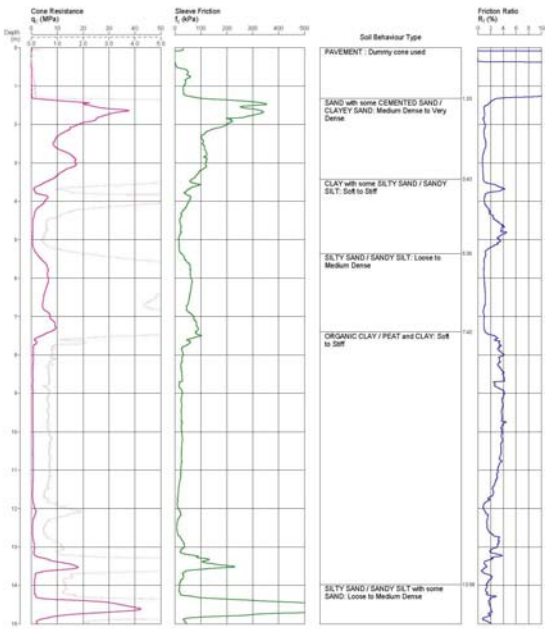


Figure 4: Sample Cone Plot

Description and Classification Methods

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

Soil Types

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

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

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

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

Definitions of grading terms used are:

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

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

In fine grained soils (>35% fines)

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

In coarse grained soils (>65% coarse)
- with clays or silts

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

In coarse grained soils (>65% coarse)
- with coarser fraction

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

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

Soil Descriptions

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Origin

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

- Residual soil - derived from in-situ weathering of the underlying rock;
- Extremely weathered material – formed from in-situ weathering of geological formations. Has soil strength but retains the structure or fabric of the parent rock;
- Alluvial soil – deposited by streams and rivers;
- Estuarine soil – deposited in coastal estuaries;
- Marine soil – deposited in a marine environment;
- Lacustrine soil – deposited in freshwater lakes;
- Aeolian soil – carried and deposited by wind;
- Colluvial soil – soil and rock debris transported down slopes by gravity;
- Topsoil – mantle of surface soil, often with high levels of organic material.
- Fill – any material which has been moved by man.

Moisture Condition – Coarse Grained Soils

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

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

Moisture Condition – Fine Grained Soils

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

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

Symbols & Abbreviations

Douglas Partners

Introduction

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

Drilling or Excavation Methods

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

Water

▷	Water seep
▽	Water level

Sampling and Testing

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

Description of Defects in Rock

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

Defect Type

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

Orientation

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

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

Coating or Infilling Term

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

Coating Descriptor

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

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

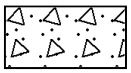
Symbols & Abbreviations

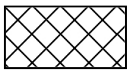
Graphic Symbols for Soil and Rock

General

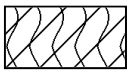

Asphalt

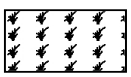

Road base

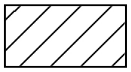

Concrete

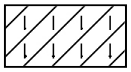

Filling

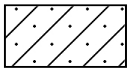
Soils


Topsoil

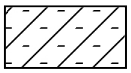

Peat

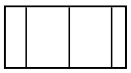

Clay

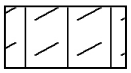

Silty clay

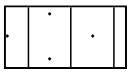

Sandy clay

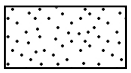

Gravelly clay

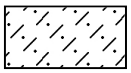

Shaly clay

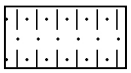

Silt


Clayey silt


Sandy silt

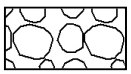

Sand

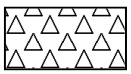

Clayey sand


Silty sand


Gravel

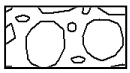

Sandy gravel


Cobbles, boulders

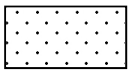

Talus

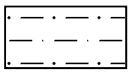
Sedimentary Rocks

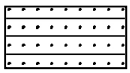

Boulder conglomerate

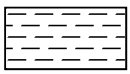

Conglomerate


Conglomeratic sandstone

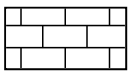

Sandstone


Siltstone

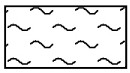

Laminite

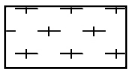

Mudstone, claystone, shale

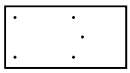

Coal


Limestone

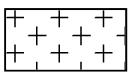
Metamorphic Rocks

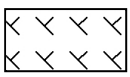

Slate, phyllite, schist

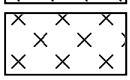

Gneiss

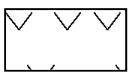

Quartzite

Igneous Rocks

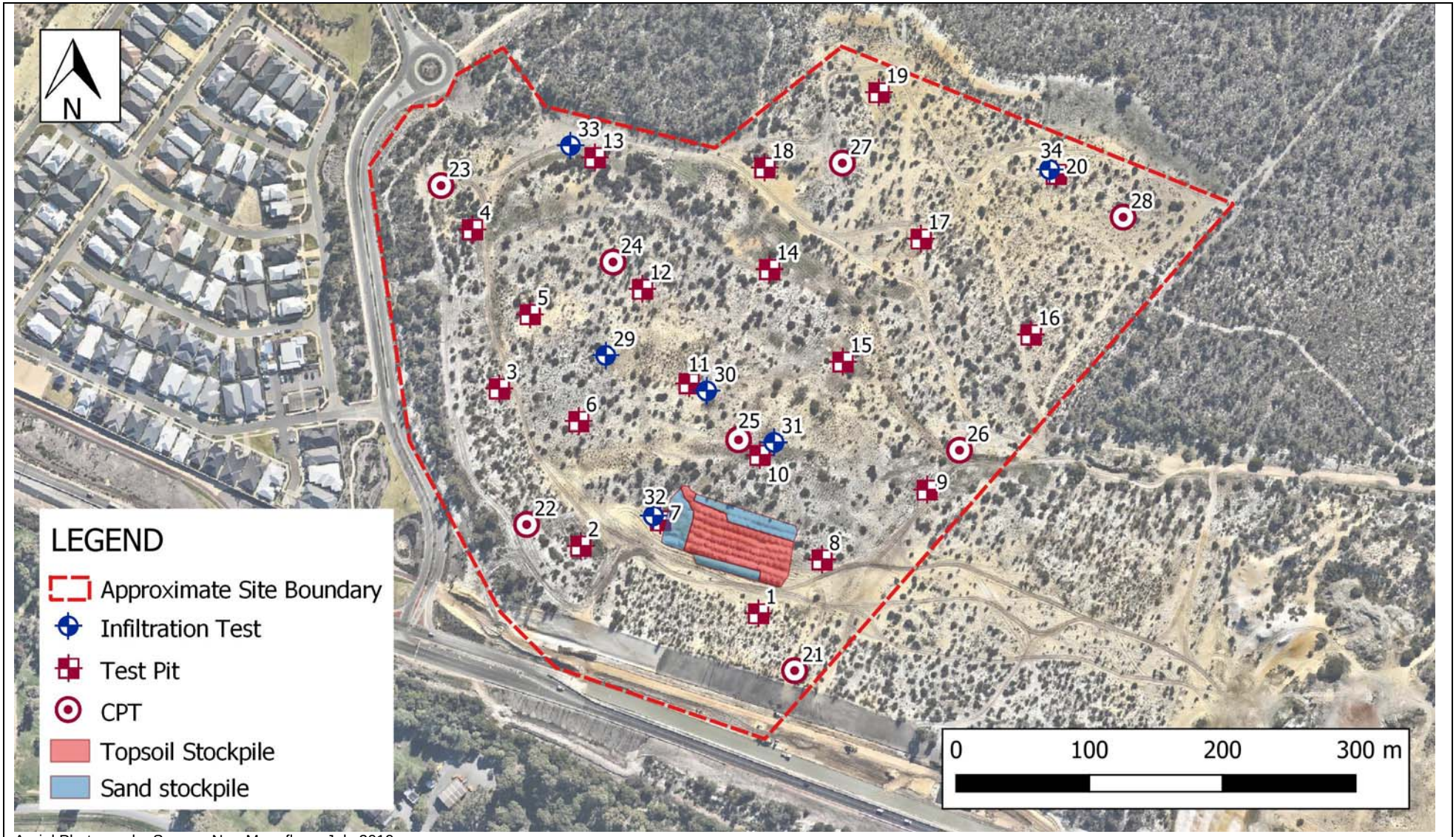

Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry



Aerial Photography Source: NearMap, flown July 2019.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Anstey Road Developments Pty Ltd	**Test Location Plan**	PROJECT No:	96594
	OFFICE:	Perth	**Proposed Residential Development**	DRAWING No:	1
	DATE:	2-9-2019	**Lot 821 Armadale Road, Banjup**	REVISION:	0

Appendix B

Results of Field Work

TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 31 m AHD*
EASTING: 394266
NORTHING: 6444506

PIT No: 1
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
31	0.1	FILL/SAND SP - fine to medium grained, grey, trace silt, trace organics, moist.		D	0.0 0.1				
		FILL/SAND SP - fine to medium grained, yellow-brown mottled grey, trace silt, moist, medium dense. Rootlets present to 0.2 m.							
30	1								1
				D	1.9 2.0				
29	2								2
	2.1	Pit discontinued at 2.1m (collapse)							



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR and field observation

☒ 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

TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 31 m AHD*
EASTING: 394133
NORTHING: 6444556

PIT No: 2
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
31		FILL/SAND SP - fine to medium grained, dark grey-grey, trace silt, moist, loose.							
30	1	- becoming brown-grey, medium dense from 0.6 m depth.							1
29	2 2.0	Pit discontinued at 2.0m (collapse)		D	1.9 2.0				2



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR and field observation

☒ 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

TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30.5 m AHD*
EASTING: 394072
NORTHING: 6444674

PIT No: 3
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0	FILL/SAND SP - fine to medium grained, grey-brown, trace silt, trace organics, moist, loose. Rootlets to 0.2 m.							5 10 15 20
	1								1
29	1.2	SAND SP - fine to medium grained, pale yellow, trace silt, moist, loose. - becoming medium dense from 1.35 m depth.							
	1.6	Pit discontinued at 1.6m (collapse)							
	2								
28									



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR and field observation

☒ 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

TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30.5 m AHD*
EASTING: 394052
NORTHING: 6444794

PIT No: 4
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.3	FILL/SAND SP - fine to medium grained, grey/brown, trace silt, with rootlets, moist, loose.							
		SAND SP - fine to medium grained, yellow-brown, trace silt, moist, medium dense.							
		- becoming pale yellow from 0.7 m depth.							
29	1.7	Pit discontinued at 1.7m (collapse)							
28									



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR and field observation

☒ 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

TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394095
NORTHING: 6444730

PIT No: 5
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.0	FILL/SAND SP - fine to medium grained, grey/brown, trace silt, with rootlets, moist, loose.		D	0.0 0.1				
	0.3	SAND SP - fine to medium grained, pale yellow, trace silt, moist, medium dense.							
29	1								1
	1.9	Pit discontinued at 1.9m (collapse)							
28	2								

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



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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

TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394131
NORTHING: 6444650

PIT No: 6
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP - fine to medium grained, grey-brown, trace silt, trace organics, moist, loose. Rootlets to 0.2 m.							
		- becoming dense from 0.45 m depth.							
	0.6	SAND SP - fine to medium grained, pale yellow, trace silt, moist, dense.		D	0.8 0.9				
29	1	- becoming pale white from 0.9 m depth.							1
28	2	2.0 Pit discontinued at 2.0m (collapse)							2



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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

TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394193
NORTHING: 6444575

PIT No: 7
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.1	FILL/GRAVELLY SAND SW - fine to medium grained, brown, moist. Gravel comprises granite, brick, crushed rock.		D	0.0 0.1				
		FILL/SAND SP-SW - fine to medium grained, dark grey, with gravel, moist, loose.							
	0.55	SAND SP - fine to medium grained, pale yellow, trace silt, moist. - becoming medium dense.							
29	1	- becoming pale white from 1.4 m depth.							1
	1.8	Pit discontinued at 1.8m (collapse)							
28	2								



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394314
NORTHING: 6444546

PIT No: 8
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP - fine to medium grained, grey-white, trace silt, with rootlets, moist, loose. Rubber hose and glass found at surface.							
		- becoming dense from 0.45 m depth.							
		- becoming yellow-brown mottled grey from 0.6 m depth.		D	1.2 1.3				
29	1								1
		- becoming brown with gravel sized pieces of coffee rock. Occasional cobbles of coffee rock.		D	2.0 2.1				
28	2								2
	2.4	Pit discontinued at 2.4m (collapse)							



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394393
NORTHING: 6444598

PIT No: 9
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/GRAVELLY SAND SW - fine to medium grained, pale brown-grey, moist, medium dense. Gravel comprises granite, brick, crushed rock.		D	0.2 0.3				
	0.55	FILL/SAND SP - fine to medium grained, dark grey mottled yellow-brown, trace gravel, moist, medium dense.							
	0.75	SAND SP - fine to medium grained, pale grey, trace silt, moist, desne.							
29	1			D	1.1 1.2				1
	1.6	Pit discontinued at 1.6m (collapse)							
28	2								



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394267
NORTHING: 6444624

PIT No: 10
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/GRAVELLY SAND SW - fine to medium grained, brown, loose. Gravel comprises granite, brick, crushed rock.		D	0.3 0.4				
		- becoming medium dense from 0.6 m depth.							
	0.8	FILL/SAND SP - fine to medium grained, dark grey,trace silt, moist, medium dense to dense.		D	1.0 1.1				
29	1								1
28	2								2
	2.2	Pit discontinued at 2.2m (collapse)							



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394214
NORTHING: 6444678

PIT No: 11
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		SAND SP-SM - fine to medium grained, dark grey, with silt, trace rootlets, moist, medium dense.		D	0.0 0.1				
	0.35	SAND SP - fine to medium grained, pale white, trace silt, moist, medium dense.							
29	1	- becoming dense from 0.6 m depth.		D	0.5 0.6				
	1.9	Pit discontinued at 1.9m (collapse)							
28	2								

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



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394179
NORTHING: 6444749

PIT No: 12
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP - fine to medium grained, grey-brown, trace silt, trace gravel, moist, loose.		D	0.2				
	0.3	SAND SP - fine to medium grained, yellow, trace silt, moist, medium dense.			0.3				
29	1	- becoming dense from 0.75 m depth.		D	0.6 0.7				1
	1.7	Pit discontinued at 1.7m (collapse)							
28	2								



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394144
NORTHING: 6444848

PIT No: 13
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30	0.5	FILL/GRAVELLY SAND SW - fine to medium grained, pale brown-grey, moist, loose. Gravel comprises granite, brick, crushed rock.		D	0.1 0.2				
29	1.3	FILL/SAND SP - fine to medium grained, yellow-grey, trace silt, trace organics, moist, loose. - becoming dense from 0.6 m depth.		D	0.6 0.7				
28	1.9	SAND SP - fine to medium grained, pale yellow, trace silt, moist.		D	1.4 1.5				
		Pit discontinued at 1.9m (collapse)							



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394275
NORTHING: 6444764

PIT No: 14
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP-W - fine to medium grained, brown, with gravel, moist, loose. Gravel comprises granite, brick, crushed rock.		D	0.2 0.3				
	0.5	SAND SP - fine to medium grained, pale grey, trace silt, moist, dense.							
29	1	- becoming yellow-brown from 1.7 m depth.		D	1.8 1.9				
28	2 2.0	Pit discontinued at 2.0m (collapse)							



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394330
NORTHING: 6444694

PIT No: 15
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP - fine to medium grained, grey/brown, trace silt, trace rootlets, moist. Gravel (brick, granite, crushed rock) on surface.							
		- becoming dense from 0.45 m depth.							
	0.65								
29	1	SAND SP - fine to medium grained, pale grey mottled pale brown, trace silt, moist, dense. Possible fill.		D	1.5 1.6				1
	1.8								
28	2	Pit discontinued at 1.8m (collapse)							



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394471
NORTHING: 6444715

PIT No: 16
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP - fine to medium grained, brown mottled grey, trace silt, moist, dense. Rootlets to 0.4 m depth.							
		- becoming yellow-brown mottled grey from 0.3 m depth.							
29	1			D	0.9 1.0				1
28	2								2
	2.5			D	2.5				
	2.6	SAND SP - fine to medium grained, orange-brown, trace silt, moist.			2.6				
		Pit discontinued at 2.6m (collapse)							



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394388
NORTHING: 6444787

PIT No: 17
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP - fine to medium grained, brown, trace silt, moist, loose to medium dense. Roots (10-20 mm thick) to 0.3 m depth.							
		- becoming dense from 0.45 m depth.							
		- becoming grey-brown from 0.6 m depth.							
29	1			D	1.0 1.1				1
28	2								2
	2.4	SAND SP - fine to medium grained, yellow, trace silt, moist.							
	2.6	Pit discontinued at 2.6m (collapse)							



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394271
NORTHING: 6444840

PIT No: 18
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP - fine to medium grained, yellow-grey, trace silt, trace organics, moist, medium dense.							
		- becoming dark grey-yellow from 0.5 m depth.							
		- becoming dense from 0.6 m depth.							
29	1			D	0.9 1.0				1
		- old rubber pipe at approximately 1.1 m depth.							
28	2	2.0 Pit discontinued at 2.0m (collapse)							2



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394357
NORTHING: 6444896

PIT No: 19
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP - fine to medium grained, grey mottled yellow-brown, trace silt, moist, medium dense.		D	0.45 0.5				
29	1	- becoming dense from 0.6 m depth.							
28	2								
	2.4 2.5	SAND SP - fine to medium grained, pale yellow, trace silt, moist. Pit discontinued at 2.5m (collapse)		D	2.4 2.5				



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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TEST PIT LOG

CLIENT: Anstey Road Developments Pty Ltd
PROJECT: Proposed Residential Development
LOCATION: Lot 821 Armadale Road, Banjup

SURFACE LEVEL: 30 m AHD*
EASTING: 394490
NORTHING: 6444835

PIT No: 20
PROJECT No: 96594
DATE: 30/8/2019
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
30		FILL/SAND SP - fine to medium grained, brown mottled dark grey, trace silt, moist, medium dense to dense.							
29	1								
28	2								
	2.4	Pit discontinued at 2.4m (collapse)							



RIG: 8T Excavator with 800 mm wide bucket

LOGGED: PJ

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: *surface levels interpolated from publicly available LiDAR

☒ 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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CONE PENETRATION TEST

CLIENT: Anstey Road Developments Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 821 Armadale Road

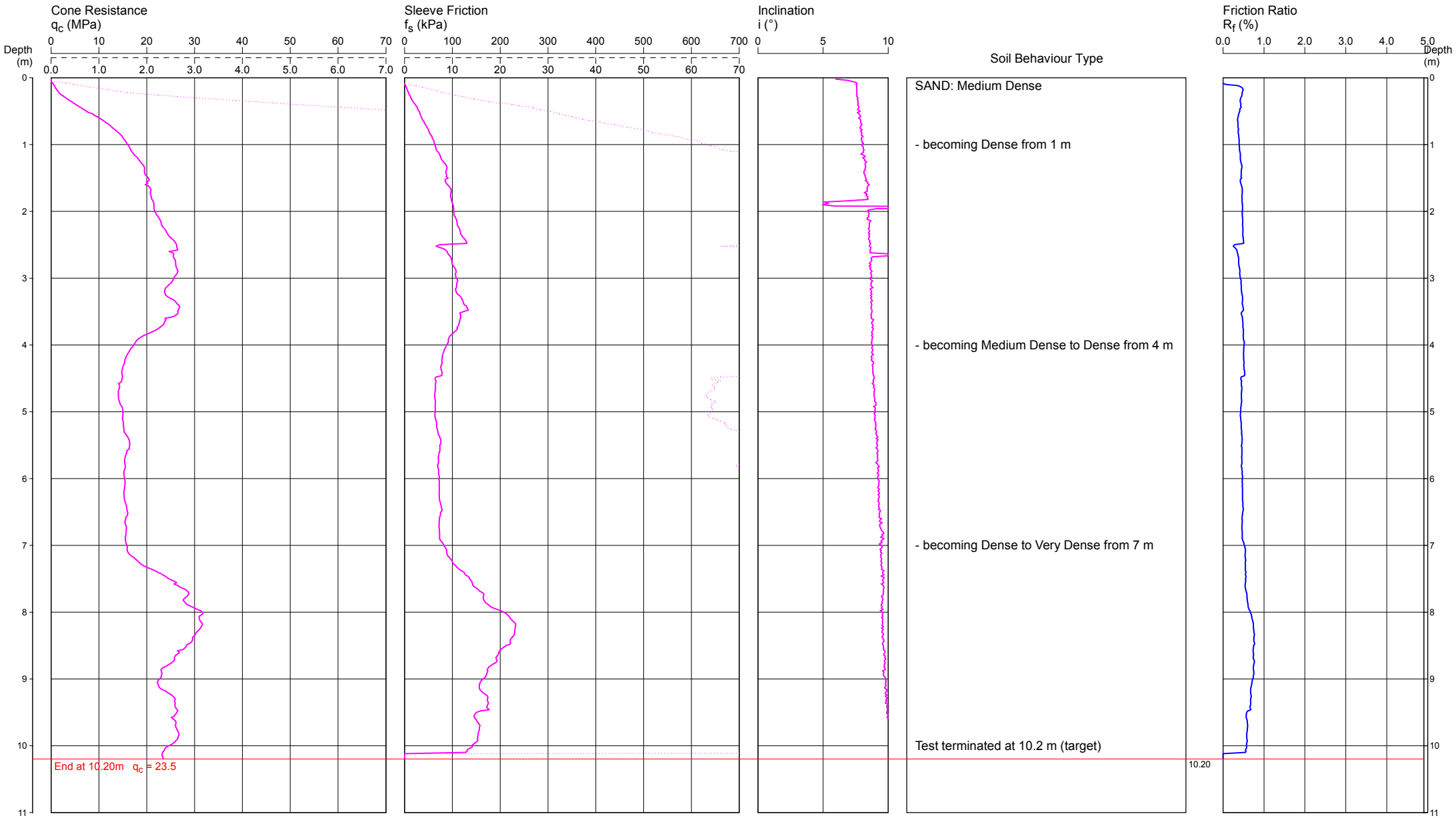
REDUCED LEVEL: 37.3

COORDINATES: 394294E 6444462N

CPT 21

DATE 2/09/2019

PROJECT No: 96594.00



REMARKS: Surface level interpolated from publicly available LiDAR data.

File: P:\96594.00 - BANJUP, Lot 821 Armadale Road\4.0 Field Work\CPT\DP\96594 - CPT 21.CP5
Cone ID: Probedrill **Type:** EC05

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: Anstey Road Developments Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 821 Armadale Road

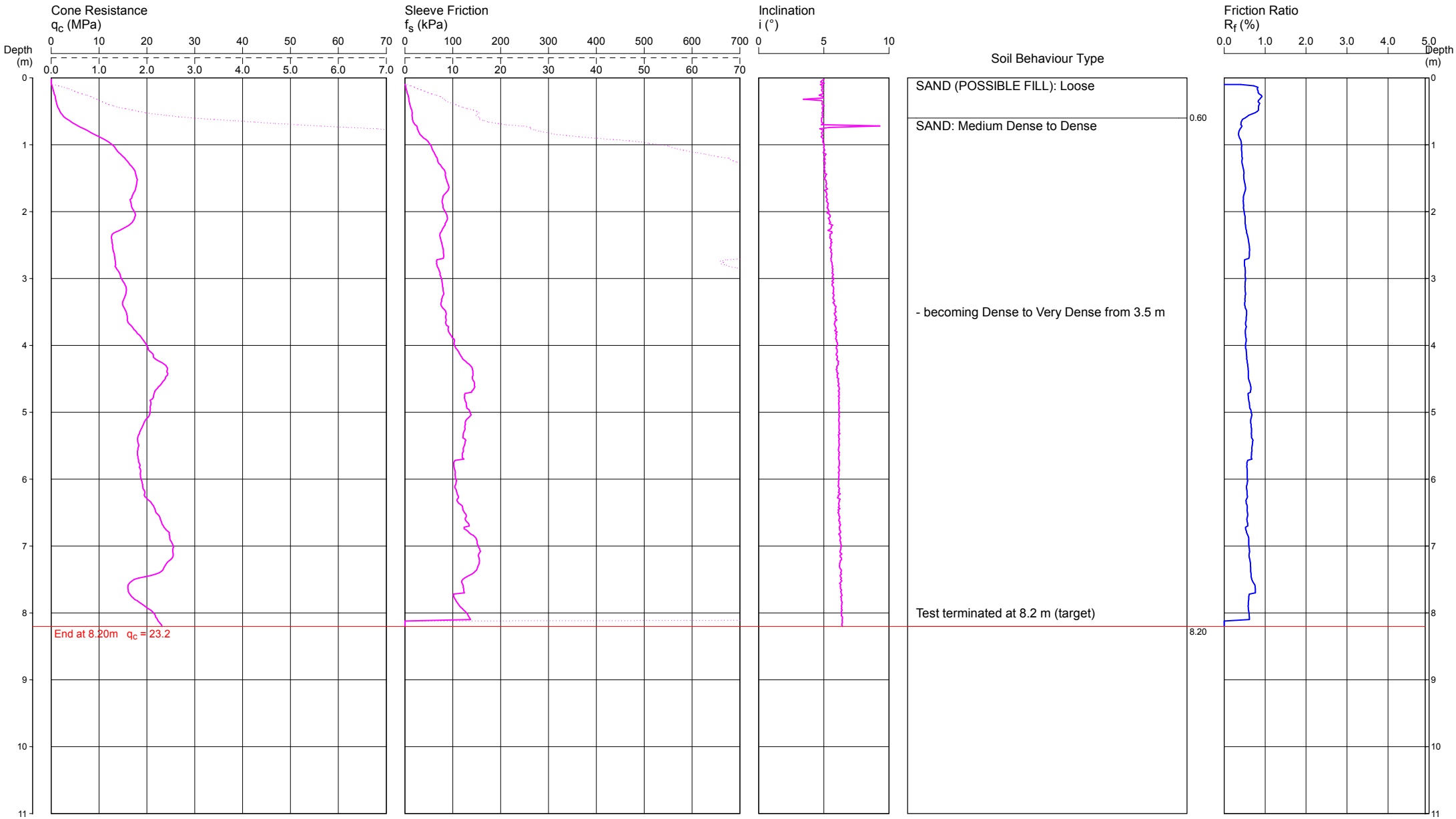
REDUCED LEVEL: 36.5

COORDINATES: 394093E 6444572N

CPT 22

DATE 2/09/2019

PROJECT No: 96594.00



REMARKS: Surface level interpolated from publicly available LiDAR data.

File: P:\96594.00 - BANJUP, Lot 821 Armadale Road\4.0 Field Work\CPT\DP\96594 - CPT 22.CP5
Cone ID: Probedrill **Type:** EC05

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: Anstey Road Developments Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 821 Armadale Road

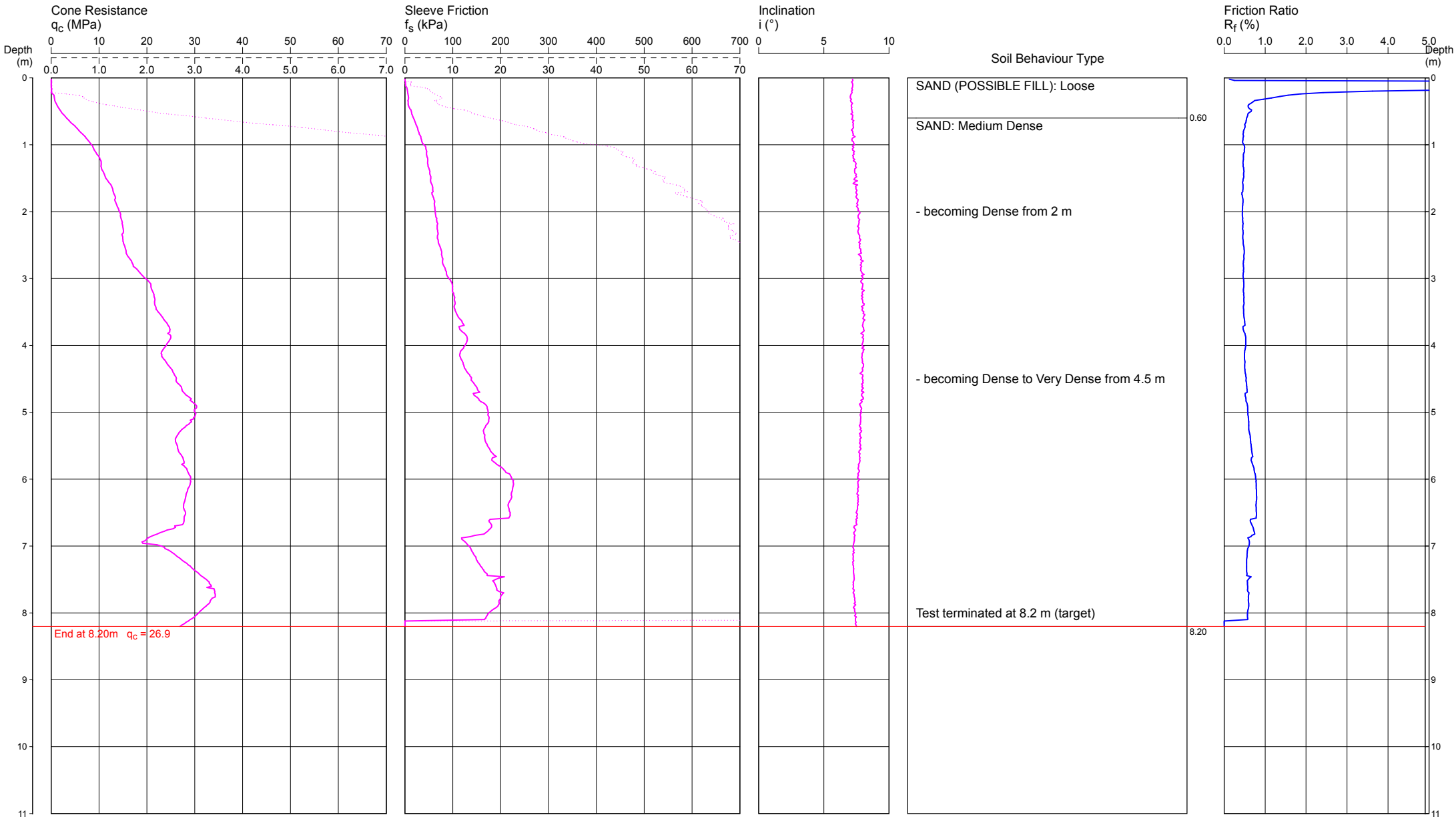
REDUCED LEVEL: 35.6

COORDINATES: 394028E 6444826N

CPT 23

DATE 2/09/2019

PROJECT No: 96594.00



REMARKS: Surface level interpolated from publicly available LiDAR data.

File: P:\96594.00 - BANJUP, Lot 821 Armadale Road\4.0 Field Work\CPT\DP\96594 - CPT 23.CP5
Cone ID: Probedrill **Type:** EC05

ConePlot Version 5.9.2
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CONE PENETRATION TEST

CLIENT: Anstey Road Developments Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 821 Armadale Road

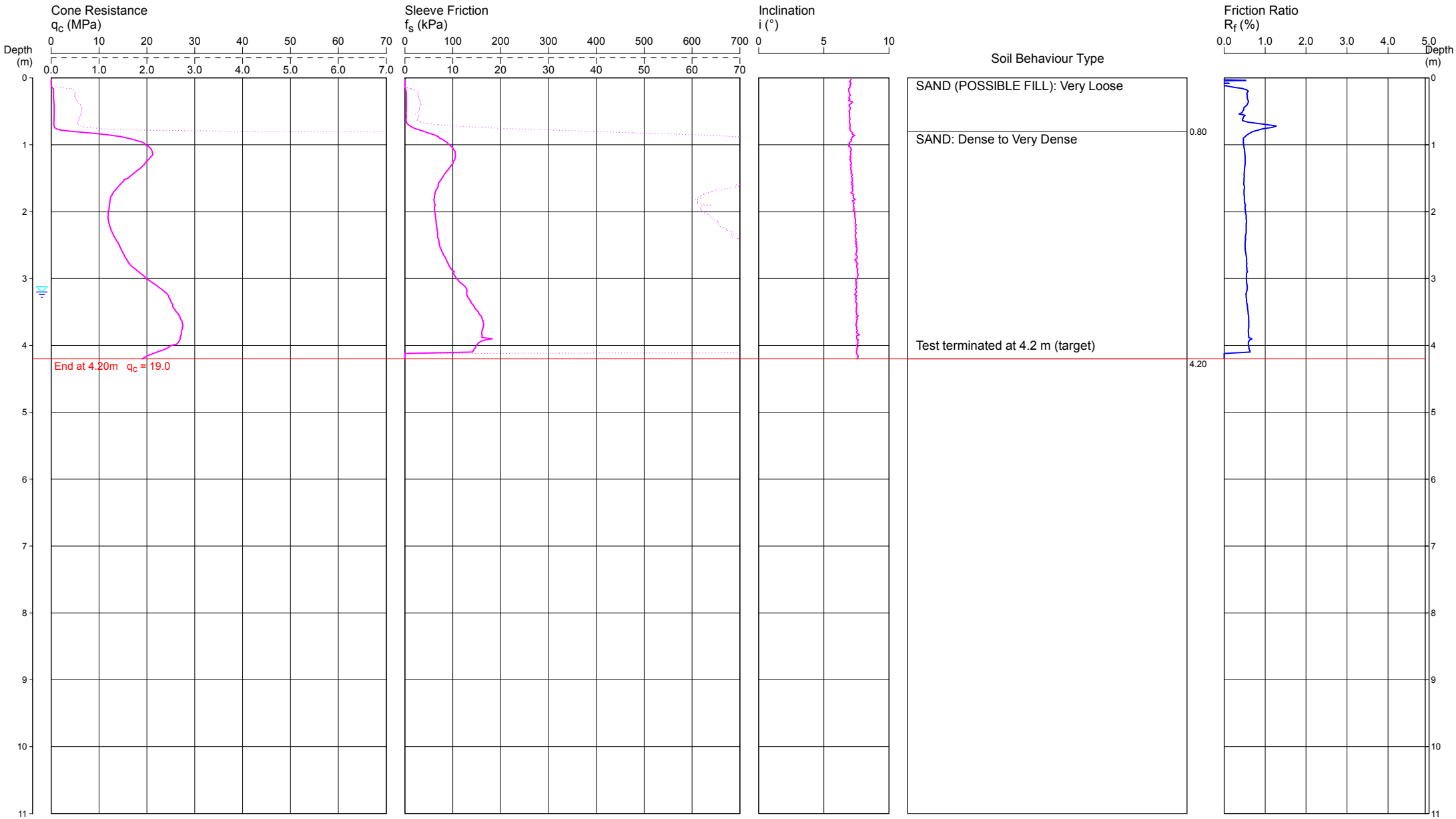
REDUCED LEVEL: 30

COORDINATES: 394158E 6444769N

CPT 24

DATE 2/09/2019

PROJECT No: 96594.00



REMARKS: Surface level interpolated from publicly available LiDAR data.

Water depth after test: 3.20m depth (assumed)

File: P:\96594.00 - BANJUP, Lot 821 Armadale Road\4.0 Field Work\CPT\DP\96594 - CPT 24.CP5
Cone ID: Probedrill **Type:** EC05

ConePlot Version 5.9.2
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CONE PENETRATION TEST

CLIENT: Anstey Road Developments Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 821 Armadale Road

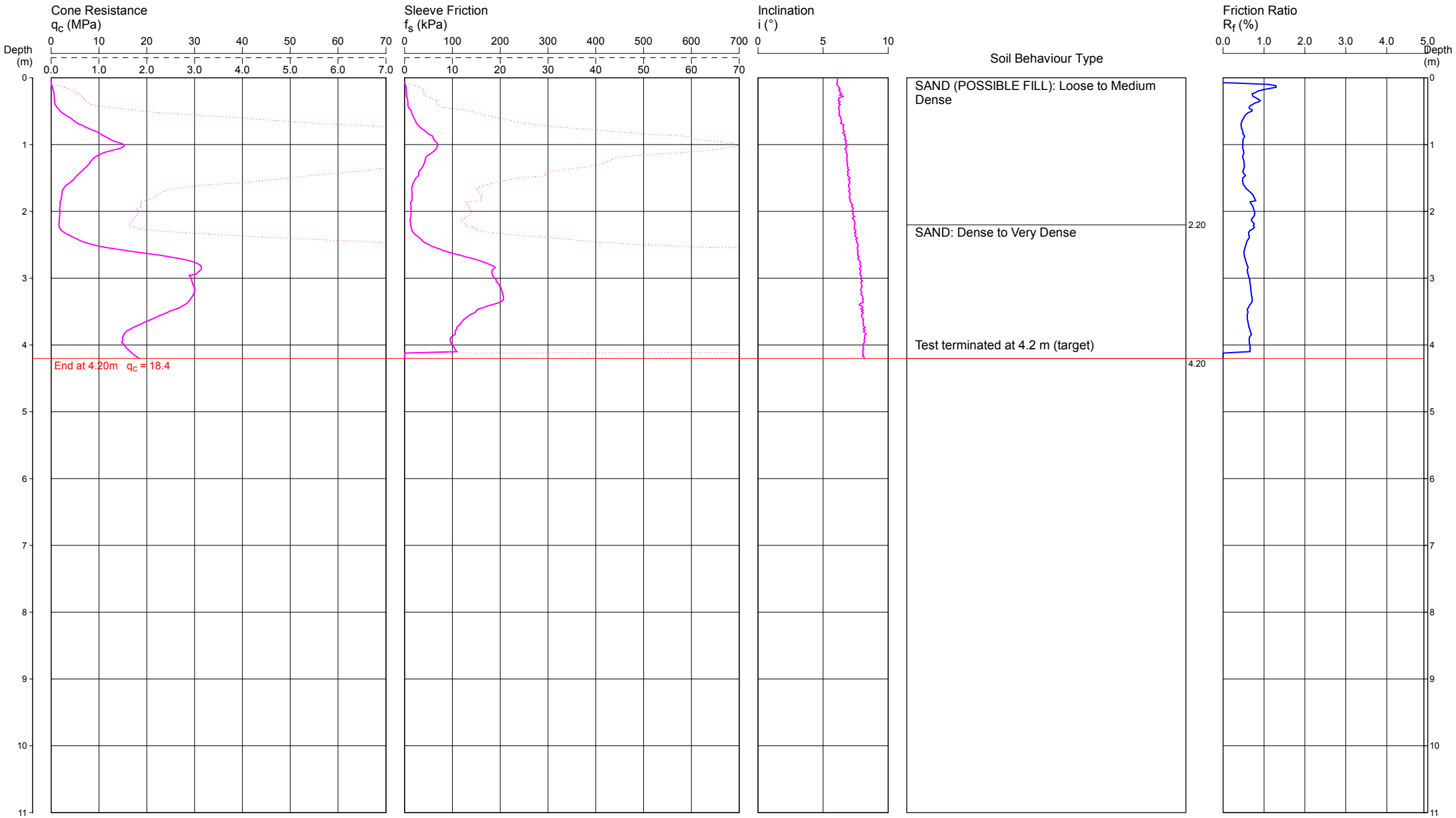
REDUCED LEVEL: 30

COORDINATES: 394252E 6444636N

CPT 25

DATE 2/09/2019

PROJECT No: 96594.00



REMARKS: Surface level interpolated from publicly available LiDAR data.

File: P:\96594.00 - BANJUP, Lot 821 Armadale Road\4.0 Field Work\CPT\DP\96594 - CPT 25.CP5
Cone ID: Probedrill **Type:** EC05

ConePlot Version 5.9.2

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CONE PENETRATION TEST

CLIENT: Anstey Road Developments Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 821 Armadale Road

REDUCED LEVEL: 30

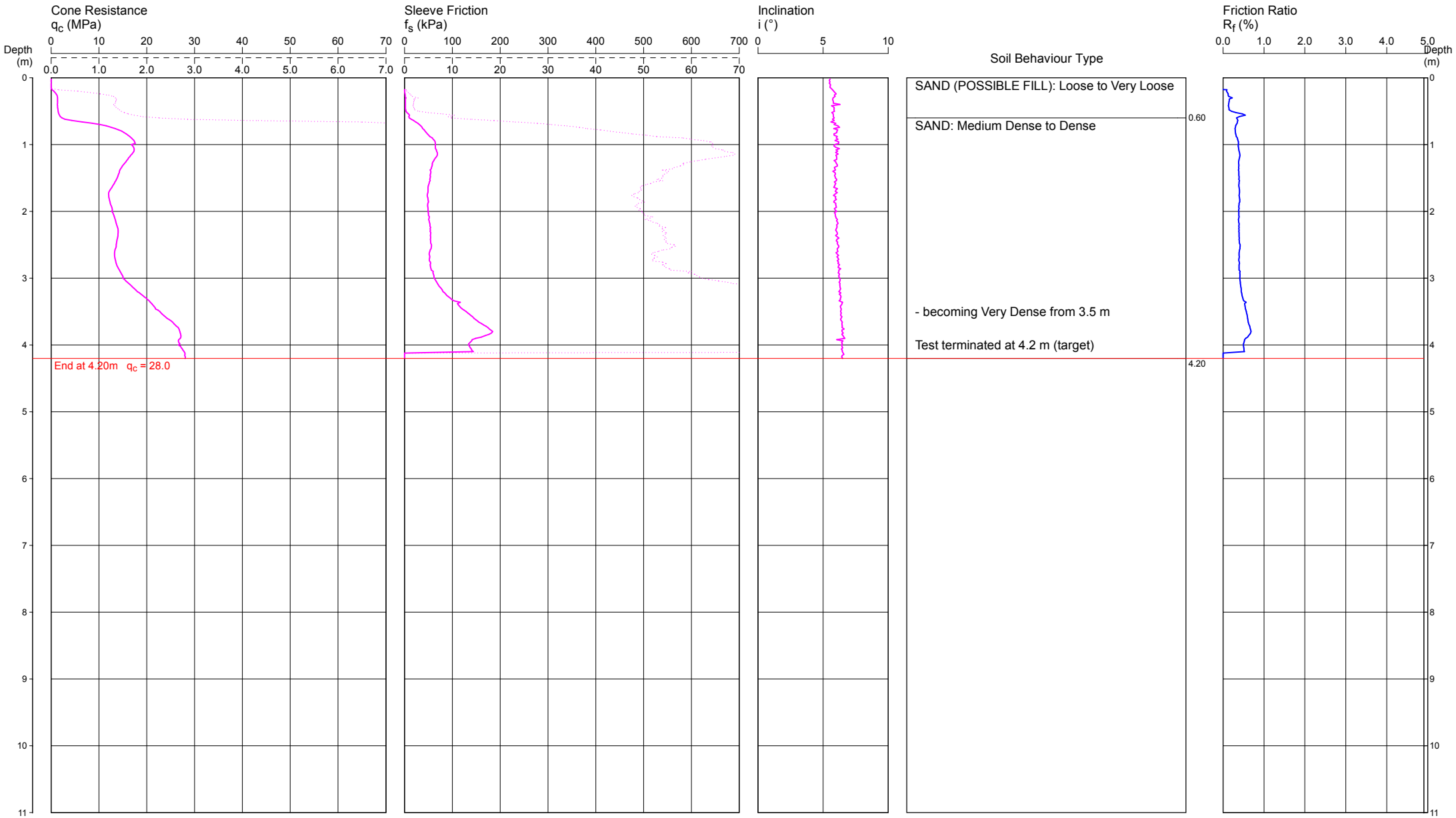
COORDINATES: 394418E 6444628N

CPT 26

Page 1 of 1

DATE 2/09/2019

PROJECT No: 96594.00



REMARKS: Surface level interpolated from publicly available LiDAR data.

File: P:\96594.00 - BANJUP, Lot 821 Armadale Road\4.0 Field Work\CPT\DP\96594 - CPT 26.CP5
Cone ID: Probedrill **Type:** EC05

ConePlot Version 5.9.2
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CONE PENETRATION TEST

CLIENT: Anstey Road Developments Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 821 Armadale Road

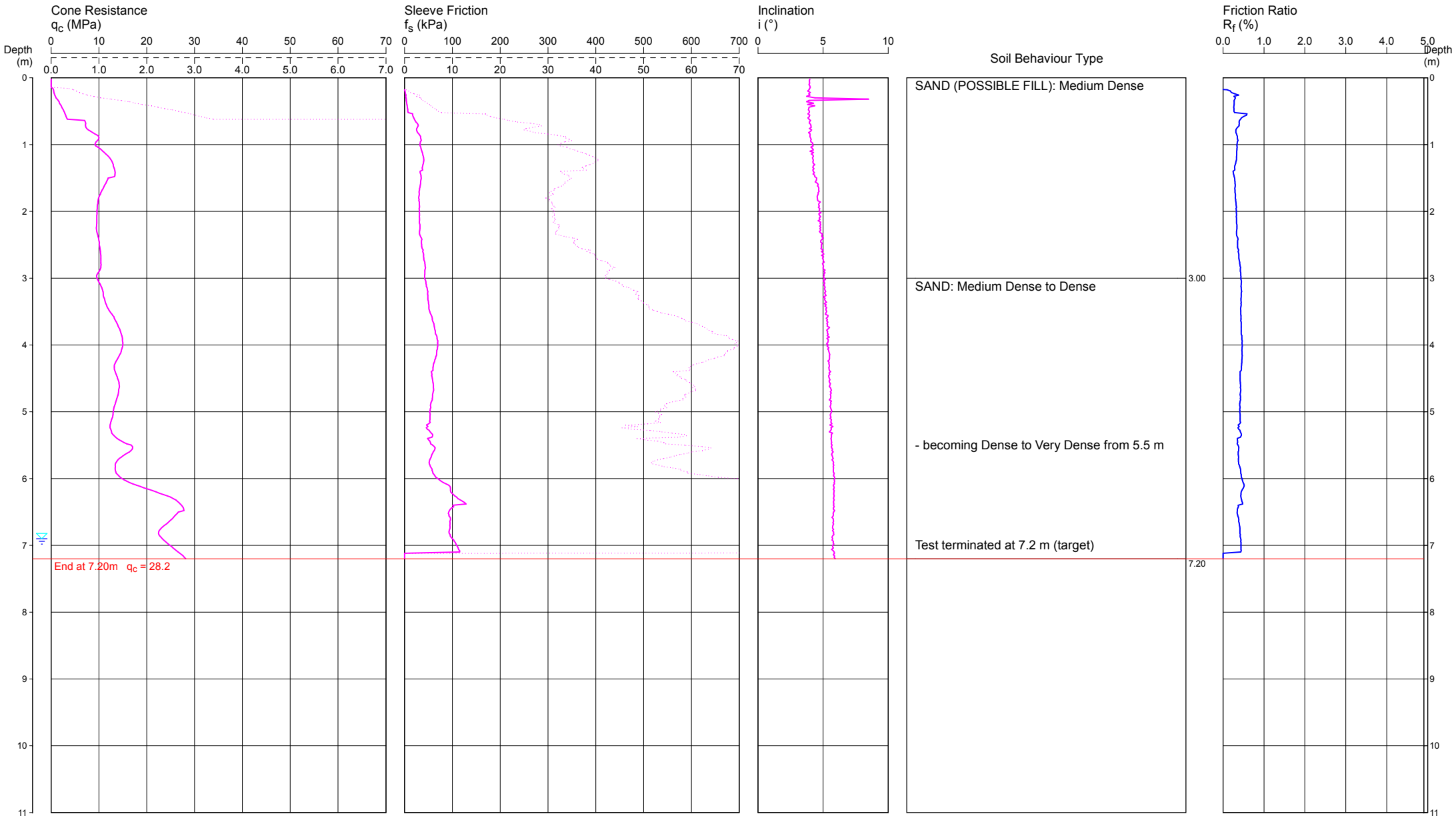
REDUCED LEVEL: 33.8

COORDINATES: 394330E 6444843N

CPT 27

DATE 2/09/2019

PROJECT No: 96594.00



REMARKS: Surface level interpolated from publicly available LiDAR data.

Water depth after test: 6.90m depth (assumed)

File: P:\96594.00 - BANJUP, Lot 821 Armadale Road\4.0 Field Work\CPT\DP\96594 - CPT 27.CP5
Cone ID: Probedrill **Type:** EC05

ConePlot Version 5.9.2
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CONE PENETRATION TEST

CLIENT: Anstey Road Developments Pty Ltd

PROJECT: Proposed Residential Development

LOCATION: Lot 821 Armadale Road

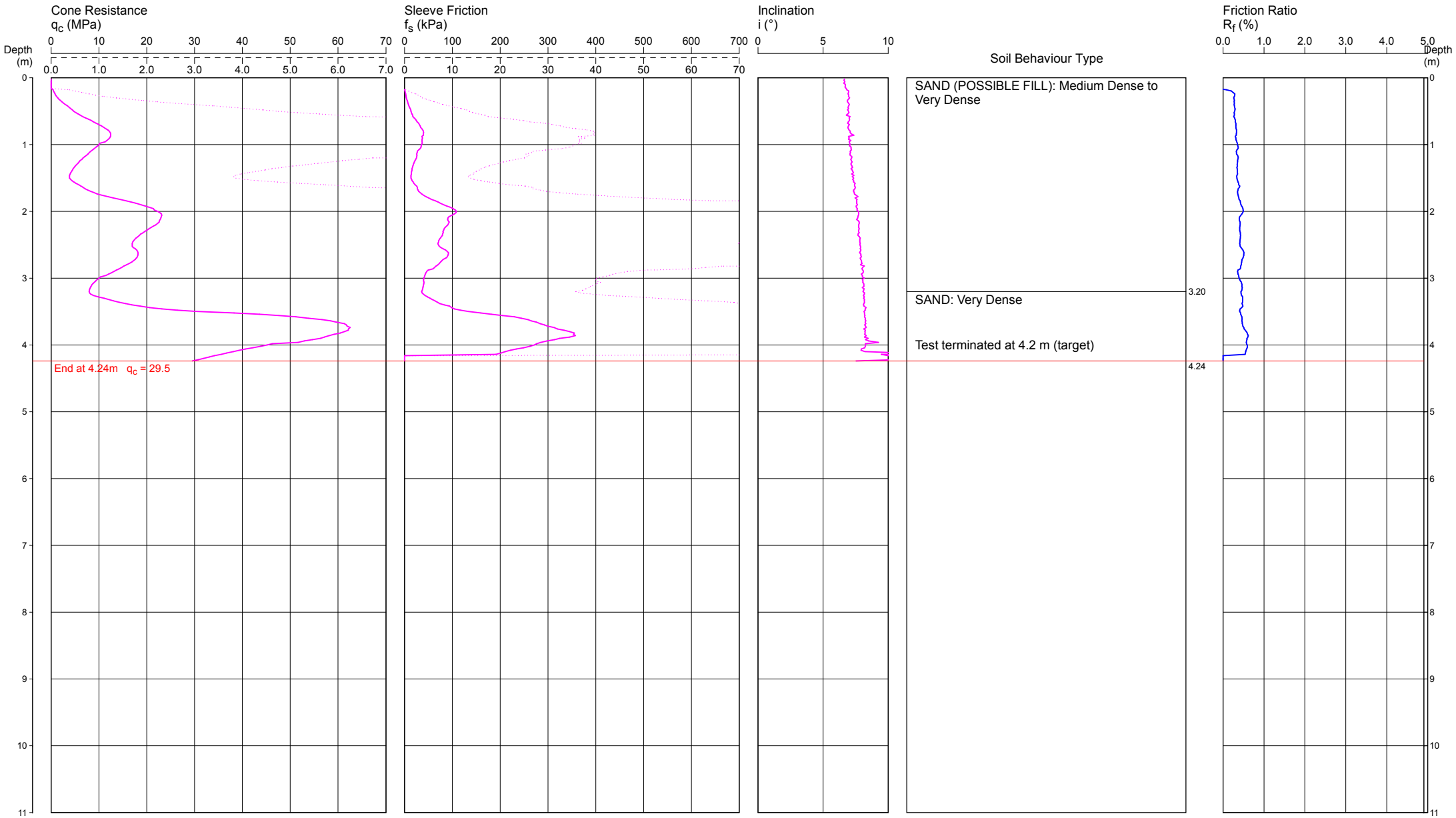
REDUCED LEVEL: 30

COORDINATES: 394540E 6444802N

CPT 28

DATE 2/09/2019

PROJECT No: 96594.00



REMARKS: Surface level interpolated from publicly available LiDAR data.

File: P:\96594.00 - BANJUP, Lot 821 Armadale Road\4.0 Field Work\CPT\DP\96594 - CPT 28.CP5
Cone ID: Probedrill **Type:** EC05

ConePlot Version 5.9.2

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Appendix C

Results of Laboratory Testing

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

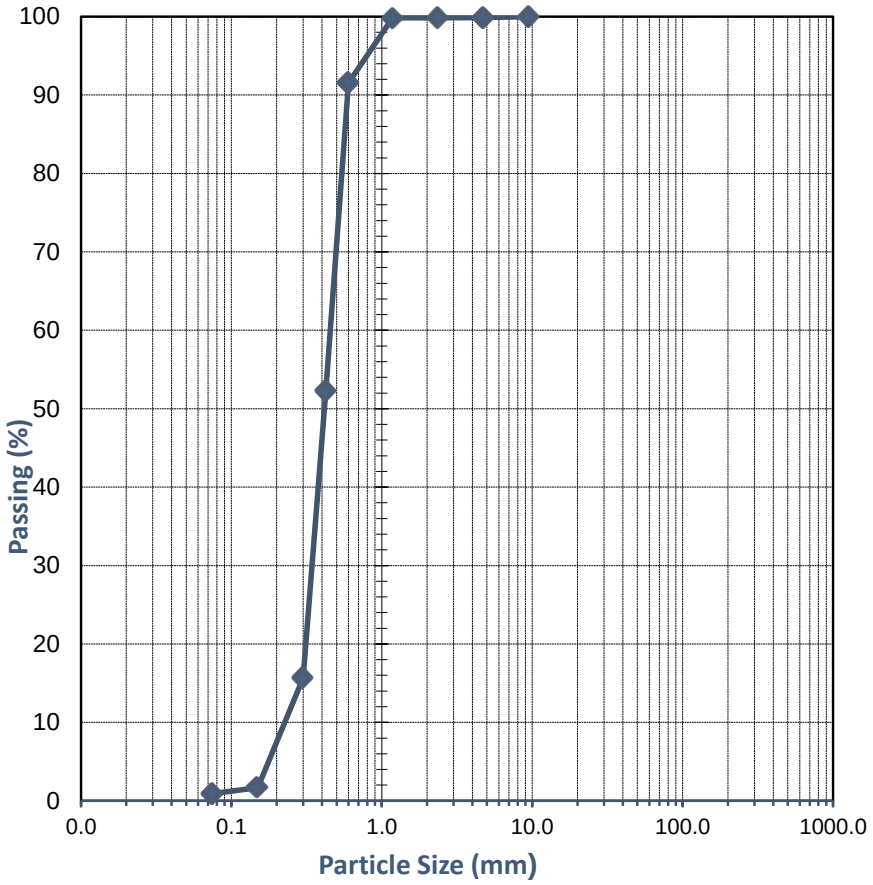
TEST REPORT - AS 1289.3.6.1

Client:	Anstey Road Developments Pty Ltd	*Ticket No.*	S341
Client Address:	-	*Report No.*	WG19/2669_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG19/2669
Location:	Lot 821 Armadale Road, Banjup	*Date Sampled:*	1-09-2019
Sample Identification:	TP2 1.9-2.0m	*Date Tested:*	4-09-2019

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve
75.0	
53.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	100
0.600	92
0.425	52
0.300	16
0.150	2
0.075	1



Comments:

Approved Signatory:

Name: Matt van Herk
Function: General Manager
Date: 05-September-2019

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

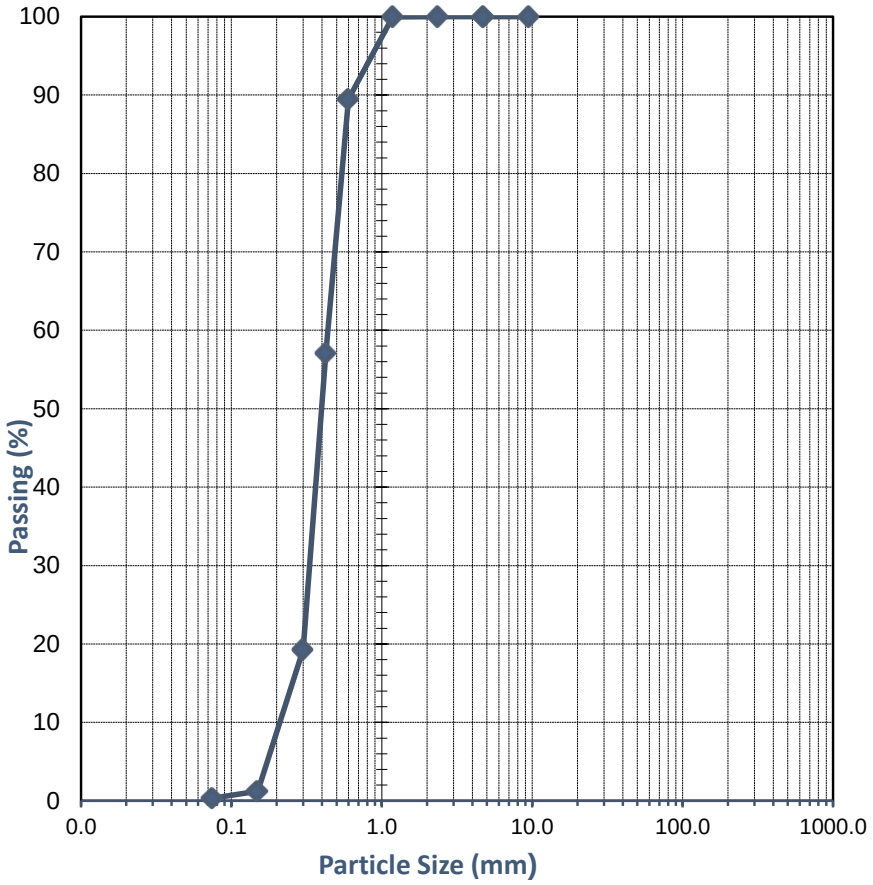
TEST REPORT - AS 1289.3.6.1

Client:	Anstey Road Developments Pty Ltd	*Ticket No.*	S341
Client Address:	-	*Report No.*	WG19/2671_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG19/2671
Location:	Lot 821 Armadale Road, Banjup	*Date Sampled:*	1-09-2019
Sample Identification:	TP12 0.6-0.7m	*Date Tested:*	4-09-2019

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve
75.0	
53.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	100
0.600	89
0.425	57
0.300	19
0.150	1
0.075	0



Comments:

Approved Signatory:

Name: Matt van Herk
Function: General Manager
Date: 05-September-2019

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

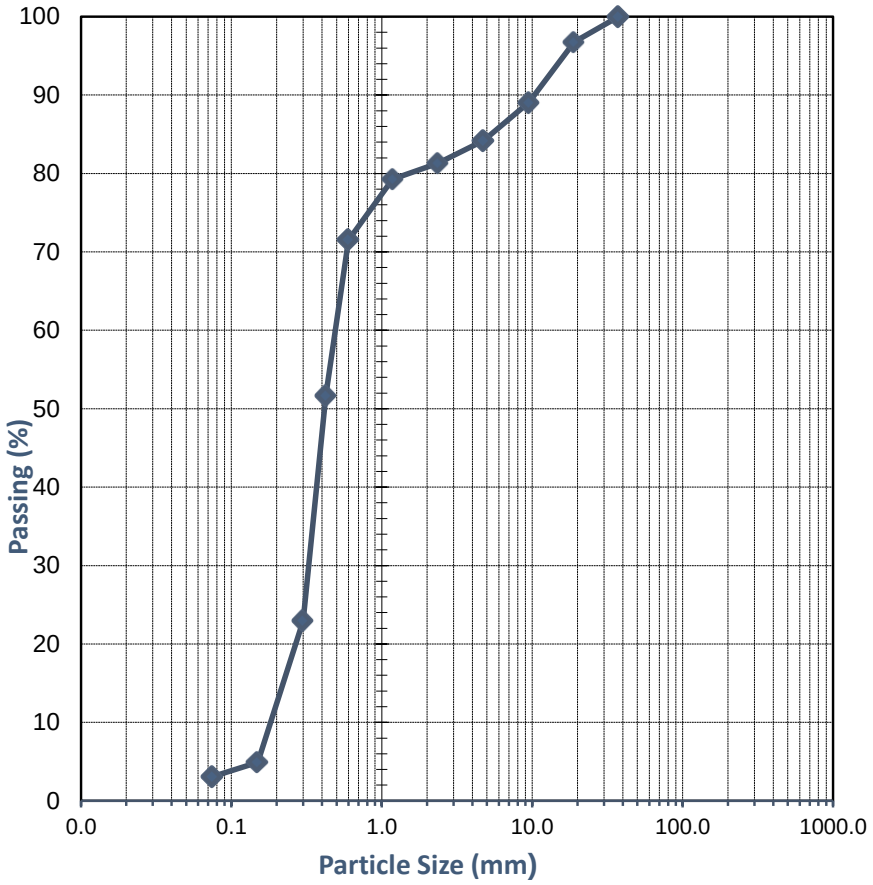
TEST REPORT - AS 1289.3.6.1

Client:	Anstey Road Developments Pty Ltd	*Ticket No.*	S341
Client Address:	-	*Report No.*	WG19/2673_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG19/2673
Location:	Lot 821 Armadale Road, Banjup	*Date Sampled:*	1-09-2019
Sample Identification:	TP14 0.2-0.3m	*Date Tested:*	4-09-2019

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve
75.0	
53.0	
37.5	100
19.0	97
9.5	89
4.75	84
2.36	81
1.18	79
0.600	72
0.425	52
0.300	23
0.150	5
0.075	3



Comments:

Approved Signatory:

Name: Matt van Herk
Function: General Manager
Date: 05-September-2019

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

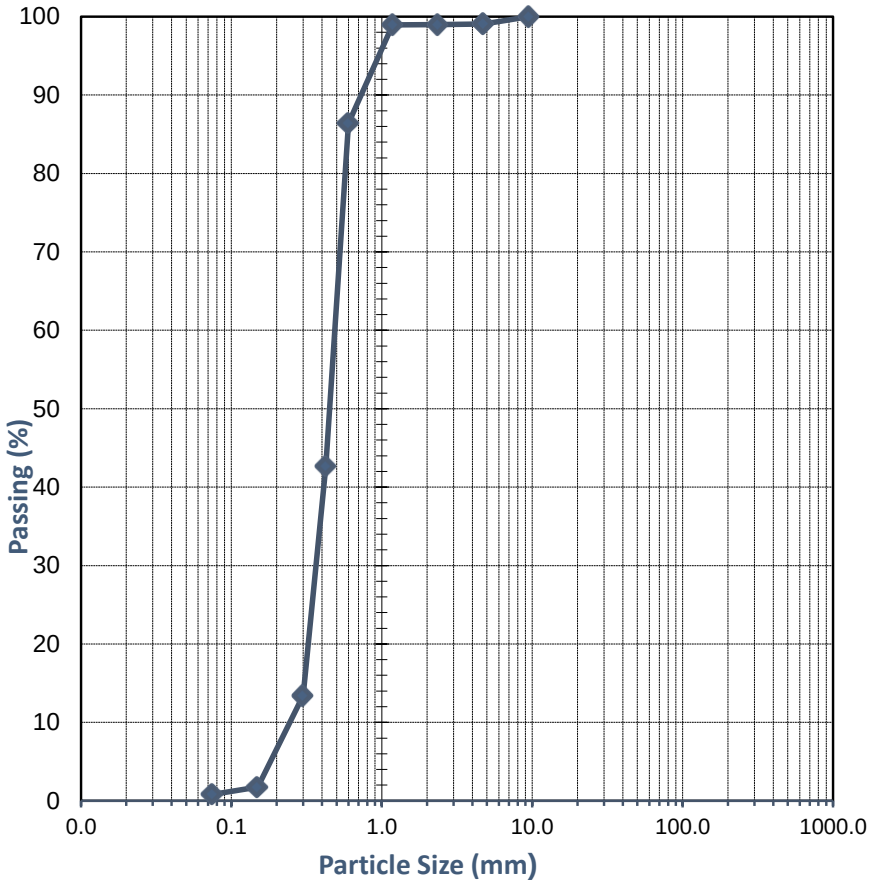
TEST REPORT - AS 1289.3.6.1

Client:	Anstey Road Developments Pty Ltd	*Ticket No.*	S341
Client Address:	-	*Report No.*	WG19/2672_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG19/2672
Location:	Lot 821 Armadale Road, Banjup	*Date Sampled:*	1-09-2019
Sample Identification:	Perm31 0.65-0.75m	*Date Tested:*	4-09-2019

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve
75.0	
53.0	
37.5	
19.0	
9.5	100
4.75	99
2.36	99
1.18	99
0.600	86
0.425	43
0.300	13
0.150	2
0.075	1



Comments:

Approved Signatory:

Name: Matt van Herk
Function: General Manager
Date: 05-September-2019

NATA WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

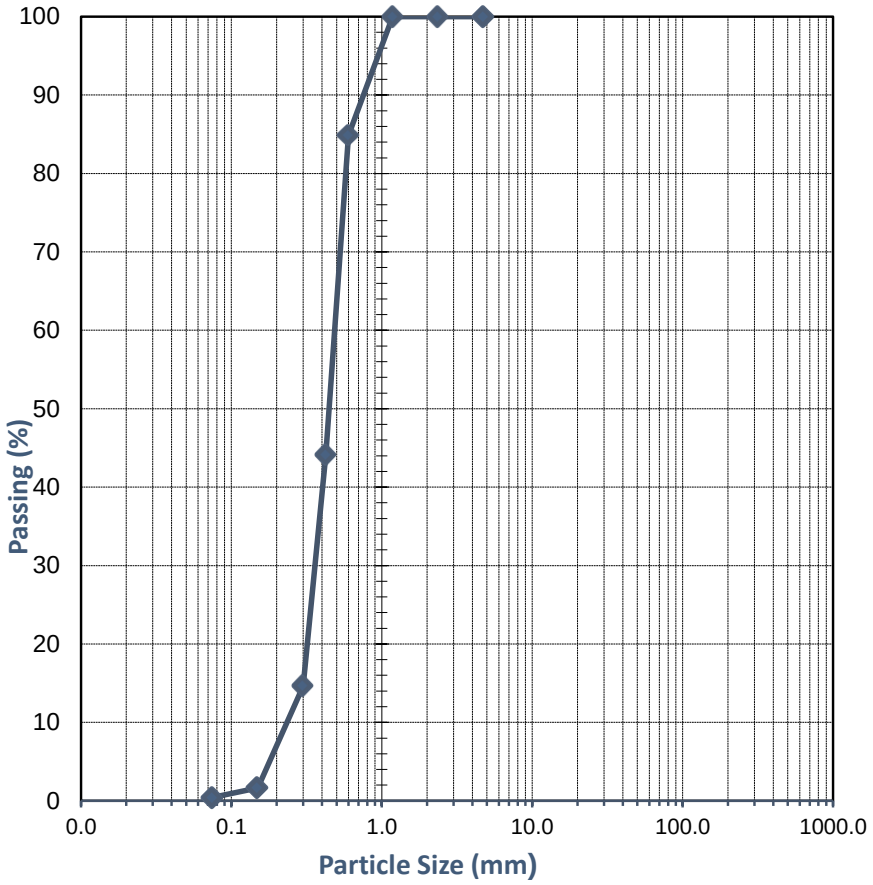
TEST REPORT - AS 1289.3.6.1

Client:	Anstey Road Developments Pty Ltd	*Ticket No.*	S341
Client Address:	-	*Report No.*	WG19/2670_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG19/2670
Location:	Lot 821 Armadale Road, Banjup	*Date Sampled:*	1-09-2019
Sample Identification:	Perm34 0.55-0.7m	*Date Tested:*	4-09-2019

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve
75.0	
53.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	85
0.425	44
0.300	15
0.150	2
0.075	0



Comments:

Approved Signatory:

Name: Matt van Herk
Function: General Manager
Date: 05-September-2019

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

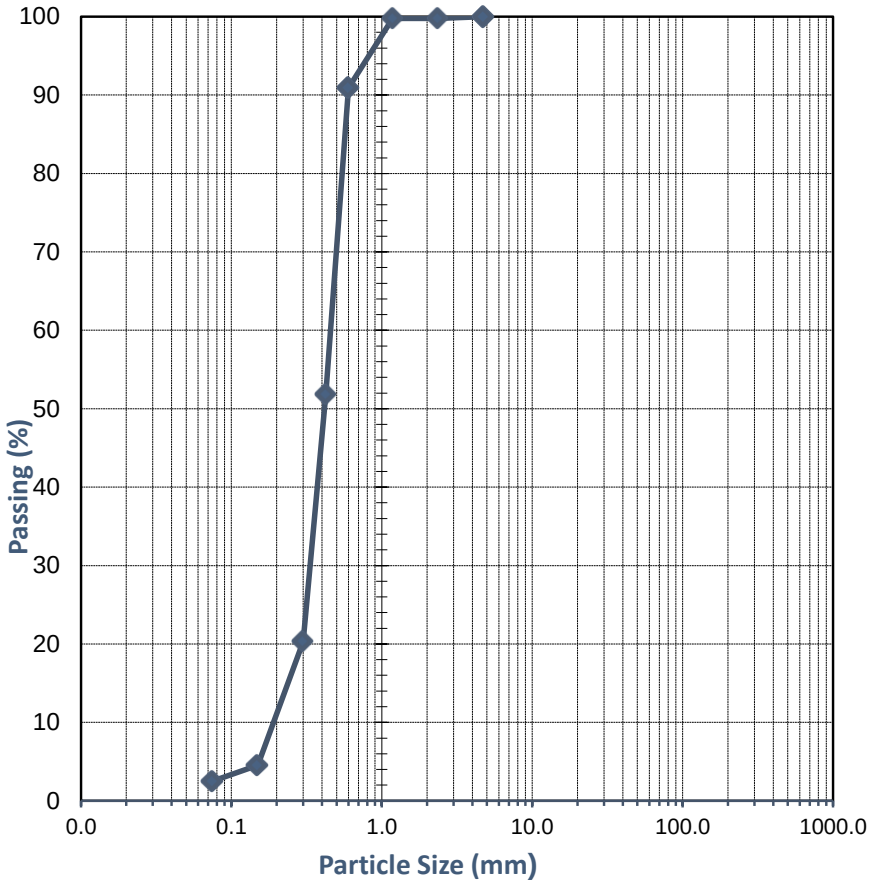
TEST REPORT - AS 1289.3.6.1

Client:	Anstey Road Developments Pty Ltd	*Ticket No.*	S341
Client Address:	-	*Report No.*	WG19/2674_1_PSD
Project:	Proposed Residential Development	*Sample No.*	WG19/2674
Location:	Lot 821 Armadale Road, Banjup	*Date Sampled:*	1-09-2019
Sample Identification:	Stockpile 4	*Date Tested:*	4-09-2019

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve
75.0	
53.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	91
0.425	52
0.300	20
0.150	5
0.075	3



Comments:

Approved Signatory:

Name: Matt van Herk
Function: General Manager
Date: 05-September-2019

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - ASTM D2974-14 (Test Method C)

Client:	Anstey Road Developments Pty Ltd	*Ticket No.*	S341
Client Address:	-	*Report No.*	WG19/2669-2675_1_ORG
Project:	Proposed Residential Development	*Sample No.*	WG19/2669-2675
Location:	Lot 821 Armadale Road, Banjup	*Date Sampled:*	1-09-2019
Sample Identification:	Various, see below	*Date Tested:*	4-09-2019

TEST RESULTS - Organic Content

Sampling Method: Sampled by Client, Tested as Received

Testing Completed By: Kirk McConachy

Furnace Temperature (°): 442

Sample Number	Sample Identification	Ash Content (%)	Organic Content (%)
WG19/2669	TP2 1.9-2.0m	99.7	0.3
WG19/2671	TP12 0.6-0.7m	99.9	0.1
WG19/2674	Stockpile 4	98.5	1.5
WG19/2675	Stockpile 3	96.9	3.1

Comments:

Approved Signatory:

Name: Matt van Herk
Function: General Manager
Date: 05-September-2019

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APPENDIX C

Cossill & Webley Proposed Subsoil Drainage Outlet to Atwell Drain

GHOSTGUM AVENUE

ARMADALE ROAD

OUTLET INTO EXISTING DRAIN

LEGEND

- EXISTING CONTOUR (1.0m)
- DESIGN CONTOUR (0.5m)
- PROPOSED DESIGN LOT PAD LEVEL
- PROPOSED SUBSOIL DRAINAGE (SLOTTED PIPE)
- PROPOSED SUBSOIL DRAINAGE (SOLID PIPE)
- AAMGL CONTOUR (0.2m)

1:1000 0m 20 40 60m

REV	DATE	DRN	CKD	APP	AMENDMENT
B	15.11.19	ARH	-		UPDATED TO REVISED LOT LAYOUT
A	14.10.19	AMP	JW	M WALLIS	ISSUED FOR APPROVAL

N

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Cossill & Webley CONSULTING ENGINEERS

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Street Address
B12 (Level 2) 431 Roberts Road
Subiaco WA 6008

T (08) 9422 5800 F (08) 9422 5801 E admin@cosweb.com.au

CLIENT

APPROVED

DESIGNED AMP

SCALE 1:1000

PROJECT LOT 821 ARMADALE RD, BANJUP

TITLE PROPOSED SUBSOIL DRAINAGE PLAN

WAPC No.

DRAWING No. 6234-LWP-SK07

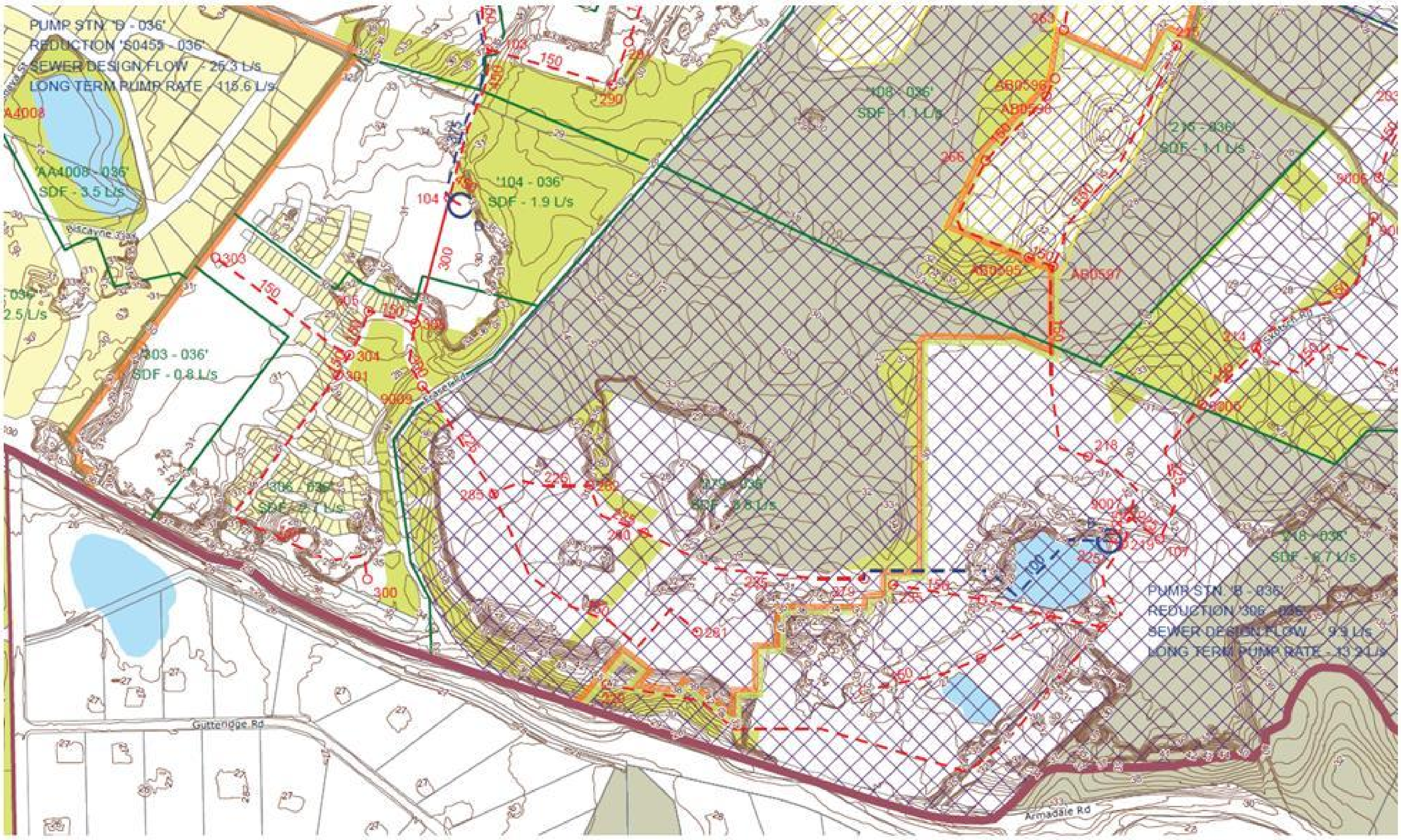
REVISION B

ORIGINAL SIZE A1

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APPENDIX D

Water Corporation's Wastewater Strategy



Preliminary Wastewater Planning Only

APPENDIX E

Water Corporation Water Headwork Strategy

Preliminary Water Planning Only - Not Approved.

DN 375
DN 375
DN 375
DN 375
DN 375
DN 375
DN 375
DN 500
DN 375
DN 500
DN 375
New Control Valve Location
Control Valve to be Relocated
DN 700
DN 700
DN 700
DN 700
DN 600
DN 1400
DN 1400
DN 1400
DN 1400
DN 600

Existing/Proposed Distribution
Existing/Proposed DN 250
Control Valve
Change of Diameter

APPENDIX F

Cossill & Webley Preliminary Earthworks Strategy

6234-LWP-SK06_A

GHOSTGUM AVENUE

ARMADALE ROAD

LEGEND

- EXISTING CONTOUR (1.0m) — 25.0
- DESIGN CONTOUR (0.5m) — 28.0
- PROPOSED DESIGN LOT PAD LEVEL — 25.00
- EARTHWORKS BOUNDARY

REV	DATE	DRN	CKD	APP	AMENDMENT
B	15.11.19	ARH	-	mjwall	UPDATED TO REVISED LOT LAYOUT
A	11.10.19	AMP		M. WALLIS	ISSUED FOR APPROVAL

N

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0m 20 40 60
1:1000

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CLIENT

APPROVED mjwall

DESIGNED AMP

SCALE 1:1000

PROJECT LOT 821 ARMADALE RD, BANJUP

TITLE PRELIMINARY EARTHWORKS

WAPC No.

DRAWING No. 6234-LWP-SK06

REVISION B

ORIGINAL SIZE A1

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