Douglas Partners
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Report on
Geotechnical Investigation

Proposed Helicopter Facility
89-151 Old Castlereagh Road, Penrith

Prepared for
Colliers International Pty Ltd

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

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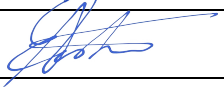
Reviewer		1 October 2021

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Report on Geotechnical Investigation
Proposed Helicopter Facility
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1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed helicopter facility at 89-151 Old Castlereagh Road, Penrith. The investigation was commissioned by Scott Anderson of Colliers International Pty Ltd and was undertaken in accordance with Douglas Partners' proposal 204635.00.P.001.Rev0 dated 7 May 2021.

It is understood that the proposed development includes:

- Demolition of 2 single storey sheds and integrated hardstand extending beyond the footprint of the sheds;
- Demolition of 1 small single storey shed and associated pavement;
- Removal of 1 inground tank;
- Removal of 1 flood light;
- Removal of less than 10 trees;
- Reinstatement of grass turf in locations of removed hardstands and pavement;
- New concrete hardstand in location of existing concrete hardstands;
- New lighting as required for the FATO.

The aim of the investigation was to assess the subsurface soil and groundwater conditions across the site in order to provide comments and advice on earthworks, excavation support, foundations and pavements

The investigation included cone penetration testing (CPTu) at 16 locations, the excavation of geotechnical test pits at seven (7) locations, and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the items listed above.

It is noted that the geotechnical investigation was undertaken in parallel with a preliminary site investigation (PSI) with limited sampling. The results of the PSI are reported separately (reference: 204635.01.R.001).

2. Previous Investigations

The site has been the subject of several previous investigations by Coffey Geotechnics Pty Ltd (Coffey). A report prepared by Coffey; 'Landform Appraisal – Old Castlereagh Road Land Parcel' (reference: GEOTLCOV24000HB-CT) was provided as background information for the project.

The Coffey report includes historical aerial imagery of the site between 1955 and 2012 provided by Penrith Lakes Development Corporation (PLDC), showing the extent of previous quarrying activity on and in proximity to the site (reference: PLDC-11568). These aerial images have been considered in the preparation of this report and are re-produced in Appendix E for information.

The Coffey report also includes earthworks density testing records from 1984 to 1991, during the placement of fill to remediate the quarried land.

3. Site Description

The site (Lot 2 in DP1013504) is located at 89 – 151 Old Castlereagh Road, Penrith. The site has an approximate area of 11.3 ha, although the proposed development will only cover a small part of the site. It is noted that the site was previously identified as 100 – 275 Old Castlereagh Road during the investigation, and some of the attachments to this report refer to it as such.

The site borders Old Castlereagh Road to the south and the Sydney International Regatta Centre lake to the north. Residential and commercial properties comprising mostly open space border the site to the east and west.

Currently, the site is mostly open space, with several existing single storey buildings, sheds, and internal roads / on-grade parking areas concentrated in the higher elevation parts of the site. There is a man-made lake / dam in the north-west corner of the site. The existing buildings and pavements appeared to be in fair condition, with some minor cracking in the existing pavements.

Existing ground surface levels across the site (relative to Australian Height Datum (AHD)) range from about RL 26.5 m AHD in the south-east, to about RL 15 m AHD near the dam in the north-west. In general, the existing ground surface forms a relatively level plateau in the southern half of the site, with a 'peninsula' jutting out to the north. The edge of this plateau falls away relatively quickly towards the north, with existing slope angles of about 6° to 12°. The plateau edges generally align with the approximate boundaries of previously quarried land, based on the historical photographs in Appendix E.

4. Regional Mapping

4.1 Geology

Reference to the Penrith 1:100,000 Geology Sheet indicates that the site is underlain by Quaternary sediments of the Cranebrook Formation, which typically comprises a mixture of gravel, sand, silt and clay. Where inferred naturally deposited sediments were encountered, the results of the investigation generally agree with the mapping.

4.2 Soil Landscape

Reference to the Penrith 1:100,000 Soils Landscape Sheet (SLS) indicates that the site is underlain by the Richmond alluvial soil landscape, typically characterised by relatively flat slopes, and generally comprising poorly structured clay loams, clays, and sands.

The SLS also indicates disturbed terrain encroaching on the eastern part of the site, owing to quarrying in the area. It is noted that the extent of disturbed terrain is likely greater than shown on the SLS, based on the aerial photographs in Appendix E.

4.3 Acid Sulphate Soils

The site is not within a region of mapped acid sulphate soil risk. It is noted that acid sulphate soils mostly occur in low lying coastal areas, typically below RL 5 m AHD, and rarely above RL 10 m AHD. The nearest mapped region is the Nepean River to the south, where there is no known occurrence of acid sulphate soils.

4.4 Salinity

Reference to the 2002 Map of Salinity Potential in Western Sydney indicates that the site is in a region of moderate salinity risk. A detailed assessment of salinity potential was beyond the scope of this investigation, however no obvious signs of salinity were observed during the field work, and some comments on management of potential salinity are provided in Section 8.9.

5. Field Work

5.1 Field Work Methods

The field work for the geotechnical investigation was carried out over a three day period between 18 May 2021 and 20 May 2021, and included:

- A walkover inspection of the site by a geotechnical engineer;
- Cone penetration testing with pore pressure measurement (CPTu) at 16 locations (1 to 16) to depths of between 1.6 m and 15 m using a truck mounted testing apparatus. During a CPTu, a 36 mm diameter instrumented cone is pushed into the ground while recording continuous measurements of the end bearing resistance, shaft friction, and excess pore pressure in the soil during the test;
- Following each CPTu, the test hole was dipped to measure any groundwater in the open hole;
- Excavation of test pits at 14 locations (17 to 30) to depths of between 2.3 m and 3.3 m using an 8.5 tonne excavator fitted with a 450 mm wide toothed bucket;
- A dynamic cone penetrometer (DCP) test was undertaken in or adjacent to each test pit, to maximum depths of 2.4 m;

- The subsurface conditions encountered in the test pits were logged on-site by a geotechnical engineer, who also collected samples for subsequent laboratory testing.

The coordinates and ground surface levels at the CPTu and test pit locations were measured relative to GDA94 MGA Zone 56, and AHD, respectively, using a high precision differential GPS (dGPS) receiver, which is generally accurate to within ±0.1 m. At seven of the locations (3, 8, 13, 15, 21, 29 and 30), a fix could not be achieved with the dGPS, resulting in an accuracy within approximately ±5 m. This is considered acceptable for horizontal accuracy, but elevations at these locations have instead been approximated based on the survey overlain on Northrop Drawing 201524-SKC03.01-Rev1.

The determined coordinates and elevations at each location are shown on the test pit logs and CPTu results in Appendix C. The locations are shown on Drawing 1 in Appendix B.

5.2 Field Work Results

The subsurface conditions encountered during the field investigation are shown on the test pit logs and interpreted CPTu result plots presented in Appendix C, together with notes defining classification methods and descriptive terms used in their preparation.

A summary of the typical subsurface conditions encountered at the site is presented below:

Topsoil / Fill Generally comprising two distinct 'types' of fill across the site.

Within the region shown as 'non-quarried land' on Drawing 1 in Appendix B, surficial fill, typically comprising sands, gravelly sands, silty clays underlying silty / clayey topsoils or asphaltic pavements, was encountered to maximum depths of about 1 m below the surface. The surficial fill in these areas typically appeared variably compacted but typically consistent with loose to dense granular soil and stiff to very stiff clayey soil with some weaker and stronger layers.

Generally, beyond the region shown as 'non-quarried land' on Drawing 1, material inferred to be fill was encountered to significant depths, potentially up to 12.2 m below existing surface levels. The inferred fill typically comprised interbedded sands and clays, with gravel (possibly site won from nearby quarrying activities), and generally appeared variably compacted but typically consistent with loose to dense granular soil and stiff to very stiff clayey soil with some weaker and stronger layers.

Alluvial Sediments Underlying the fill, alluvial sediments were typically encountered to the investigation limits or refusal (typically inferred to be on gravel), to depths of between 2.2 m and 8.6 m in the 'non-quarried' areas, and to depths of between 5.9 m and 15 m in the 'quarried' areas.

The alluvial sediments generally comprised interbedded loose to very dense sands, and firm to hard clays.

Groundwater was observed in at three CPTu locations following completion of the tests, as summarised in Table 1 below:

Table 1: Summary of Groundwater Observations

Location	Date	Depth to Groundwater (m)	Groundwater Elevation (m AHD)
6	19/05/21	5.5	19.9
7	19/05/21	6.1	19.8
12	19/05/21	5.6	17.9

It should be noted that groundwater levels are transient and may fluctuate in response to seasonal and climatic variations.

6. Laboratory Testing

Following completion of the field work, a suite of laboratory testing was undertaken on selected samples recovered from the test pits, including:

- Atterberg Limits, Linear Shrinkage and Moisture Content on 5 samples;
- Particle Size Distribution and Hydrometer Grading on 5 samples;
- Aggressivity (pH, electrical conductivity, sulphate and chloride ion content) on 10 samples; and
- California Bearing Ratio (4 day soak) on 8 samples.

The results of the laboratory testing are summarised in Table 3 to Table 5, and the detailed laboratory test certificates are included in Appendix D.

Table 2: Summary of Plasticity Laboratory Test Results

Location	Depth (m)	LL (%)	PL (%)	PI (%)	LS (%)	FMC (%)
TP17	0.5-0.8	50	19	31	15.0	19.3
TP21	1.0-1.5	38	16	22	11.0	15.5
TP24	0.5-1.0	38	16	22	11.5	14.2
TP26	0.8-1.2	24	18	6	5.5	15.9
TP29	1.4-1.5	34	15	19	9.0	11.3

Table 3: Summary of Grading Laboratory Test Results

Location	Depth (m)	% Gravel	% Sand	% Silt	% Clay
TP18	1.0	1	41	38	20
TP22	1.5	0	31	35	34

Location	Depth (m)	% Gravel	% Sand	% Silt	% Clay
TP24	2.5	0	34	41	25
TP29	2.0	73	16	7	4
TP30	2-2.1	0	34	40	26

Table 4: Summary of Aggressivity Laboratory Test Results

Location	Depth (m)	pH	EC (µS/cm)	Cl (mg/kg)	SO4 (mg/kg)
BH17	0.2-0.3	7.2	19	< 10	< 10
BH18	2.0	6.7	44	38	22
BH19	0.4-0.5	7.2	12	< 10	< 10
BH20	2.0	6.8	70	48	62
BH21	0.5	6.6	14	< 10	< 10
BH23	0.2-0.3	6.9	260	230	130
BH24	0.4-0.5	6.6	36	20	39
BH25	0.5-0.6	7.1	68	< 10	80
BH27	0.2-0.3	6.7	16	< 10	< 10
BH29	0.4-0.5	8.6	94	< 10	10

Table 5: Summary of Earthworks / Pavement Design Laboratory Test Results

Location	Depth (m)	CBR (%)	MDD (t/m^3)	OMC (%)
TP17	0.5-0.8	4.0	1.75	18.5
TP19	0.4-0.9	14.0	1.95	11.5
TP21	1.0-1.5	3.5	1.85	15.5
TP22	0.9-1.2	13.0	1.87	14.0
TP23	0.5-1.0	12.0	1.87	13.5
TP24	0.5-1.0	7.0	1.86	15.0
TP26	0.8-1.0	14.0	1.79	15.5
TP27	1.1-1.4	5.0	1.86	16.0

7. Proposed Development

It is understood that the proposed development includes:

- Demolition of 2 single storey sheds and integrated hardstand extending beyond the footprint of the sheds;
- Demolition of 1 small single storey shed and associated pavement;
- Removal of 1 inground tank;
- Removal of 1 flood light;
- Removal of less than 10 trees;
- Reinstatement of grass turf in locations of removed hardstands and pavement;
- New concrete hardstand in location of existing concrete hardstands;
- New lighting as required for the FATO.

The proposed development will involve minor earthworks and the construction of new pavements and foundations.

8. Comments

8.1 Geotechnical Model

The geotechnical model for the site is summarised on cross-sections A-A', B-B' and C-C' (shown on Drawing 2 and Drawing 3) in Appendix B. The cross-sections show the interpreted geotechnical units across the site between test locations, particularly targeted at highlighting the inferred depth of fill across the site. Given the variability of the subsurface profile, the interpreted strata descriptions are highly generalised, and should be used as a general guide only. The interpreted strata boundaries on the cross-sections are accurate only at the test locations. Reference should be made to the test pit logs and CPT results for more detailed information, and for descriptions of the soil profile.

Generally, the inferred fill encountered during the investigation was of variable consistency, but generally comprising interbedded gravels, sands, silts, and clays, most likely 'site won' from quarrying activities. The fill was typically consistent with loose to dense granular soil and stiff to very stiff clayey soil with some weaker and stronger layers.

The Coffey report referenced in Section 2 includes earthworks density testing records from across the site, taken between 1984 and 1991, during the placement of fill to raise site levels in previously quarried areas. The results of the past density testing indicate a fairly poor level of compaction (<95% relative to Standard Compaction) achieved across parts of the site, particularly in the fill within several metres of the existing surface levels to the east and north of the 'non-quarried' land. It is understood from the Coffey report that only the bottom few metres of fill were roller compacted, with the majority of the fill, including that closest to the surface, being 'scraper compacted'. Given the available data on the fill and the variable relative compaction during placement, the existing fill should be considered 'uncontrolled'.

The natural alluvial subsurface profile was encountered along the southern site boundary, and on the 'non-quarried peninsula' in the middle of the site. The depth to this natural profile increases with distance from the southern site boundary and 'peninsula', indicative of a (now buried) batter falling away from Old Castlereagh Road, and the 'non-quarried' part of the site.

Groundwater observed at locations 6, 7 and 12, at the time of the investigation, was encountered at depths unlikely to be reached during the proposed minor earthworks. Groundwater levels will fluctuate and long term monitoring of water levels using data loggers in wells would be required to assess potential rises and response to rainfall.

Given the shape of the inferred natural subsurface profile, the depth of uncontrolled fill is expected to vary across the site in both a north-south and east-west orientation, as shown on Drawing 3 and Drawing 4 in Appendix B. It is considered likely that significant variations in fill thickness will occur within the proposed pavement footprint.

The main geotechnical considerations for the design and construction of the proposed development are:

- Suitability of cut materials for re-use as engineered fill;
- Excavation stability during bulk earthworks, and in the long-term at the edges of raised fill platforms;
- Settlement of fill (new and existing) under additional loading due to raising of site levels which presents a significant surcharge, or proposed structures, and ongoing creep settlements.

8.2 Subgrade Preparation

Based on the subsurface conditions encountered during the investigation, and the results of density testing undertaken during the placement of the existing fill, it is evident that the proposed development spans across areas of varying fill thickness and quality.

The existing fill is likely to experience ongoing creep settlements, with magnitudes dependent on the thickness and quality of the fill (i.e., varying across the site). Given the age of the fill (approx. 30-35 years), it is likely that a significant proportion of the expected creep settlements under the current loading regime (i.e., the current depth of fill) have already occurred, particularly in the deepest existing fill.

However, there is still potential for significant differential settlements to occur throughout the life of the proposed development, particularly between areas over deep existing fill and areas where there is little or no existing fill. Subgrade improvement could be considered to create a relatively uniform upper subgrade below the proposed pavements and footings. This would reduce the risk of differential settlements and improve the long-term performance of proposed pavements and footings. However, given the relatively minor scope of proposed earthworks, it is expected that subgrade improvement works are unlikely to be undertaken, in which case the potential for differential settlements will need to be allowed for in design.

8.3 Excavation and Placement of New Fill

The finished level for the proposed pavement is understood to be roughly RL 26.2 m AHD, with bulk earthworks levels likely to be up to 0.5 m lower (i.e. RL 25.7 m AHD). Given existing site levels in the

area of the proposed pavement are between RL 25 m and RL 26.5 m AHD, it is expected that up to about 1 m of excavation may be required for levelling of the site in some areas. Additional detailed excavations beyond this may be required for footings, services, etc.

It is anticipated that all necessary excavations will encounter either natural alluvial soils (gravels, sands, silts and clays) and / or existing uncontrolled fill (generally consisting of similar materials), noting that some boulders up to 400 mm diameter were encountered during the investigation as well. Excavation of these soil layers should be readily achieved using conventional earthmoving equipment such as tracked excavators and scrapers. For economical use of scrapers, pre-ripping of hard clayey soils is recommended.

Surface levels may also need to be raised 1 to 2 m with engineered fill in parts of the proposed pavement area. . The following methodology is suggested for subgrade preparation and placement of engineered fill following subgrade improvement works:

- Strip all topsoil and any root-affected material from areas where site levels are to be raised. Ensure such material is also completely stripped from cut areas. Topsoil / root affected material should not be re-used as engineered fill, but may be stockpiled separately for landscaping use;
- To reduce the risk of differential settlements due to the presence of uncontrolled fill, the exposed existing subgrade should be improved (and validated) as per the comments in Section 8.2
- Proof roll the improved subgrade surface using a minimum 10 tonne smooth drum roller in non-vibration mode. The surface should be rolled a minimum of six times with the last two passes observed by an experienced geotechnical engineer to detect any soft or heaving areas. Any soft, heaving or otherwise unsuitable material identified during proof rolling should be removed and replaced;
- Compact the exposed subgrade to a minimum dry density ratio of 98% relative to Standard compaction, maintaining the moisture content of the subgrade to within 2% of Standard OMC. In cut areas where no additional fill is to be placed, the exposed subgrade should be compacted to a minimum dry density ratio of 100% relative to Standard compaction;
- Place suitable site won materials in layers of 300 mm maximum (loose) thickness and compact to a minimum dry density ratio of 98% relative to Standard compaction, maintaining the moisture content of the subgrade to within 2% of Standard OMC;
- Place sufficient layers of fill to achieve design bulk level, and compact as outlined above, increasing the minimum dry density ratio to 100% relative to Standard compaction within the upper 300 mm of the fill surface.

Geotechnical inspection and testing of placed fill should be carried out in accordance with a Level 1 standard, as defined in AS3798-2007.

It is expected that at least some of the fill will be site won, although the proposed earthworks balance is not known at this stage. Site won natural material (excluding topsoils) should generally be suitable for re-use as engineered fill for bulk earthworks. Fill materials encountered on the site may also be suitable for re-use as engineered fill, subject to review by the geotechnical engineer, and also subject to their contamination status and the advice of the environmental consultant (refer DPs site contamination assessment report, 204635.01.R.001). Oversize material (>150 mm diameter) should be removed from excavated material prior to re-use as controlled fill. Topsoil (or any soil with high organic content) should be stockpiled separately and may be suitable for re-use in landscaping applications. Imported fill should

be approved by the geotechnical engineer; generally, preference should be given to low plasticity gravelly and sandy fills.

Consideration should be given to the salinity status of the site-won materials re-used as engineered fill or exposed through bulk earthworks. Further comments on salinity are provided in Section 8.9.

If off-site disposal is required, then it will need to be classified in accordance with the provisions of the current legislation and guidelines, including the *Waste Classification Guidelines* (EPA, 2014). This includes both fill and natural materials that may be removed from the site. Refer to DP's site contamination assessment report for further details.

8.4 Settlement of Fill and Differential Settlements

Due to variable and significant depth of fill on the site it is not feasible to practically eliminate the risk of significant differential settlements at this site without suspending proposed structures and pavements on deep piles to competent natural soil/gravels or rock or modifying the proposed development configuration such that elements of the development do not span over such varied subsurface profiles. It is expected that this approach will not be economically feasible, so the proposed development may involve the construction of new pavements and / or footings 'on-grade'. Such constructions may span across variable depths of fill (from <1 m to possibly 15 m depth), with an associated risk of differential settlement over time due to primary consolidation under additional loading, and long-term ongoing creep settlements associated with deep fill. These settlements are in addition to normal elastic settlements.

It should be noted that estimations of settlement in variable fill (both primary consolidation and creep) are prone to a high degree of uncertainty. The estimates in Table 6 and Table 7 should be considered as having a potential variation of up to ±25%. The reliability of settlement predictions can be improved by placement and monitoring of settlement with the longer duration providing more data and therefore higher degree of reliability. It is also noted that the primary and creep consolidation settlements are under proposed new fill loads and do not include elastic settlement due to pavement and footing loads.

8.4.1 Primary Consolidation

Primary consolidation settlement occurs as excess pore pressures induced in soils under increased loading are dissipated over time. Given the age of the fill on-site, it is expected that primary consolidation under the existing loading regime (i.e., depth of fill) has largely already occurred. However, placement of additional fill over large areas (expected to be of thicknesses typically less than 2 m,) will increase stresses on the existing fill at significant depth and induce additional primary consolidation settlements. The time taken for this to occur is dependent on the soil composition – it is essentially instantaneous in free draining sands and can take many years in low permeability clays with poor drainage conditions. Given the variable nature of the fill encountered on-site, it would be very difficult to accurately estimate how long primary consolidation will take to occur, and it is not recommended to rely on any timeframe estimate in design or construction planning. If settlement data was available since placement of the current fill, then a more accurate assessment of potential settlements could be established but it is understood that such data is not available.

Total primary consolidation settlements in the 'non-quarried' parts of the site are likely to differ from that where deep fill is present, with variation in between depending on the depth of fill.

Based on the conditions encountered during the investigation, a range of estimated total primary consolidation settlements for various depths of new fill (raised levels) and depths of existing fill underlying the new fill, has been provided in Table 6. These estimates are based on a simplified profile of uniform fill of varying thickness with a constrained modulus of 20 MPa, overlying natural sediments with a constrained modulus of 60 MPa, overlying relatively stiff bedrock at depth of 15 m. A unit weight of 20 kN/m^3 is assumed for new fill, applied as a surcharge to existing fill.

Table 6: Summary of Estimated Primary Consolidation Settlements

Depth of Underlying Uncontrolled Fill (m)	Estimated Total Primary Consolidation Settlement (mm), for Depth of New Fill Placed (m)	
	1 m	2 m
0 (non-quarried)	4	8
3	6	11
5	7	14
10	10	20
15	13	25

The differential settlements due to primary consolidation, between any two parts of the site can be estimated by comparing the estimated settlements for those subsurface conditions. For example, near the edges of the non-quarried land, site levels are proposed to be raised by 1 m to 2 m, overlying deep fill, transitioning to substantially reduced fill depths (over non-quarried land) across distances of about 35 m. The resulting estimated differential settlements between these areas would be in the order of 10 to 20 mm, or about 0.3 to 0.6 mm/m (near the total primary consolidation settlement value).

8.4.2 Creep Settlement

Creep settlement occurs due to the self-weight of the fill resulting in constant high stresses that cause consolidation of lower fill layers. Creep settlements continue for many years after the completion of earthworks, and they are directly related to the type of fill, depth of fill, and the degree of compaction applied. Creep settlements can be expressed as:

Creep Settlement = C_α x fill thickness x change in log time

C_α typically lies in the range of 0.3% to 0.5% for well compacted granular and clayey filling. A larger value of 0.8% to 1% may apply to variable / poorly compacted filling.

The time of fill placement and change in thickness of fill across a site is important in consideration of the effects of creep settlements. As it is expected that construction would commence immediately after completion of earthworks, creep settlements across the site would be expected to generally occur in the following patterns:

- Creep settlement in newly placed well compacted (controlled) fill would be expected to occur entirely after construction;

- Creep settlements in existing fill below the current surface that has been in-place for a substantial period of time (30+ years), while much greater in total magnitude, has likely mostly occurred already over the first several log cycles of time. Creep settlements after construction over existing fill where site levels are not raised are expected to be relatively less over the lifespan of the proposed development, despite variable quality;
- Notably, in areas where little or no fill exists, and site levels are not to be raised, creep settlements would be expected to be relatively small, which may result in large differential settlements between these areas and other areas, potentially equal to the total expected creep settlements.

Considering the above, estimates of likely creep settlements over a range of new controlled and existing uncontrolled fill depths are provided in Table 7.

As for primary consolidation, differential settlements due to creep effects can be estimated by calculating the difference in total creep settlements for any two given points of known fill thicknesses (both placed, and existing). Where fill depths change rapidly over short plan distances, differential settlements will be high, and potentially close to the total creep value.

Table 7: Summary of Estimated Creep Settlements

Placed Fill Thickness (m)	Underlying Existing Fill Thickness (m)	Estimated Creep Settlement (mm) / Design Period (years)				
		10	20	30	40	50
0 (not raised)	1	1	2	3	3	4
	3	4	7	9	11	13
	5	6	11	15	18	21
	10	12	22	30	37	42
	15	18	33	45	55	63
1	1	5	7	9	9	11
	3	8	12	15	17	20
	5	10	16	21	24	28
	10	16	27	36	43	49
	15	22	38	51	61	70
2	1	9	12	15	16	18
	3	12	17	21	24	27
	5	14	21	27	31	35
	10	20	32	42	50	56
	15	26	43	57	68	77

8.5 Excavation Stability

8.5.1 Batters

During earthworks, it is recommended that temporary batters do not exceed 1.5H:1V (about 33°) within fill and natural clay soils, for batters up to 4 m high, above the groundwater table.. For permanent batters, a maximum grade of 2.5H:1V (about 22°) is recommended. Permanent batter faces should be protected with shotcrete or vegetation matting, and have adequate drainage provided at the crest to minimise runoff and erosion over the face. If maintenance access is required for permanent batters (e.g. mowing), it is suggested that the maximum grade is reduced to 3H:1V (about 18°). Batters (temporary or permanent) greater than 4 m in height, or with surcharge loads near the crest, or where groundwater seepage occurs from the batter face, should be assessed by a geotechnical engineer on a case by case basis.

8.5.2 Retaining Walls

Retaining walls may be designed on the basis of an average unit weight of 20 kN/m^3 for the natural soils and fill on site, with a triangular earth pressure distribution calculated using an active earth pressure coefficient (K_a) of 0.35 where some wall movement is acceptable, or an 'at-rest' earth pressure coefficient (K_o) of 0.5 where wall movement is to be reduced. A passive earth pressure coefficient (K_p) of 2 may be assumed within natural stiff clay or medium dense sand (or better), and well compacted fill. A factor of safety must be applied to the passive pressures in recognition of the fact that large movements are required to mobilise the full passive resistance.

Adequate drainage should be provided behind all retaining walls to prevent the build-up of surficial runoff behind the wall. If adequate drainage is not provided, retaining walls should be designed for full hydrostatic pressure behind the full height of the wall.

8.6 Foundations

It is understood that no new buildings are proposed as part of the development, however some foundations for lights or other lightweight structures may be required. For any structures supported on foundations spanning across areas of varied fill depths, it must be considered that the only way to eliminate the risk of differential settlements on this site would be to uniformly support all proposed footings on the same stratum using deep piles to competent natural soil/gravels or rock. This is not likely to be economically viable, and as mentioned previously, it is expected that the preferred footing system for any proposed new structures may include shallow foundations (pad/strip footings or raft slab).

New shallow footings founded on engineered fill or the natural medium dense/stiff alluvial soils could be proportioned on the basis of the parameters provided in Table 8.

Table 8: Summary of Design Parameters for Shallow Foundations

Material	Maximum Allowable Bearing Pressure (kPa)	Maximum Ultimate Bearing Pressure (kPa)	Young's Modulus (MPa)
Engineered Fill (New or Improved & Validated)	150	250	20
Alluvial Sediments (medium dense sand and stiff clay, or better)	150	400	25

Footings proportioned on the basis of the maximum allowable bearing pressures provided in Table 8 would be expected to experience elastic settlements of less than 1% of the footing width, with differential settlements less than half this value. These do not include ongoing settlements due to primary consolidation and creep, as discussed previously.

It is recommended that all footing excavations are inspected by a geotechnical engineer prior to construction to confirm that the foundation conditions are suitable for the design requirements.

Although an investigation of depths to and quality of bedrock at this site was beyond the scope of this investigation, it is noted that the Coffey report estimates that shale bedrock may be encountered around RL 10 m AHD. A preliminary estimate therefore is that piles to rock would be to minimum depths in the order of 12 m to 15 m. If piles to rock are preferred for any part of the proposed development (to eliminate the risk of significant differential settlements), it is recommended that additional investigation is undertaken using rock cored boreholes.

8.7 Soil Aggressivity

The analysed soil samples are generally classed as non-aggressive to mildly aggressive to buried concrete and steel elements, in accordance with the criteria in AS2159-2009. It would be prudent to design structural elements in contact with the ground for an exposure classification of at least 'Mild'.

8.8 Groundwater

Groundwater was encountered at depths of about 5 m to 6 m below existing surface levels. It is not expected that bulk excavations for the proposed developments will encounter groundwater. Groundwater levels will fluctuate and rise following periods of prolonged rainfall and further investigation and long term monitoring would be required if this is required for design. The design should also consider potential flood levels for the area.

8.9 Salinity

A detailed assessment of salinity was beyond the scope of this investigation. In the absence of a detailed salinity assessment, it would be prudent to adopt design and construction practices to mitigate the risk of issues associated with salinity. The following is recommended:

- Drainage should ensure runoff is not excessively concentrated leading to water-logging of pavement areas or additional recharge to the groundwater system;
- The subgrade should be sealed and pavements or slabs constructed as soon as possible following completion of earthworks;
- Unsealed areas should be protected with vegetation and/or geotextiles as soon as practical following completion of earthworks;
- Elements in contact with the ground should incorporate a damp-proof course or impervious membrane to restrict damage from rising moisture;
- Landscaping should not abut walls as this may provide a conduit for saline water to bypass damp-proofing;
- As service trenches can provide conduits for water, they should be backfilled with compacted impermeable backfill, or with a clay plug every 2 m along the trench;

8.10 Pavements

Subject to earthworks and the final condition of the soils within the upper 1 m of the design subgrade level, natural and filled subgrades at this site could be assigned a preliminary design CBR value of 5%, based on the CBR values of the soils encountered on site (likely to be re-used as fill), experience on similar projects, and the expectation that some mixing of sandy and clayey soils is likely to occur during bulk earthworks. To maintain this design value, or any other amended / alternate design value, it will be necessary to prepare the subgrade soils into a well compacted condition.

Pavement designs should incorporate suitable control measures (drainage) to collect and prevent surface runoff from entering pavement subgrade soils.

Given the likelihood of ongoing variable consolidation and creep settlements (and associated differential settlements), it is probable that new pavements will require a higher than typical degree of maintenance throughout their service life. Accordingly, consideration should be given to adopting a pavement design which allows for relatively inexpensive 'topping up' (i.e. a flexible asphalt pavement), as opposed to a durable rigid pavement. A regular and long-term inspection and maintenance programme should be adopted by the operator of the pavement. The maintenance program should be primarily aimed at limiting the amount of moisture infiltrating to the subgrade (e.g. inspecting drainage lines and repairing as required, maintaining construction joints and sealing or repairing cracks as they develop).

9. Limitations

Douglas Partners (DP) has prepared this report (or services) for this project at in accordance with DP's proposal 204635.00.P.001.Rev0 dated 7 May 2021 and acceptance received from Scott Anderson of

Colliers International Pty Ltd dated 19 May 2021. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Colliers International Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

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

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

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

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

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

Copyright

Borehole and Test Pit Logs

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

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

Groundwater

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

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

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

Reports

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

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

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

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

About this Report

Site Anomalies

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

Information for Contractual Purposes

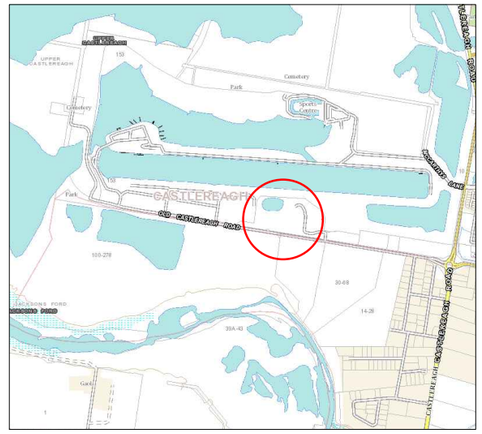
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate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

Site Inspection

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

Appendix B

Drawings



SITE LOCALITY

NOTE:
1: Base image from MetroMap.com (Dated 29.08.2020)

0 10 20 30 40 60 80 100 150 200m
1:2000 @ A3

LEGEND

- TP1 — Test Pit Location and Number
- CPT — CPT Location and Number
- Site Boundary
- Geological Cross Section

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Colliers International Pty Ltd		TITLE: **Test Location Plan**	PROJECT No: 204635.00
OFFICE: Sydney	DRAWN BY: CJ	**Proposed Helicopter Facility**	DRAWING No: 1
SCALE: 1:2000 @ A3	DATE: 28.05.2021	**89-151 Old Castlereagh Road, Penrith**	REVISION: 1

A

A'

ELEVATION (AHD)

70
60
50
40
30
20
10
0
-10
-20
-30

-50
0
50
100
150
200
250
300

DISTANCE ALONG PROFILE (m)

CPT08
Offset 8.9m
Qc
0 5
0 50
Bottom Depth 4.14 m

CPT13
Offset 9.5m
Qc
0 5
0 50
Bottom Depth 5.12 m

CPT15
Offset - 14.6m
Qc
0 5
0 50
Bottom Depth 3.46 m

30
Offset - 0.9m
Bottom Depth 2.6 m

CPT16
Offset 22.2m
Qc
0 5
0 50
Bottom Depth 7.44 m

ALLUVIAL SEDIMENTS

FILL

LEGEND

- Filling
- Sand
- Clay
- Silty Clay

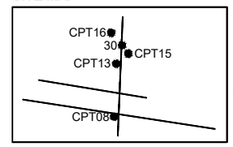
TESTS / OTHER

— ? — — - Interpreted geotechnical boundary

NOTES:

1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

SITE MAP



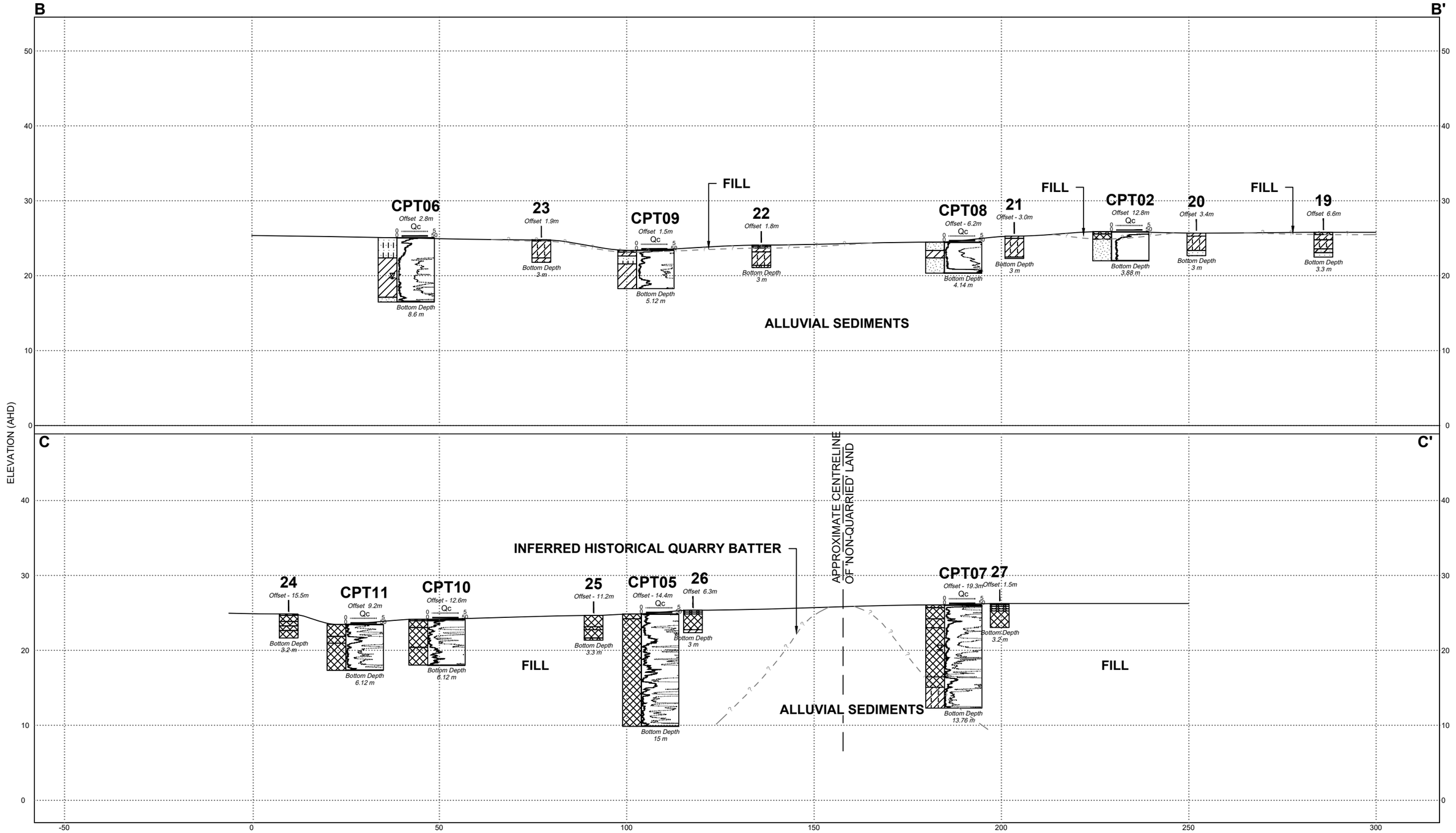
0 20

Horizontal Scale (metres)

Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Colliers International Pty Ltd		TITLE: **Cross-section A-A'**	PROJECT No: 204635.00
OFFICE: Sydney	DRAWN BY: MG	**Proposed Helicopter Facility**	DRAWING No: 2
SCALE: 1:1000 (H) 1:500 (V) @ A3	DATE: 03.06.2021	**89-151 Old Castlereagh Road, Penrith**	REVISION: 1



LEGEND

- Filling
- Silty Clay
- Sandy Clay
- Silty Sand
- Gravelly Silty Clay
- Sand
- Clay

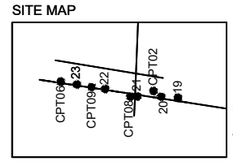
TESTS / OTHER

— ? — — - Interpreted geotechnical boundary

NOTES:

1. Subsurface conditions are accurate at the borehole locations only. Variations in subsurface conditions may occur between borehole locations. Interpreted strata boundaries are approximate and should be used as a guide only.
2. Summary logs only and should be read in conjunction with detailed logs.
3. Horizontal and vertical scales are not equal.

SITE MAP



Horizontal Scale (metres) 0 20

Vertical Exaggeration = 2.0

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Colliers International Pty Ltd		TITLE: **Cross-section B-B' and C-C'**	PROJECT No: 204635.00
OFFICE: Sydney	DRAWN BY: MG	**Proposed Helicopter Facility**	DRAWING No: 3
SCALE: 1:1000 (H) 1:500 (V) @ A3	DATE: 03.06.2021	**89-151 Old Castlereagh Road, Penrith**	REVISION: 1

Appendix C

Field Work Results

Sampling

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

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

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

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

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

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

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Description and Classification Methods

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

Soil Types

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

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

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

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

Definitions of grading terms used are:

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

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

In fine grained soils (>35% fines)

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

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

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

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

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

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

Soil Descriptions

Cohesive Soils

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

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

Cohesionless Soils

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

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

Soil Origin

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

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

Moisture Condition – Coarse Grained Soils

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

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

Moisture Condition – Fine Grained Soils

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

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

Symbols & Abbreviations

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

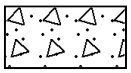
Symbols & Abbreviations

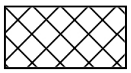
Graphic Symbols for Soil and Rock

General

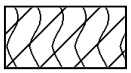

Asphalt

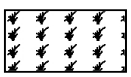

Road base

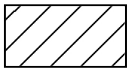

Concrete

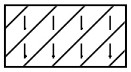

Filling

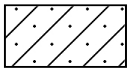
Soils


Topsoil

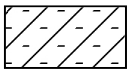

Peat

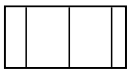

Clay

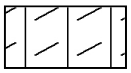

Silty clay

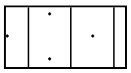

Sandy clay

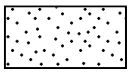

Gravelly clay

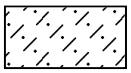

Shaly clay

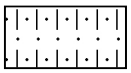

Silt


Clayey silt


Sandy silt

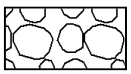

Sand

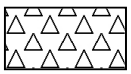

Clayey sand


Silty sand


Gravel

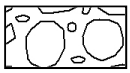

Sandy gravel


Cobbles, boulders

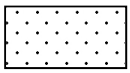

Talus

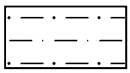
Sedimentary Rocks

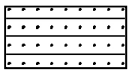

Boulder conglomerate

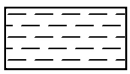

Conglomerate


Conglomeratic sandstone

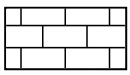

Sandstone


Siltstone

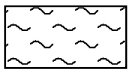

Laminite

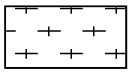

Mudstone, claystone, shale

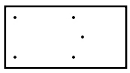

Coal


Limestone

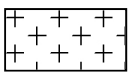
Metamorphic Rocks

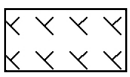

Slate, phyllite, schist

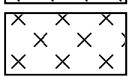

Gneiss

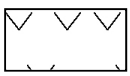

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

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

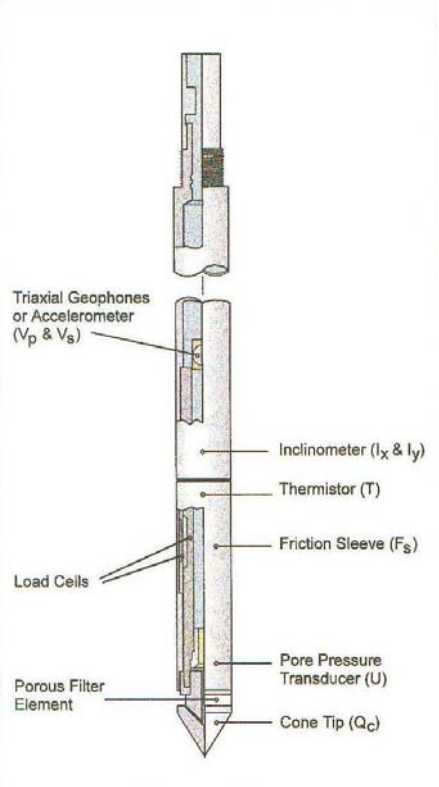


Figure 1: Cone Diagram

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

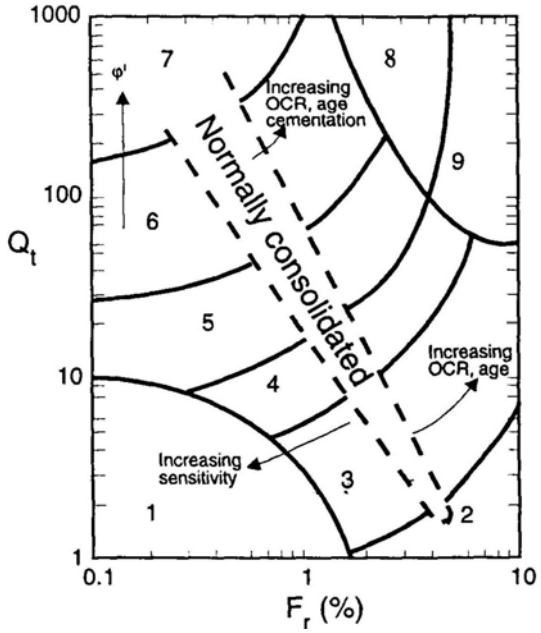


Figure 3: Soil Classification Chart

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.

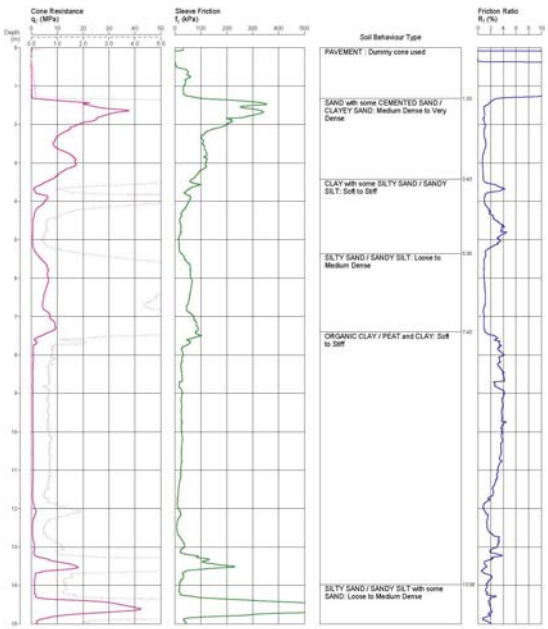


Figure 4: Sample Cone Plot

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 23.7 AHD
EASTING: 285534
NORTHING: 6265582

PIT No: TP17
PROJECT No: 204635.00
DATE: 19/5/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
23	0.08	FILL/Silty CLAY: low to medium plasticity, brown, with rootlets and grass cover, w<PL, topsoil		D/E	0.0 0.08				
		FILL/Silty CLAY/Clayey SILT: low to medium plasticity, brown, with rootlets and tree roots, trace gravel, firm to stiff		D/E	0.2 0.3				
	0.5	FILL/Silty CLAY: medium plasticity, pale grey mottled grey and brown, with high strength, medium to coarse, rounded and sub-rounded river gravel and cobbles (up to 200mm), w<PL, firm to stiff		D/E B	0.5 0.6				
	0.8	FILL/Silty Sandy CLAY: low to medium plasticity, red-brown and grey, medium to coarse sand, trace high strength, medium to coarse, rounded and sub-rounded river gravel and cobbles (up to 200mm), w<PL, stiff to very stiff		D/E	0.8 1.0 1.1				
22	1			D	1.5 1.6				
	1.9	FILL/Silty CLAY: low to medium plasticity, pale brown, brown and grey, with fine sand, high strength, rounded and sub-rounded, medium to coarse river gravel and cobbles (up to 200mm), w<PL, very stiff		D	2.0 2.1				
21	2			D	2.5 2.6				
	3.0	Pit discontinued at 3.0m - Target depth reached							
20	3								
	4								
19									

RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

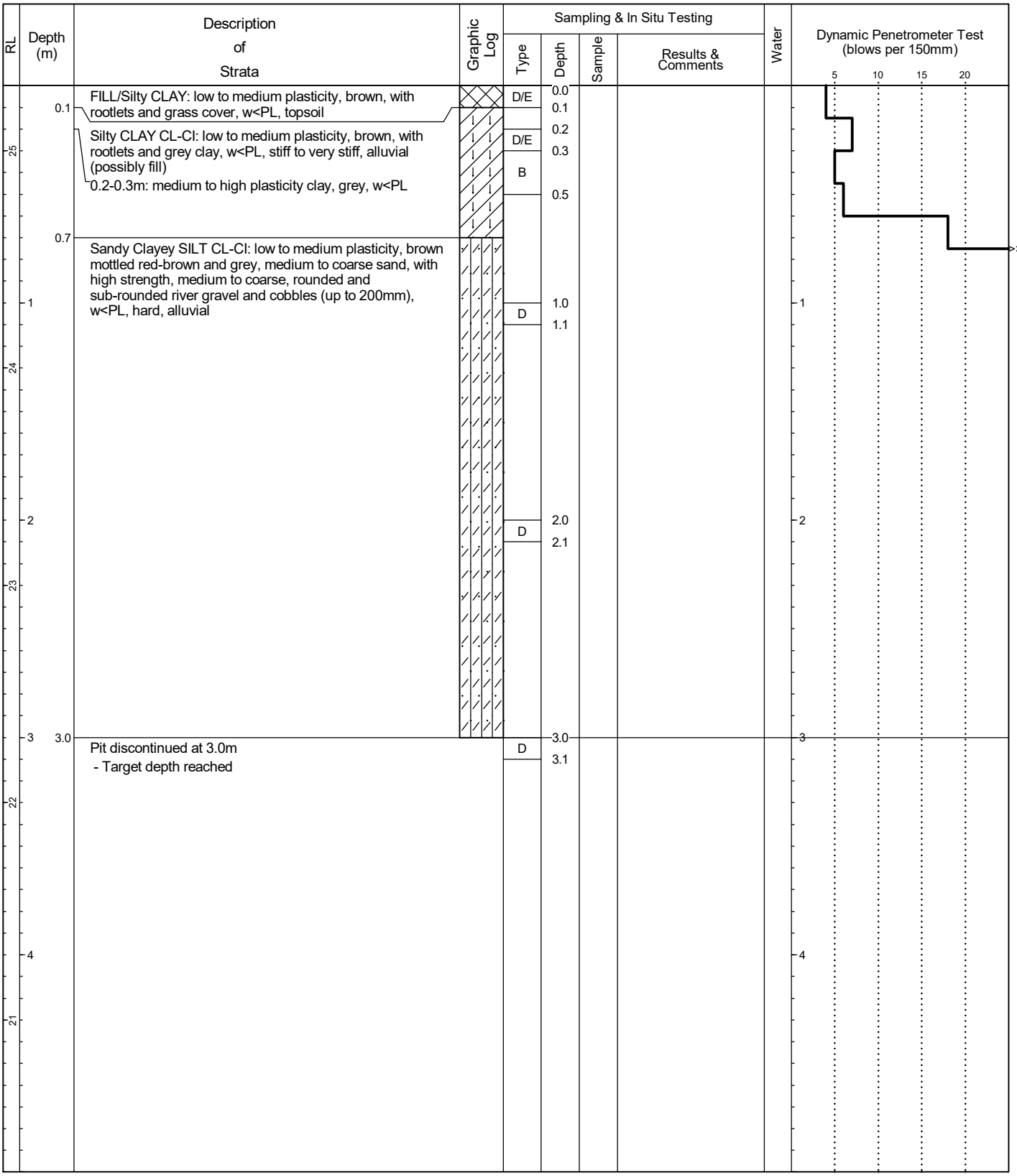
Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 25.3 AHD
EASTING: 285505
NORTHING: 6265558

PIT No: TP18
PROJECT No: 204635.00
DATE: 19/5/2021
SHEET 1 OF 1



RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 26.1 AHD
EASTING: 285454
NORTHING: 6265554

PIT No: TP19
PROJECT No: 204635.00
DATE: 19/5/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
26	0.0	FILL/Silty CLAY/Clayey SILT: low to medium plasticity, brown, w<PL, topsoil, poorly to moderately compacted		D/E	0.1 0.2				
	0.3	Silty CLAY CL-CI: low to medium plasticity, red-brown, w<PL, stiff, alluvial Below 0.5m: w~PL		D/E B	0.4 0.5 0.9				
25	1.0	Silty CLAY CL-CI: low to medium plasticity, red-brown and grey, w<~PL, firm, alluvial		D D D	1.0 1.1 1.5 1.6 2.0 2.1				
24	2.2	Sandy CLAY CI-CL: low to medium plasticity, brown, fine to medium sand, with silt, w<PL, firm to stiff, alluvial							
	2.7	Silty SAND SW: fine to medium, brown, moist, apparently loose to medium dense, alluvial		D	3.0 3.1				
23	3.3	Pit discontinued at 3.3m - Target depth reached							
22	4.0								

RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

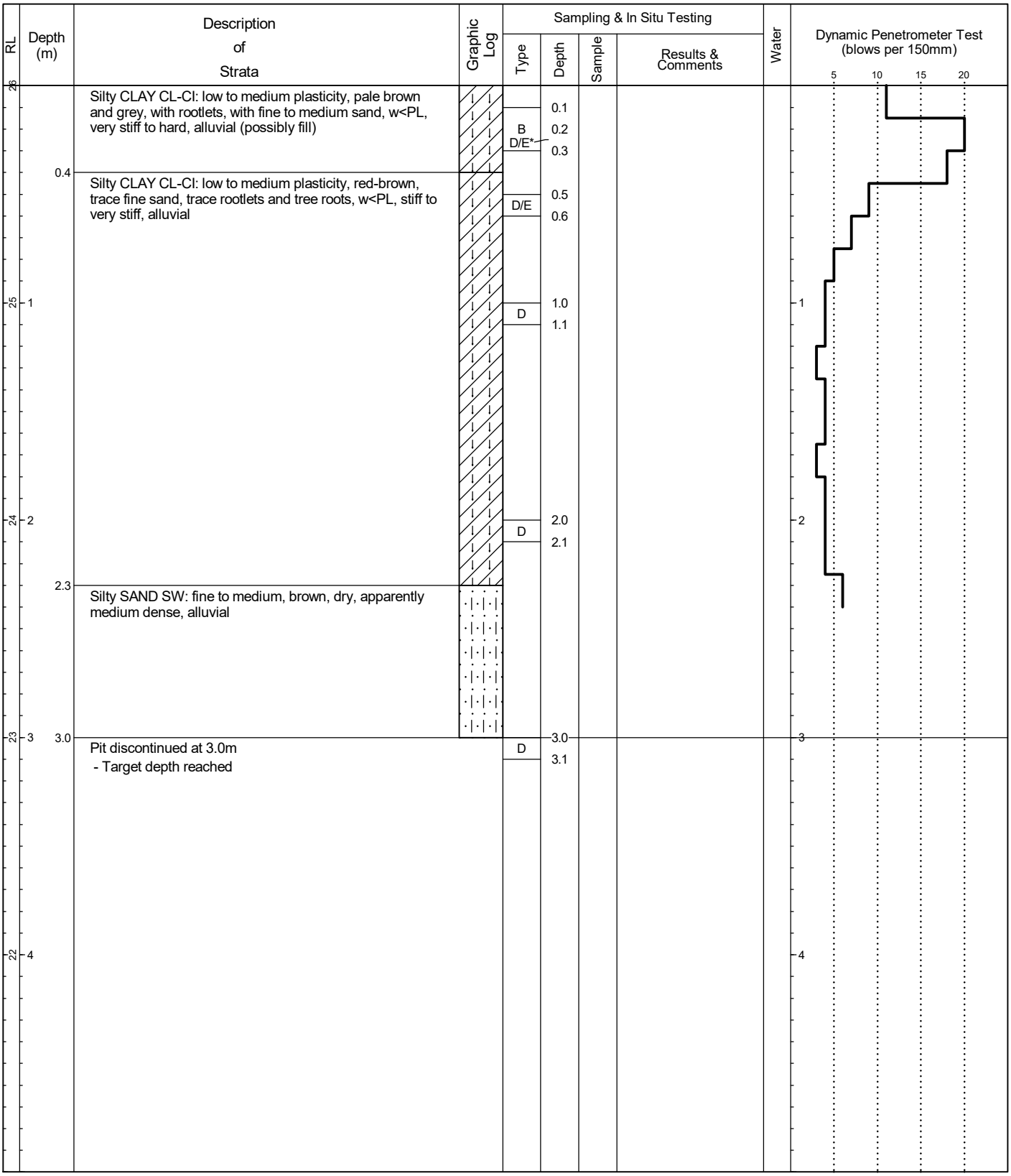
Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 26.0 AHD
EASTING: 285420
NORTHING: 6265556

PIT No: TP20
PROJECT No: 204635.00
DATE: 19/5/2021
SHEET 1 OF 1



RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *Replicate sample BD1/190521 taken at 0.2-0.3m

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

SAMPLING & IN SITU TESTING LEGEND

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

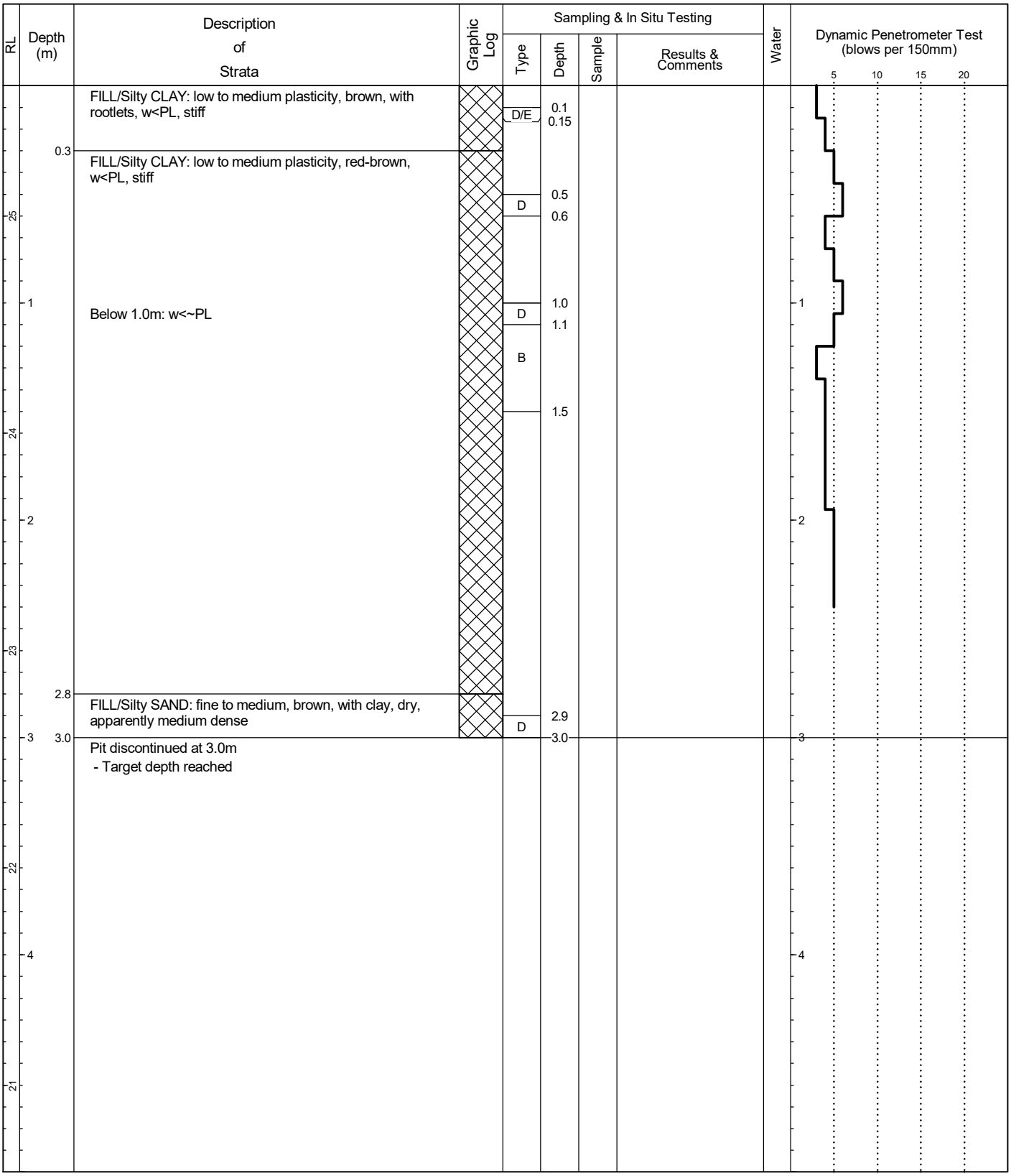
Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 25.6 AHD
EASTING: 285371
NORTHING: 6265557

PIT No: TP21
PROJECT No: 204635.00
DATE: 19/5/2021
SHEET 1 OF 1



RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

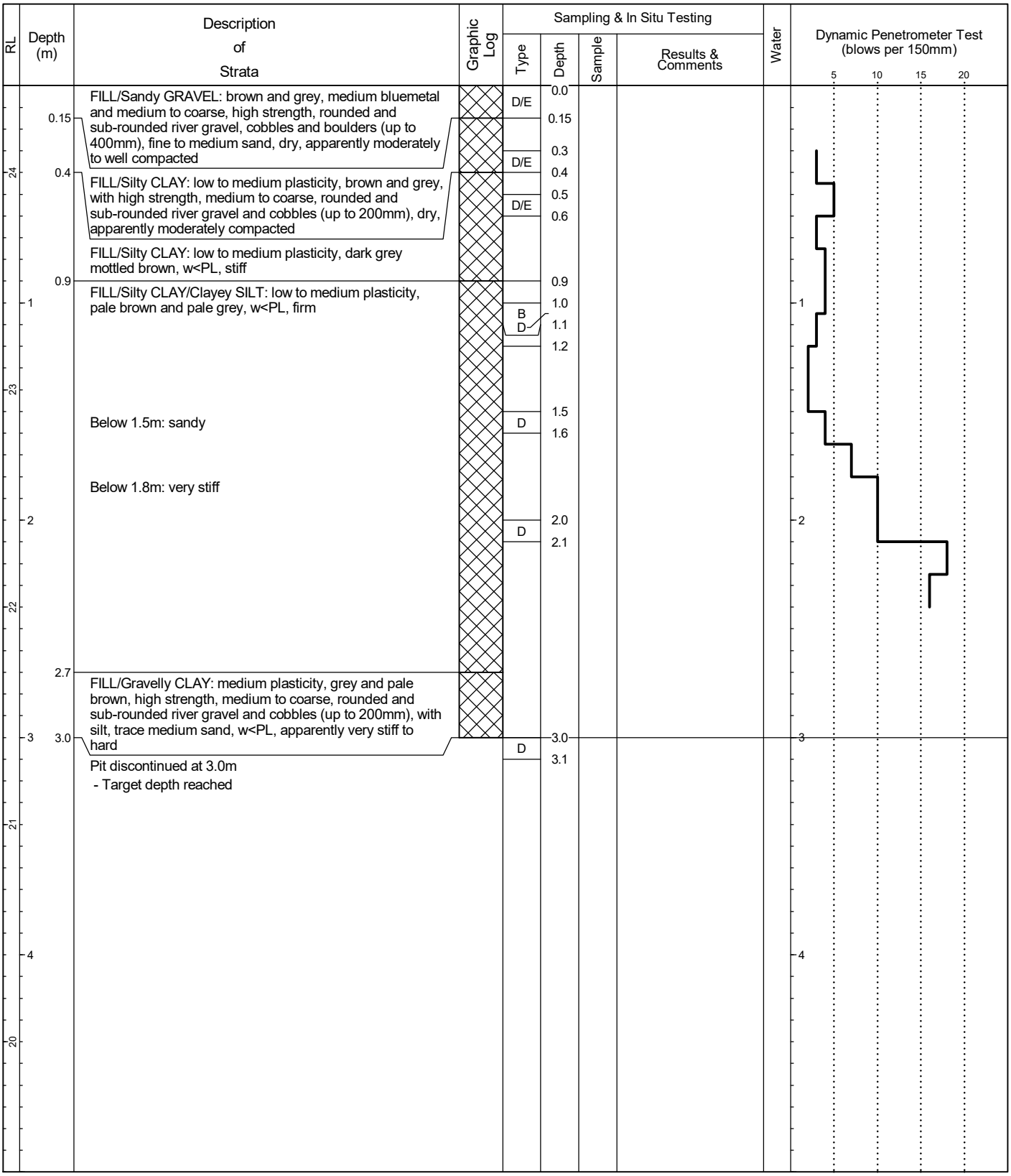
Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 24.4 AHD
EASTING: 285305
NORTHING: 6265572

PIT No: TP22
PROJECT No: 204635.00
DATE: 19/5/2021
SHEET 1 OF 1



RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

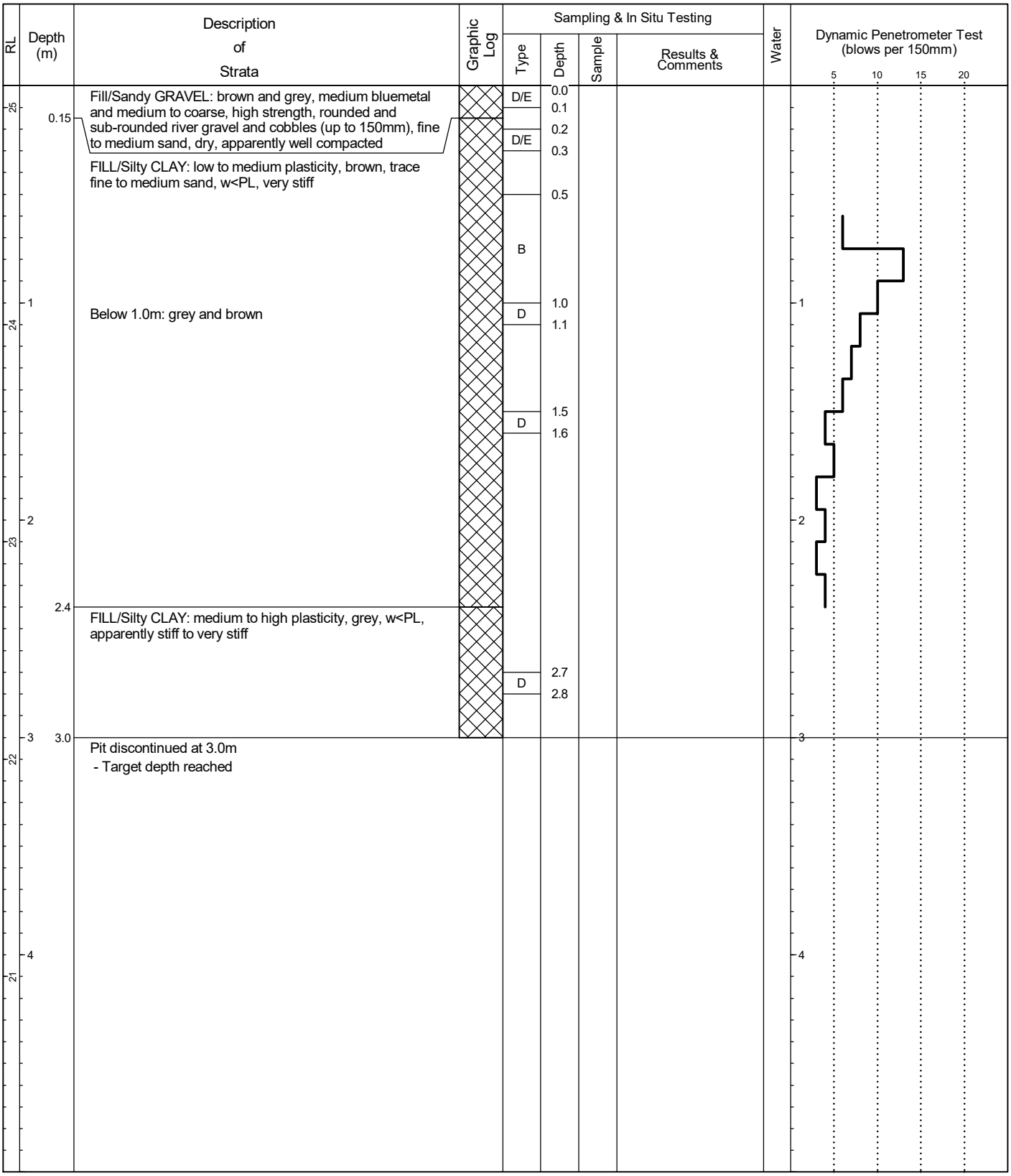
Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 25.1 AHD
EASTING: 285247
NORTHING: 6265581

PIT No: TP23
PROJECT No: 204635.00
DATE: 19/5/2021
SHEET 1 OF 1



RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 24.7 AHD
EASTING: 285210
NORTHING: 6265614

PIT No: TP24
PROJECT No: 204635.00
DATE: 20/5/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
24	0.0	FILL/Silty CLAY: low to medium plasticity, grey mottled brown, with rootlets, firm to stiff, topsoil		D/E	0.1		PID<1 ppm		
	0.2	FILL/Silty CLAY: low to medium plasticity, brown mottled pale grey, w<PL, apparently moderately compacted		D/E	0.2				
					0.4		PID<1 ppm		
				B	0.5				
1	1.0	FILL/GRAVEL: fine to coarse, high strength, rounded and sub-rounded river gravel with cobbles (up to 250mm), in medium to coarse, brown and pale grey silty sand matrix, apparently moderately to well compacted			1.0				1
				D	1.2		PID<1 ppm		
					1.3				
23	1.6	FILL/Silty SAND: medium, pale grey and brown, moist, apparently medium dense to dense, apparently moderately to well compacted							
2				D	2.0		PID<1 ppm		2
	2.2	FILL/Clayey Sandy SILT: low to medium plasticity, pale grey mottled brown, w<PL, apparently moderately to well compacted			2.1				
22		Below 2.5m: medium plasticity, with grey bands		D	2.5		PID<1 ppm		
					2.6				
3				D	3.0		PID<1 ppm		3
	3.2	Pit discontinued at 3.2m - Target depth reached			3.1				
21									
4									4
20									

RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 24.5 AHD
EASTING: 285291
NORTHING: 6265605

PIT No: TP25
PROJECT No: 204635.00
DATE: 20/5/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
24	0	FILL/Silty CLAY: low to medium plasticity, brown and grey, with medium siltstone and bluemetal gravel, and medium to coarse, high strength, rounded and sub-rounded river gravel and cobbles (up to 150mm), fine to medium sand, w<PL, apparently poorly to moderately compacted		D/E	0.1		PID<1 ppm		
					0.2				
				D/E	0.5		PID<1 ppm		
					0.6				
	1			D/E	1.0		PID<1 ppm		1
					1.1				
23	1.5	FILL/Silty CLAY: low to medium plasticity, brown, w<PL, firm to stiff, apparently poorly to moderately compacted			1.5		PID<1 ppm		
					1.6		PID<1 ppm		
				D/E B	1.7				
	1.9				1.9				
	2	FILL/Silty CLAY: low to medium plasticity, brown mottled, red-brown and pale grey, with medium to coarse, high strength, rounded and sub-rounded river gravel and cobbles (up to 150mm), w<PL, apparently moderately to well compacted			2.0		PID<1 ppm		2
				D	2.1				
22					2.5		PID<1 ppm		
				D	2.6				
	3								3
	3.0	FILL/Silty CLAY: low to medium plasticity, pale grey mottled brown, with medium to coarse, high strength, rounded and sub-rounded river gravel and cobbles (up to 150mm), w>~PL, apparently poorly compacted			3.1		PID<1 ppm		
				D	3.2				
	3.3	Pit discontinued at 3.3m - Target depth reached							
21									
	4								4
20									

RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 25.2 AHD
EASTING: 285320
NORTHING: 6265618

PIT No: TP26
PROJECT No: 204635.00
DATE: 20/5/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
25	0.25	FILL/Sandy GRAVEL: brown and grey, medium bluemetal, fine to coarse, high strength, rounded and sub-rounded river gravel, fine to medium sand, dry, well compacted		D/E	0.1 0.2				
	0.5	FILL/Silty CLAY: low to medium plasticity, red-brown, brown and grey, with medium to coarse, high strength, rounded and sub-rounded river gravel and cobbles (up to 150mm), fine to medium sand, trace timber, trace asphaltic concrete rubble, apparently well compacted		D/E	0.3 0.4				
24	1	FILL/Silty CLAY: low plasticity, grey and dark grey mottled brown, with rootlets, w<PL, apparently moderately to well compacted (strong decomposed wood odour) Below 1.0m: with tree roots		D/E B	0.8 0.9 1.0 1.2				
23	2			D	2.0 2.1				
	2.6	FILL/Silty CLAY: low to medium plasticity, brown, with fine to medium sand, w<PL, apparently very stiff		D	2.6 2.7				
22	3	Pit discontinued at 3.0m - Target depth reached							
21	4								

RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 26.1 AHD
EASTING: 285400
NORTHING: 6265600

PIT No: TP27
PROJECT No: 204635.00
DATE: 20/5/2021
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
26	0.15	FILL/Silty CLAY: low to medium plasticity, brown, with rootlets, with fine to medium gravel, w<PL		D/E	0.05 0.15				
	0.4	FILL/Silty CLAY: low to medium plasticity, brown, with fine to medium sand, medium to coarse, high strength, rounded and sub-rounded river gravel and cobbles (up to 200mm), w<PL, apparently moderately to well compacted		D/E	0.2 0.3				
	0.7	FILL/Silty SAND: medium grained, red-brown, dry, apparently moderately to well compacted		D/E	0.5 0.6				
	1.0	FILL/Silty CLAY: low to medium plasticity, red-brown mottled brown, w<PL, apparently moderately to well compacted		D	0.9 1.0				
25		FILL/Silty CLAY: medium to high plasticity, pale grey mottled brown and grey, with dark grey silty clay layers, trace medium to coarse, high strength, rounded and sub-rounded river gravel and cobbles (up to 150mm), w<PL, apparently moderately compacted		D B	1.1 1.2 1.4				
24				D/E	2.0 2.1				
23				D/E	2.9 3.0				
	3.2	Pit discontinued at 3.2m - Target depth reached							
22									

RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS: *Replicate sample BD1/200521 taken at 0.2-0.3m

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

SAMPLING & IN SITU TESTING LEGEND

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

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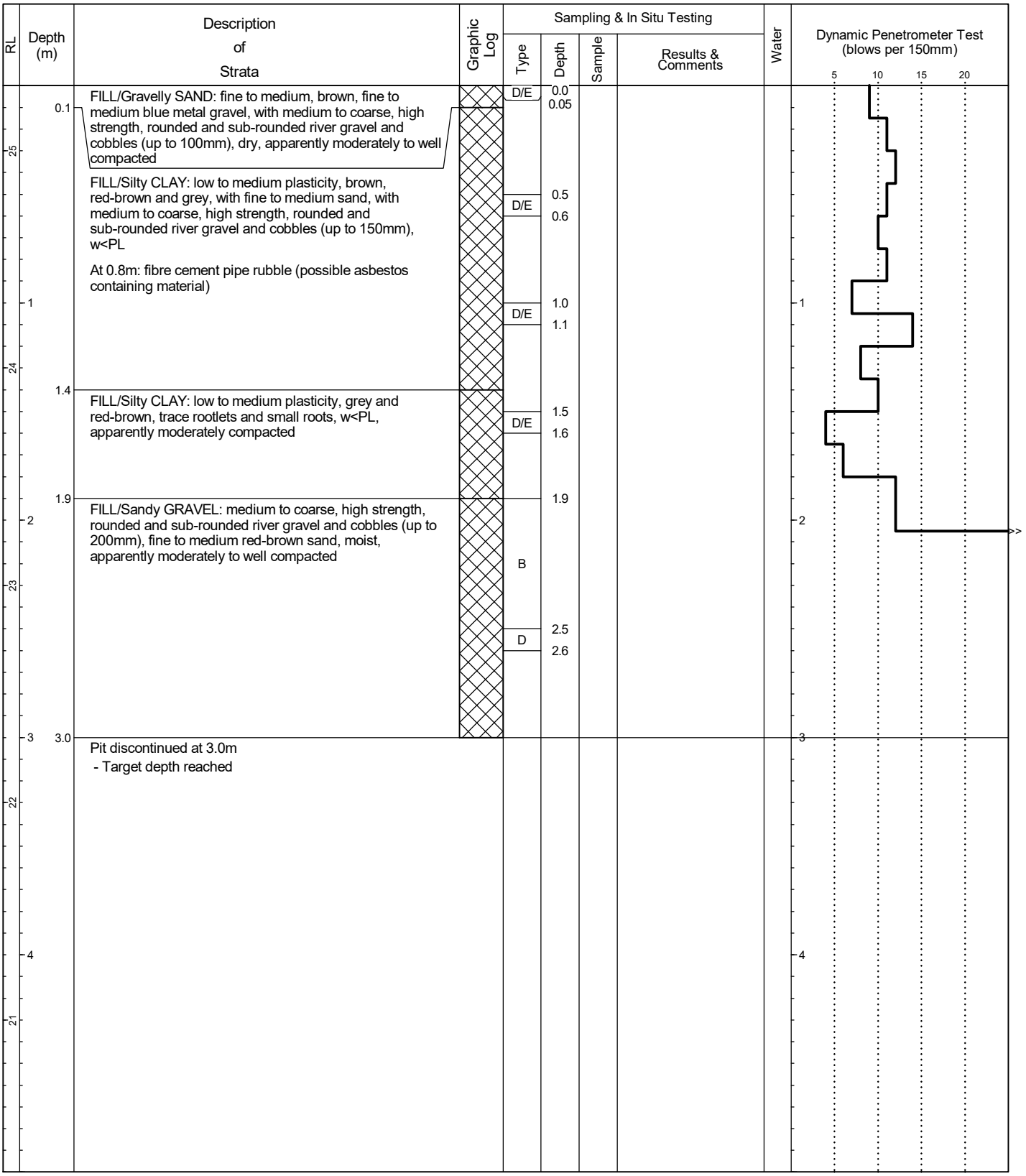
TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 25.3 AHD
EASTING: 285306
NORTHING: 6265635

PIT No: TP28
PROJECT No: 204635.00
DATE: 20/5/2021
SHEET 1 OF 1



RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

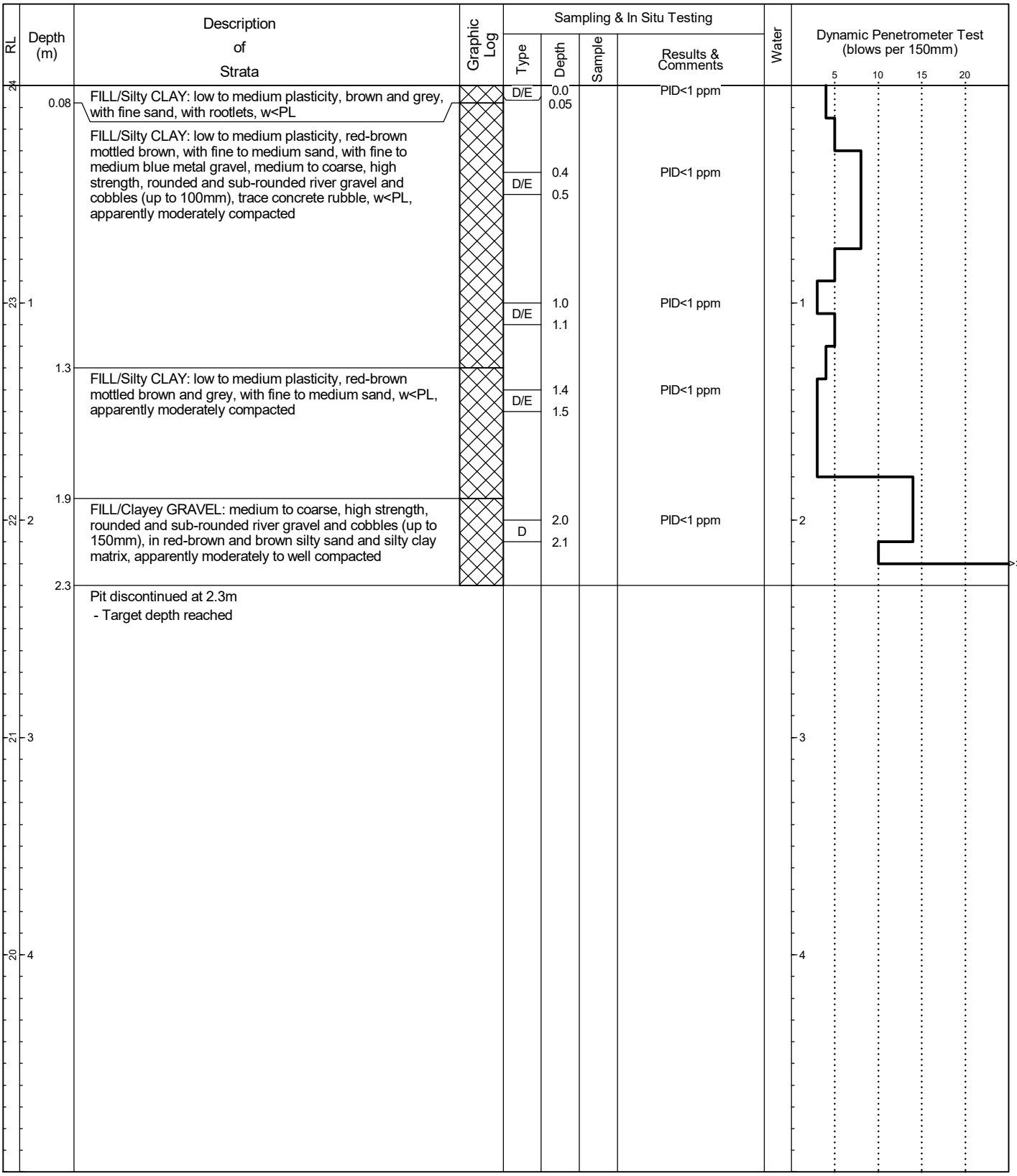
Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 24.0 AHD
EASTING: 285311
NORTHING: 6265718

PIT No: TP29
PROJECT No: 204635.00
DATE: 20/5/2021
SHEET 1 OF 1



RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

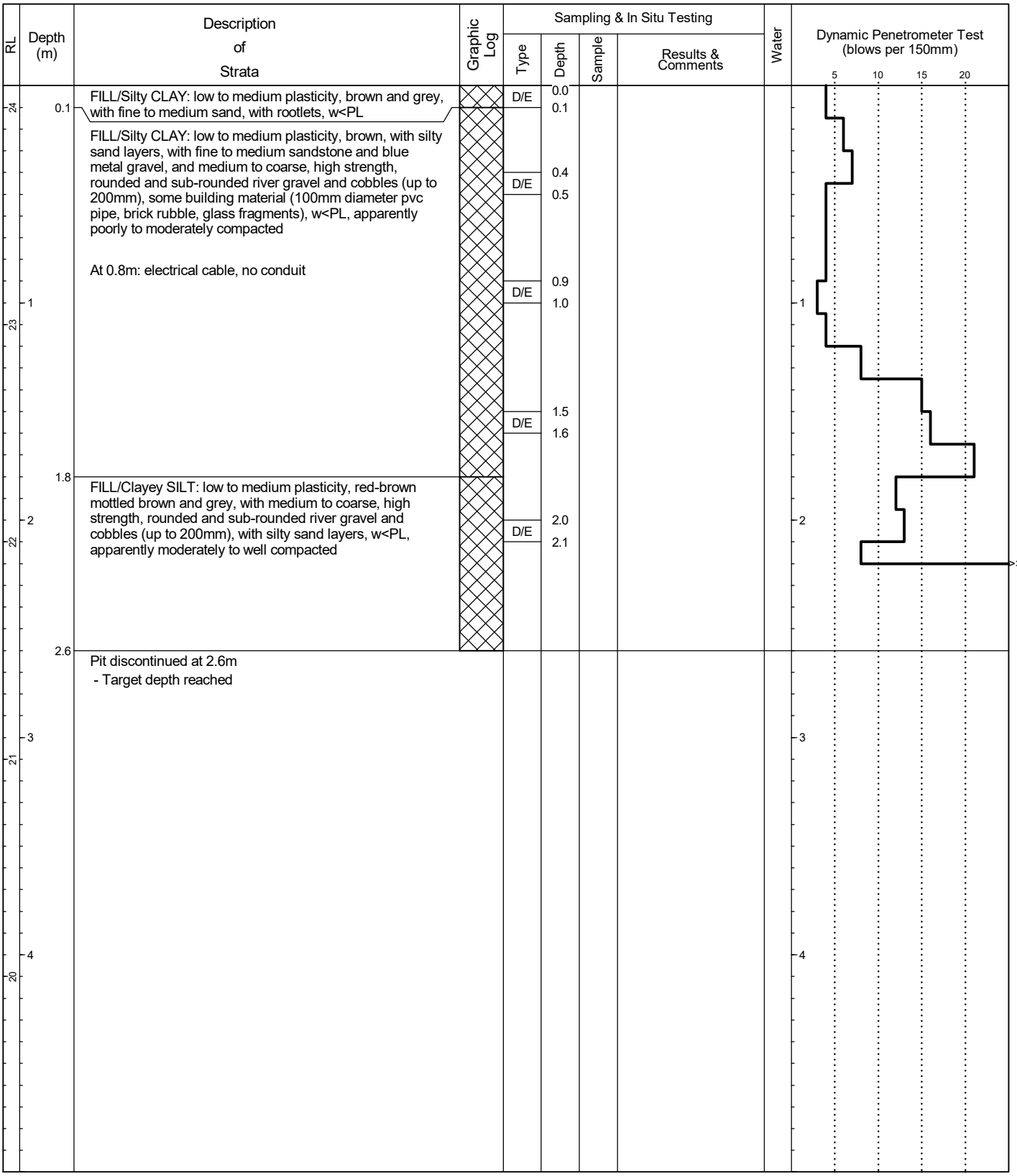
Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Colliers International Pty Ltd
PROJECT: Proposed Helicopter Facility
LOCATION: 100-275 Old Castlereagh Road, Penrith

SURFACE LEVEL: 24.1 AHD
EASTING: 285373
NORTHING: 6265702

PIT No: TP30
PROJECT No: 204635.00
DATE: 20/5/2021
SHEET 1 OF 1



RIG: 8.5 Tonne Excavator with 450mm tooth bucket

LOGGED: JS

SURVEY DATUM: MGA94 Zone 56

WATER OBSERVATIONS: No free groundwater observed

REMARKS:

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

SAMPLING & IN SITU TESTING LEGEND

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

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

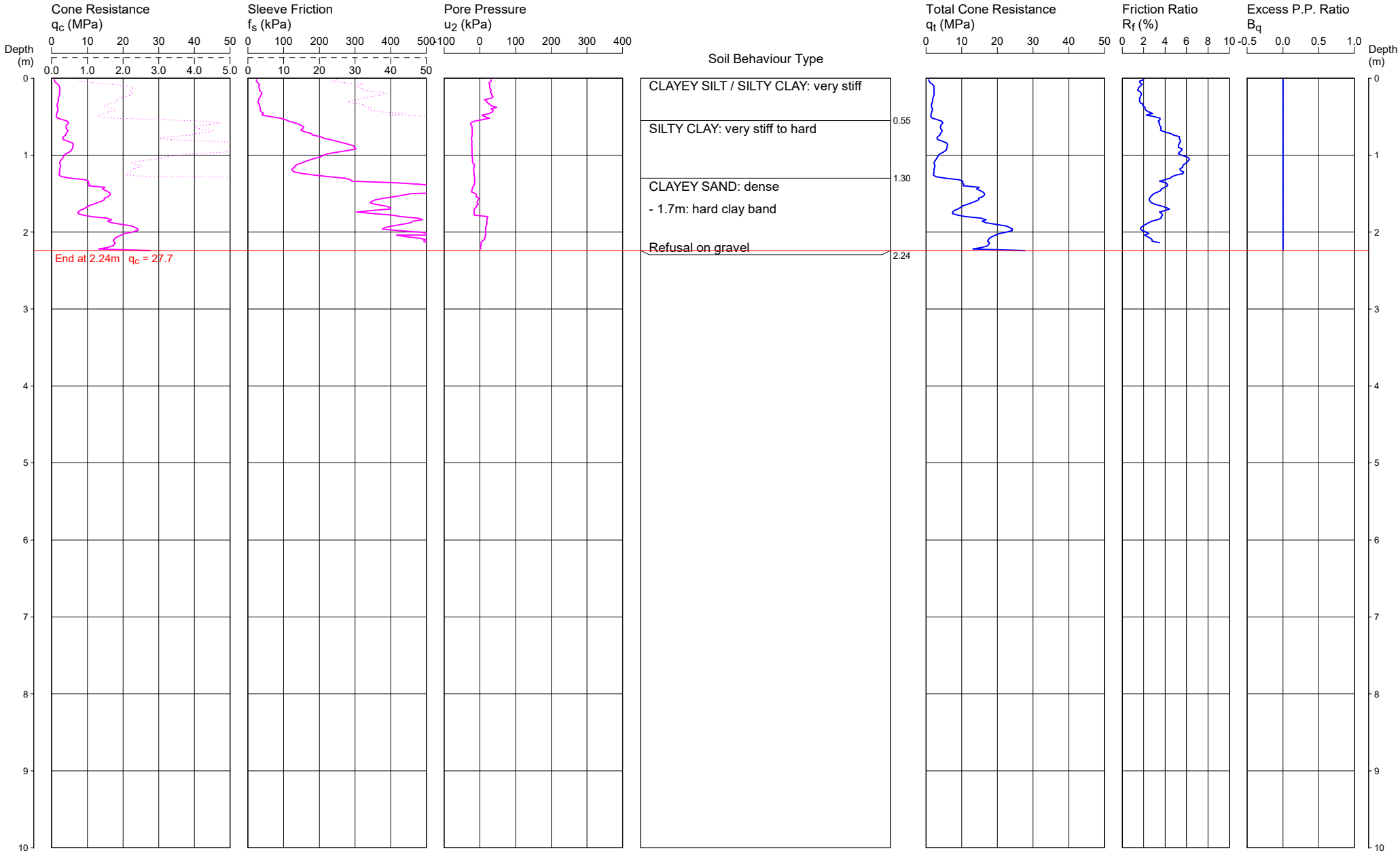
REDUCED LEVEL: 24.8 m AHD

COORDINATES: 285506E 6265567N GDA 94 MGA Zone 56

CPT01

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED GRAVEL
HOLE COLLAPSE AT 2.0m AFTER WITHDRAWAL OF RODS.

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT01.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

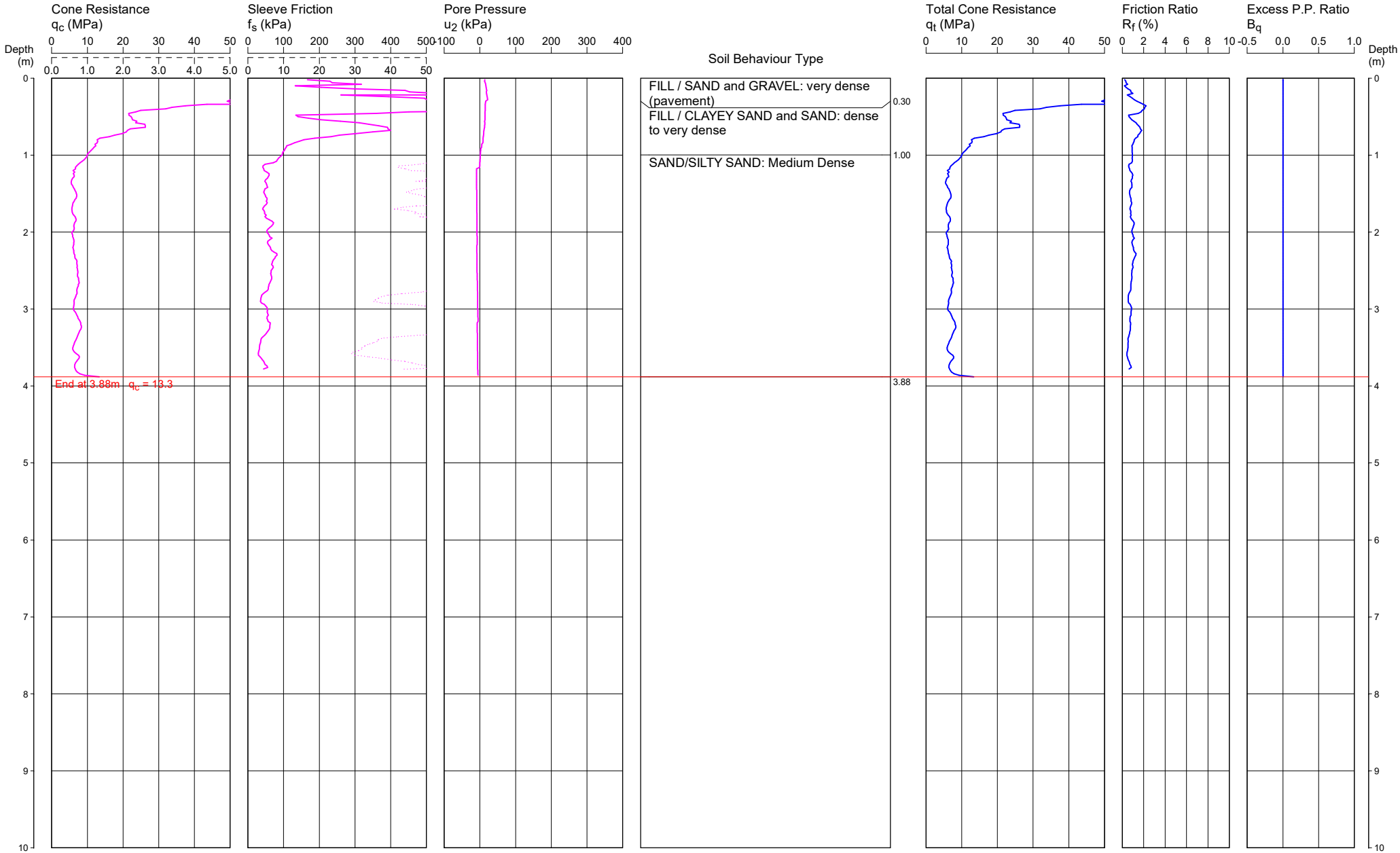
REDUCED LEVEL: 26.2 m AHD

COORDINATES: 285404E 6265568N GDA 94 MGA Zone 56

CPT02

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED GRAVEL
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT02.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

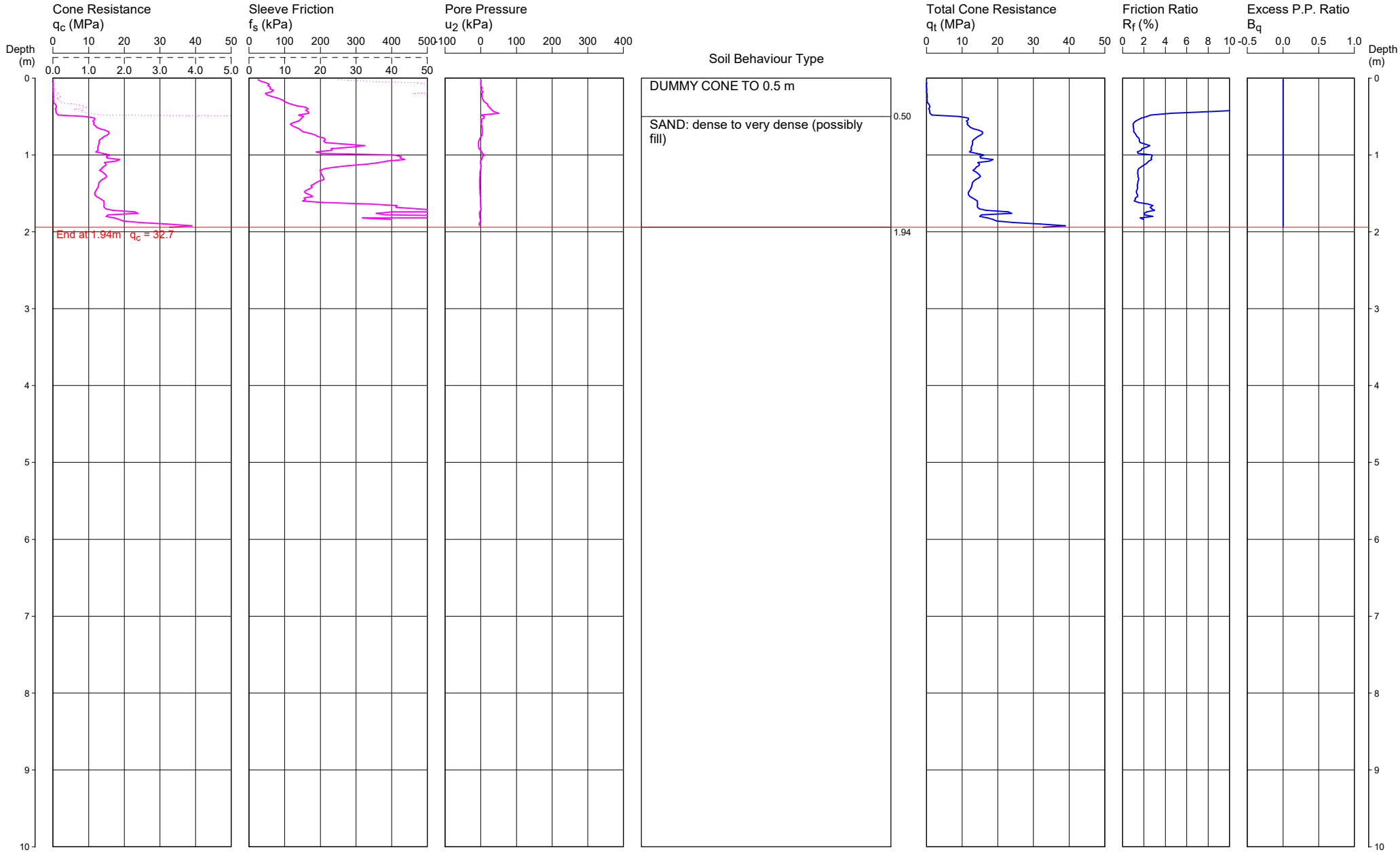
REDUCED LEVEL: 25.3 m AHD

COORDINATES: 285405E 6265640N GDA 94 MGA Zone 56

CPT03

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

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Cone ID: 120522 **Type:** I-CFXYP20-10

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

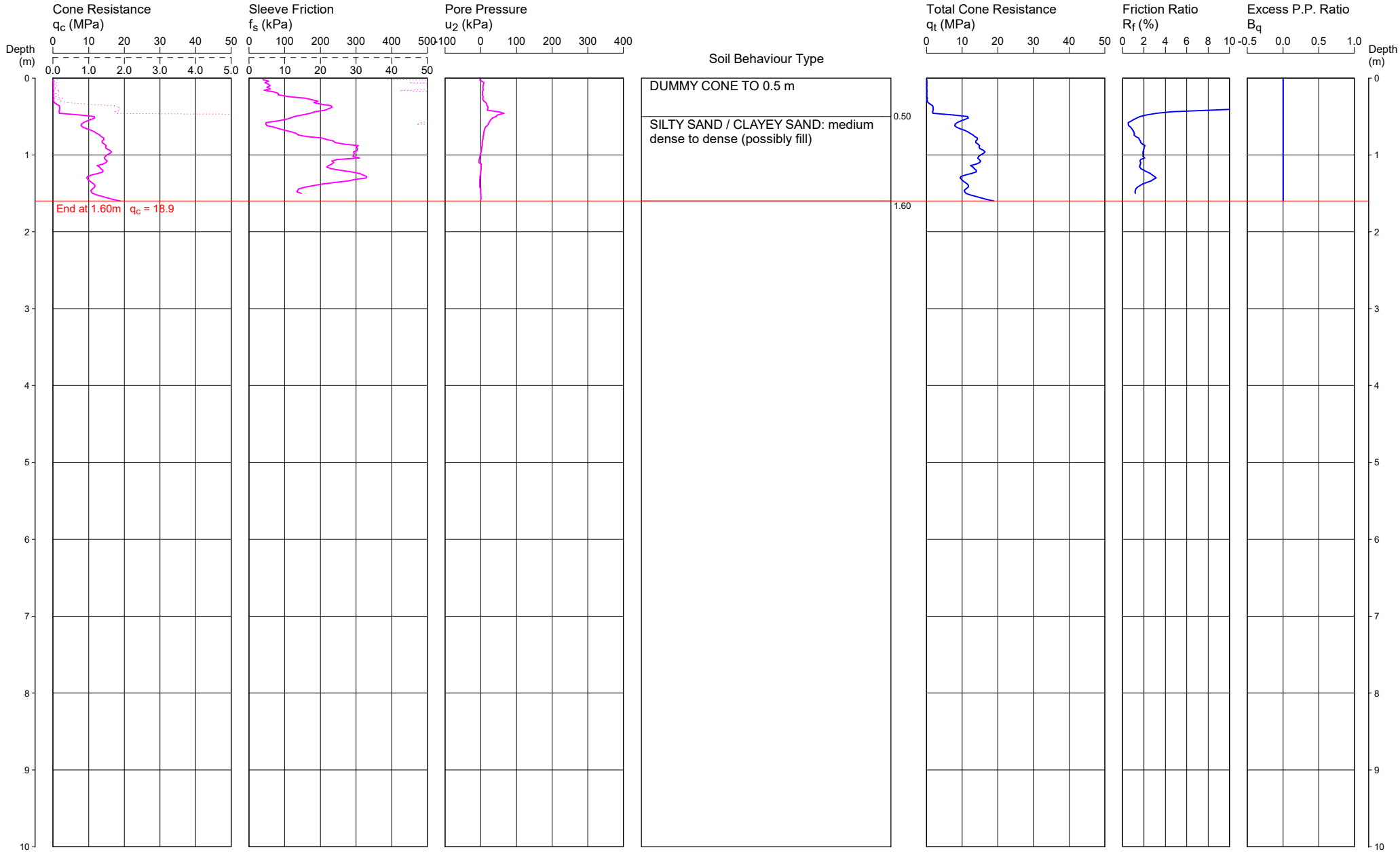
REDUCED LEVEL: 25.3 m AHD

COORDINATES: 285405E 6265640N GDA 94 MGA Zone 56

CPT03A

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

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Cone ID: 120522 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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Geotechnics | Environment | Groundwater

PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

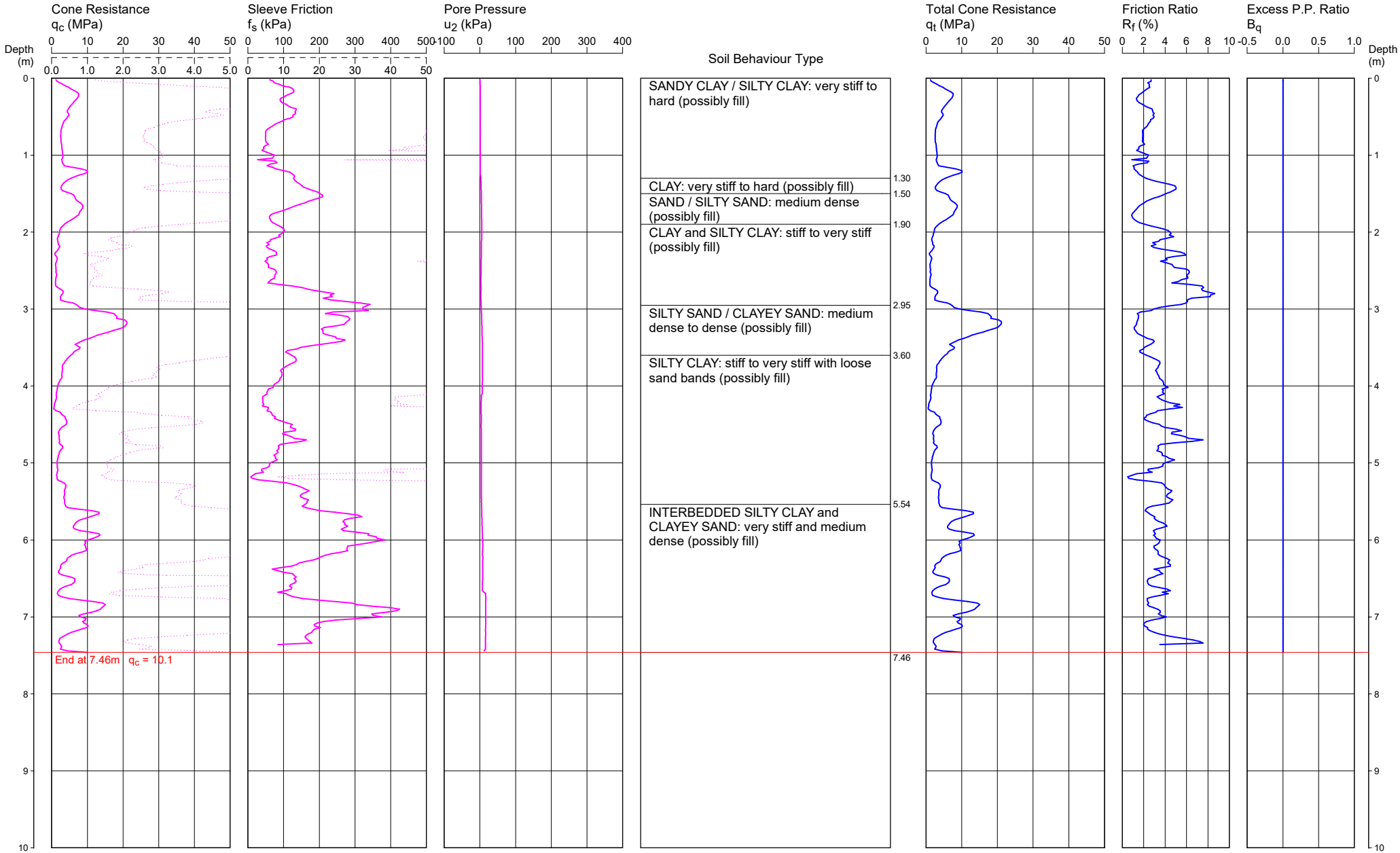
REDUCED LEVEL: 24.2 m AHD

COORDINATES: 285309E 6265700N GDA 94 MGA Zone 56

CPT04

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. HOLE COLLAPSE AT 4.8m AFTER WITHDRAWAL OF RODS.

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT04.CP5

Cone ID: 120522 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

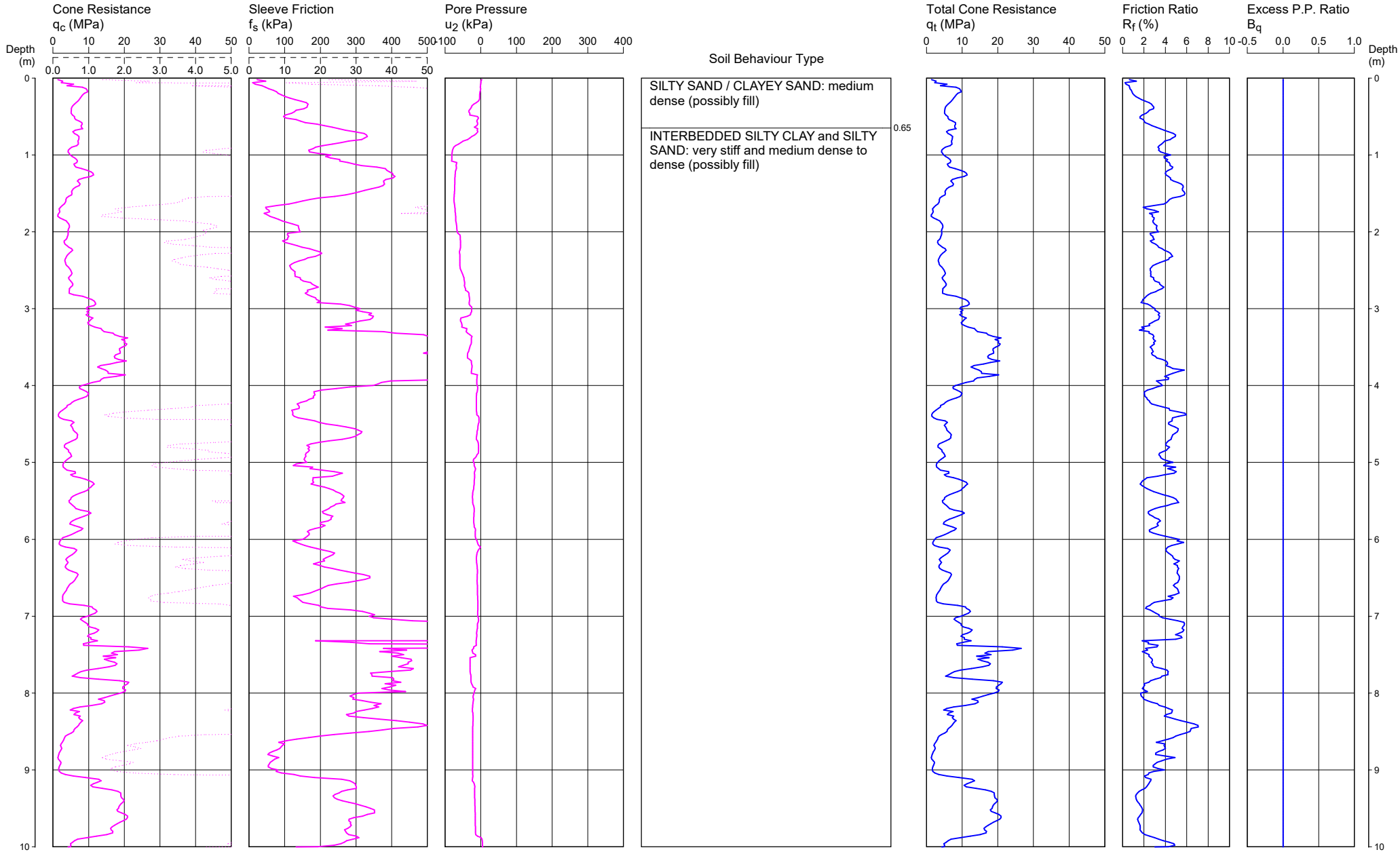
REDUCED LEVEL: 24.7 m AHD

COORDINATES: 285308E 6265599N GDA 94 MGA Zone 56

CPT05

DATE 20/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. HOLE COLLAPSE AT 1.2m AFTER WITHDRAWAL OF RODS.

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT05.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

Douglas Partners
Geotechnics | Environment | Groundwater

PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

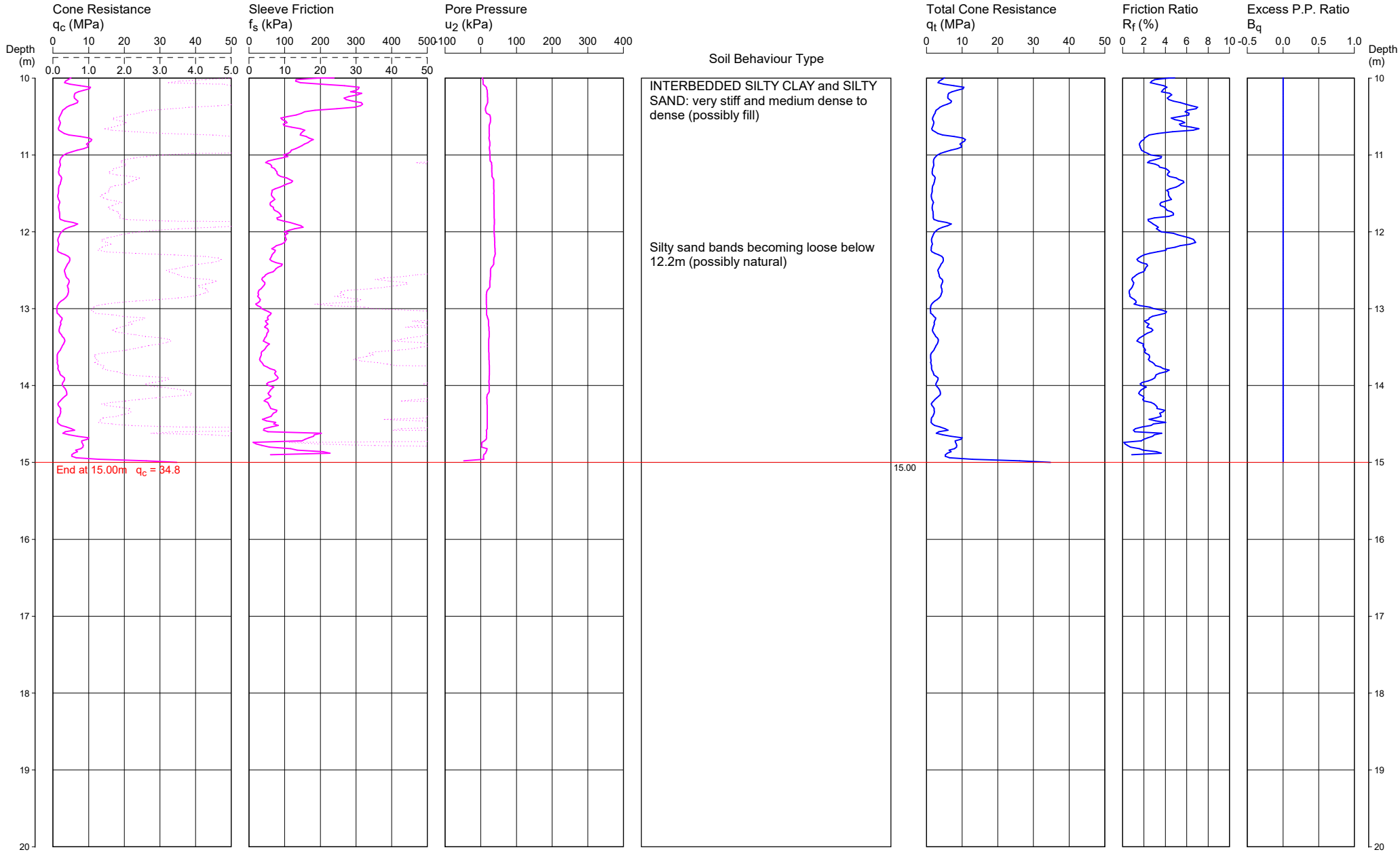
REDUCED LEVEL: 24.7 m AHD

COORDINATES: 285308E 6265599N GDA 94 MGA Zone 56

CPT05

DATE 20/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. HOLE COLLAPSE AT 1.2m AFTER WITHDRAWAL OF RODS.

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT05.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

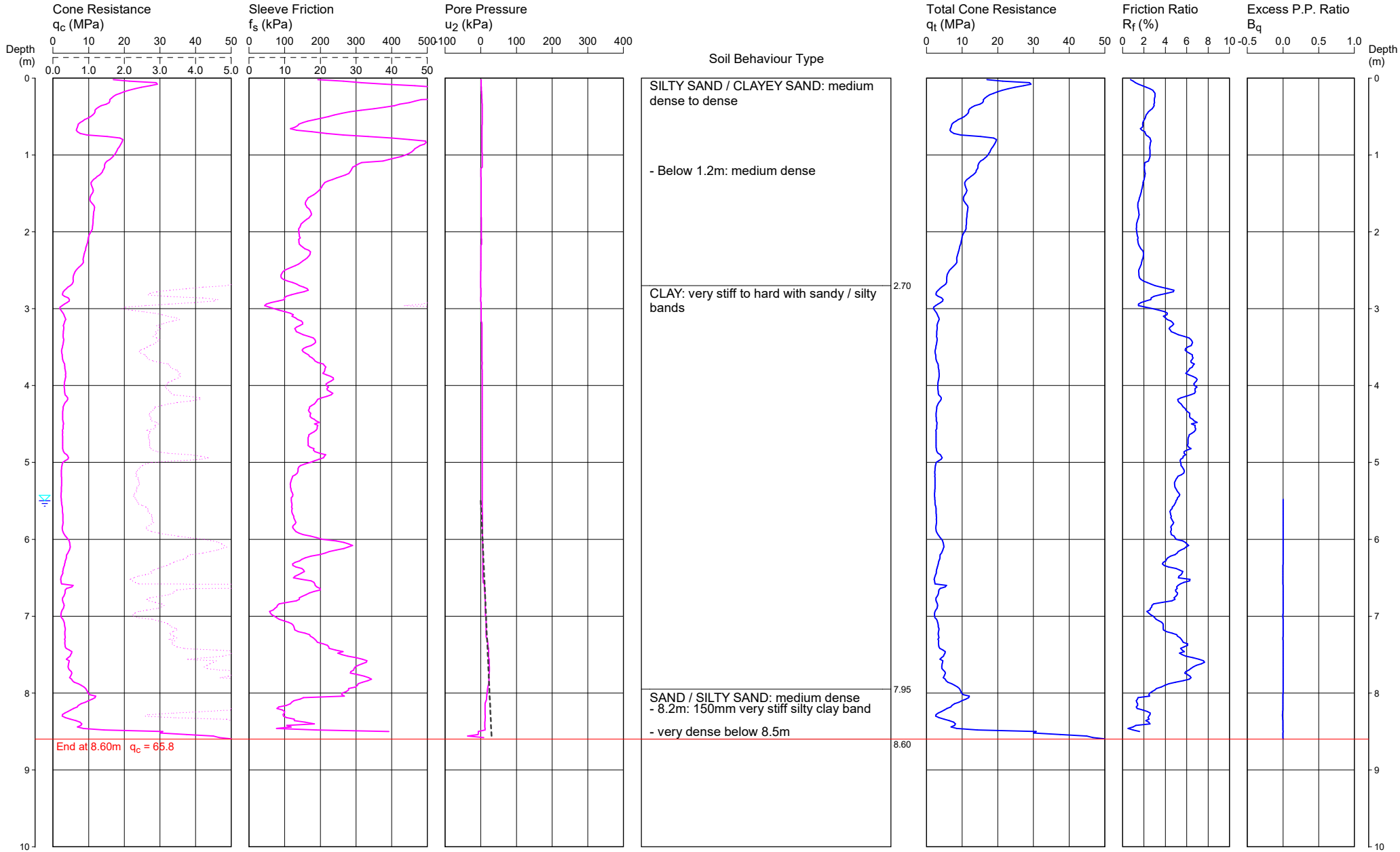
REDUCED LEVEL: 25.4 m AHD

COORDINATES: 285214E 6265587N GDA 94 MGA Zone 56

CPT06

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. GROUNDWATER OBSERVED AT 5.5m AFTER TEST

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT06.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

Water depth after test: 5.5m

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

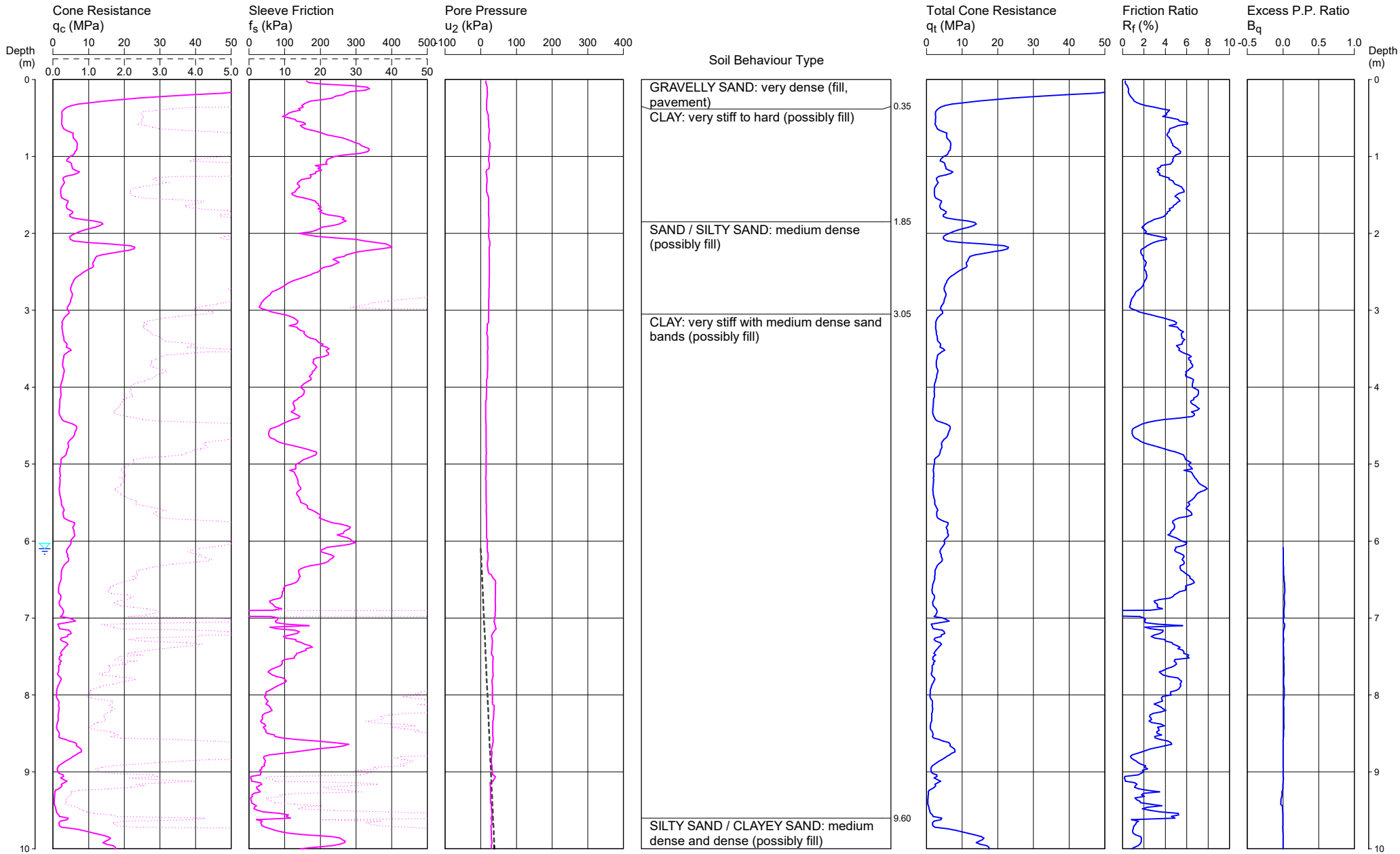
REDUCED LEVEL: 25.9 m AHD

COORDINATES: 285387E 6265581N GDA 94 MGA Zone 56

CPT07

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED GRAVEL
GROUNDWATER OBSERVED AT 6.1m AFTER TEST

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT07.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

Water depth after test: 6.1m

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

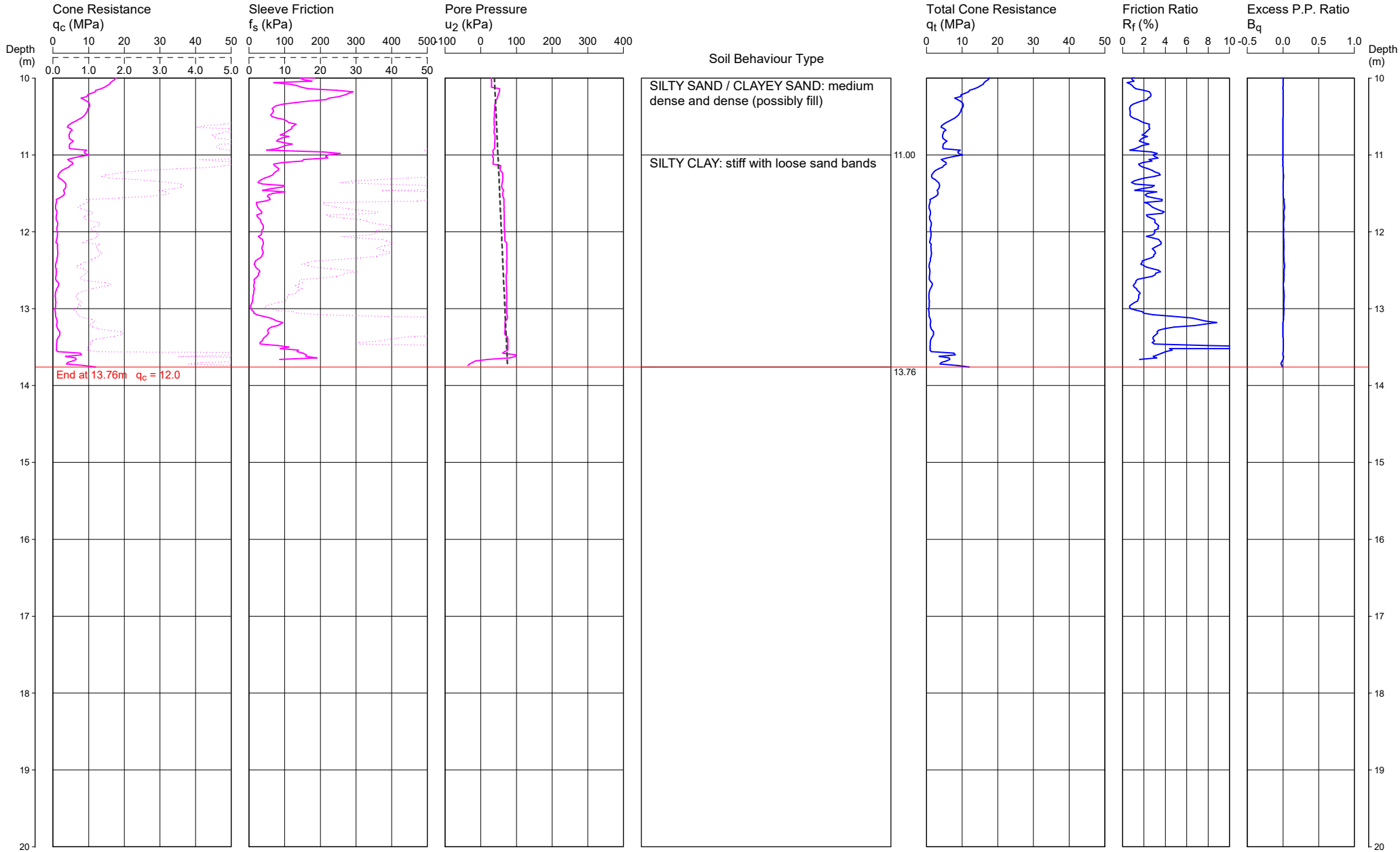
REDUCED LEVEL: 25.9 m AHD

COORDINATES: 285387E 6265581N GDA 94 MGA Zone 56

CPT07

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO REFUSAL ON INFERRED GRAVEL
GROUNDWATER OBSERVED AT 6.1m AFTER TEST

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT07.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

Water depth after test: 6.1m

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

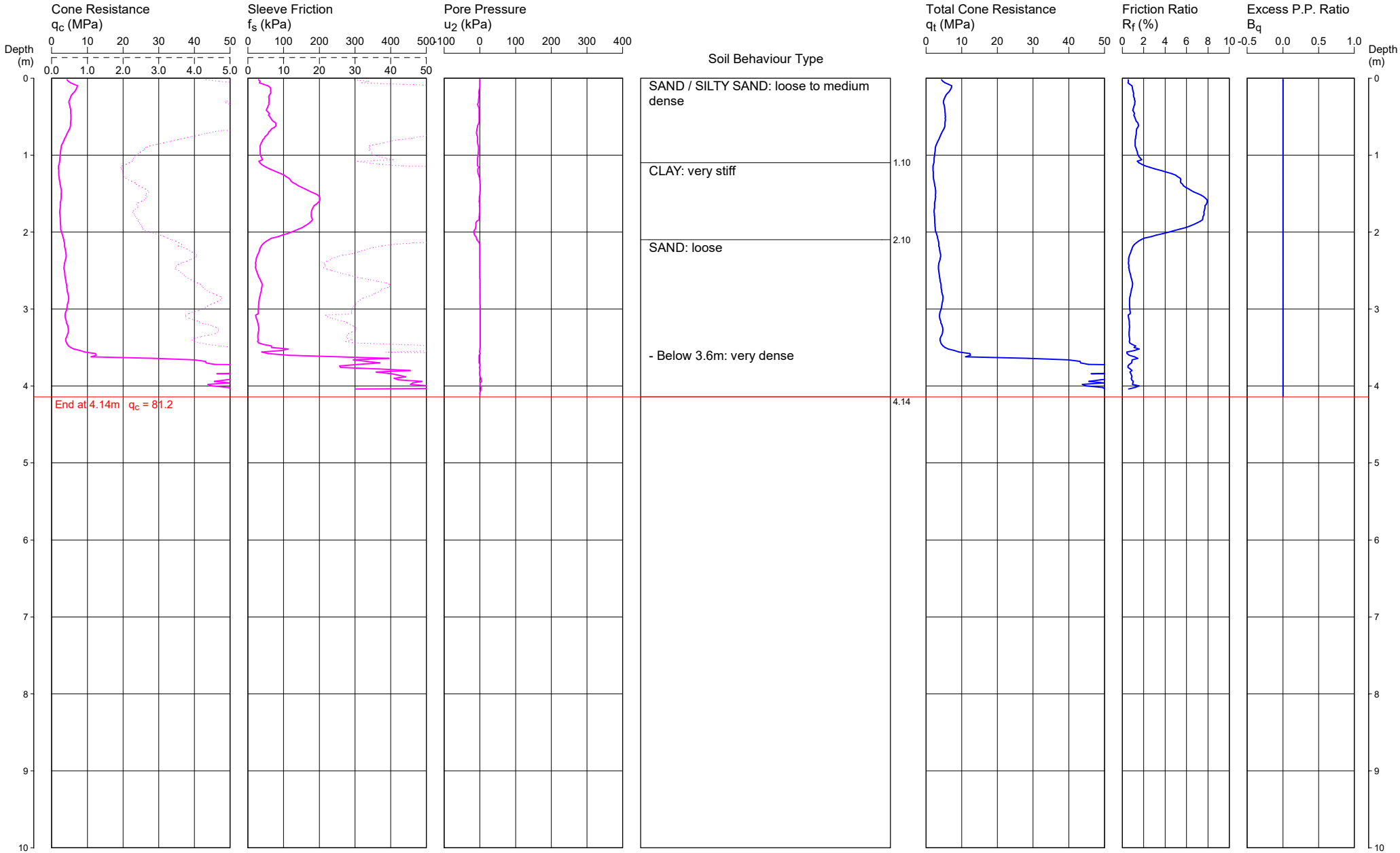
REDUCED LEVEL: 24.8 m AHD

COORDINATES: 285357E 6265556N GDA 94 MGA Zone 56

CPT08

DATE 20/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. HOLE COLLAPSE AT 2.6m AFTER WITHDRAWAL OF RODS.

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT08.CP5

Cone ID: 120522 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

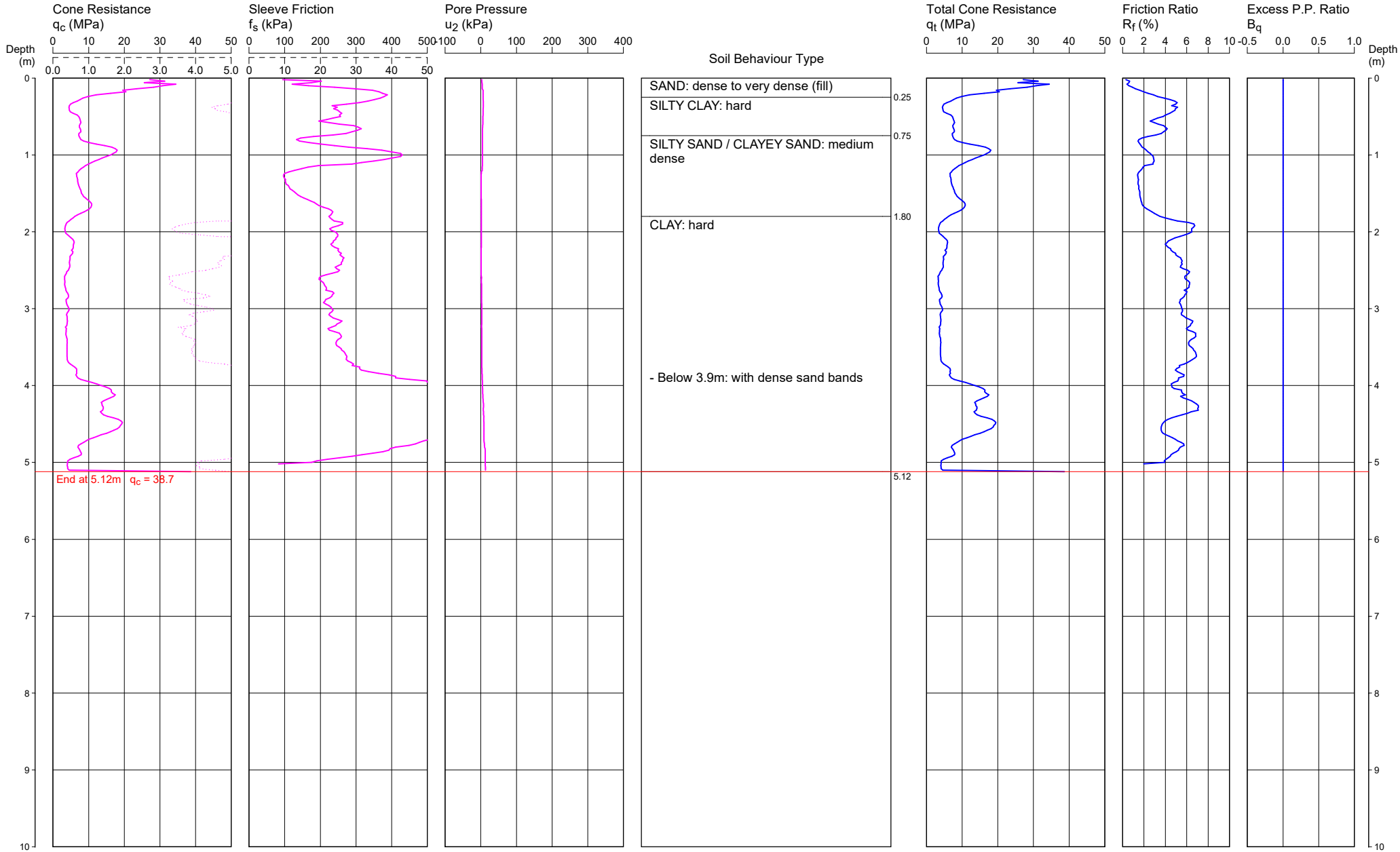
REDUCED LEVEL: 23.7 m AHD

COORDINATES: 285277E 6265576N GDA 94 MGA Zone 56

CPT09

DATE 20/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. HOLE COLLAPSE AT 2.2m AFTER WITHDRAWAL OF RODS.

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT09.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

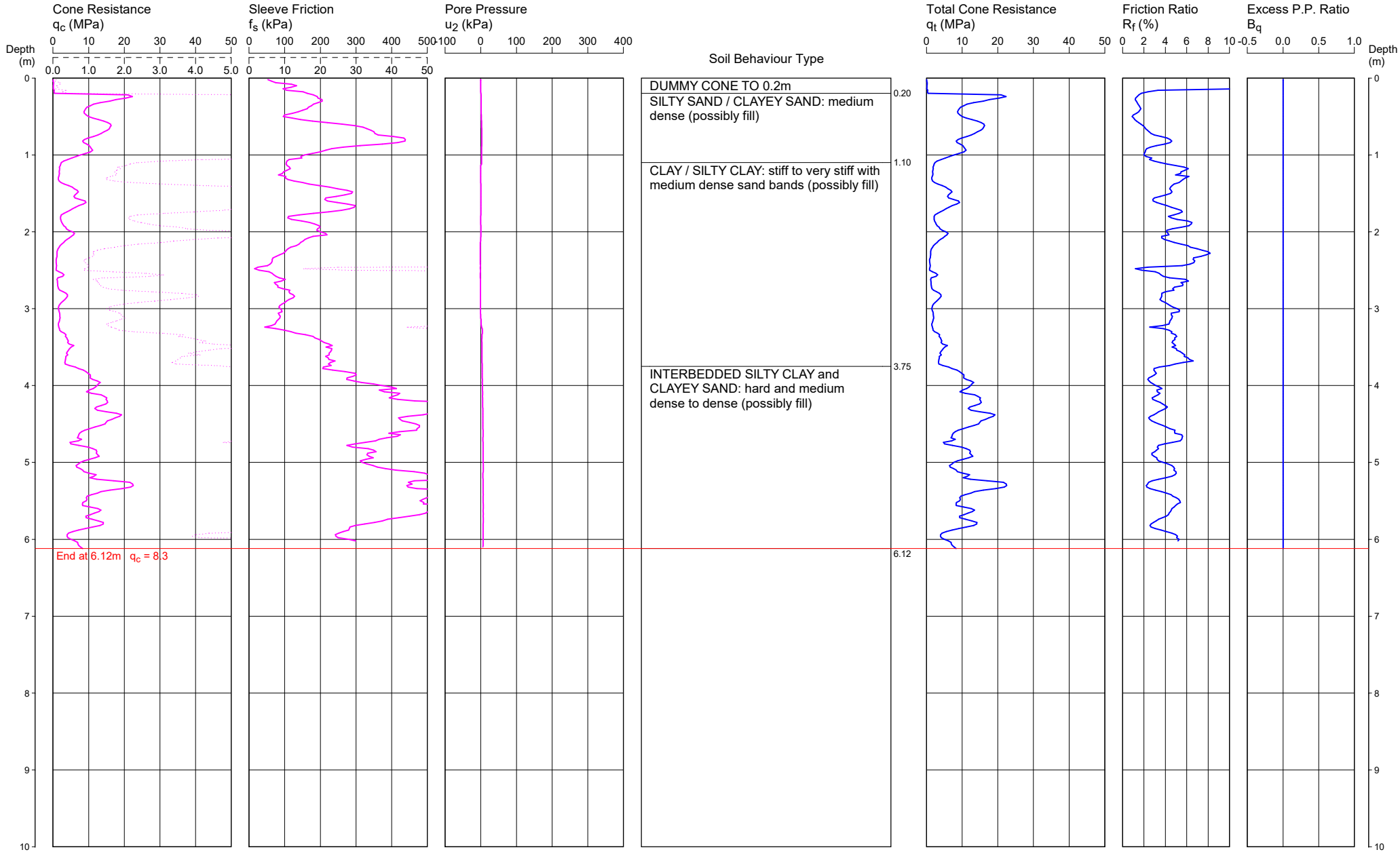
REDUCED LEVEL: 24 m AHD

COORDINATES: 285252E 6265610N GDA 94 MGA Zone 56

CPT10

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED AT TARGET DEPTH.
DUMMY CONE TO 0.2m. HOLE COLLAPSE AT 6.0m AFTER TEST

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT10.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

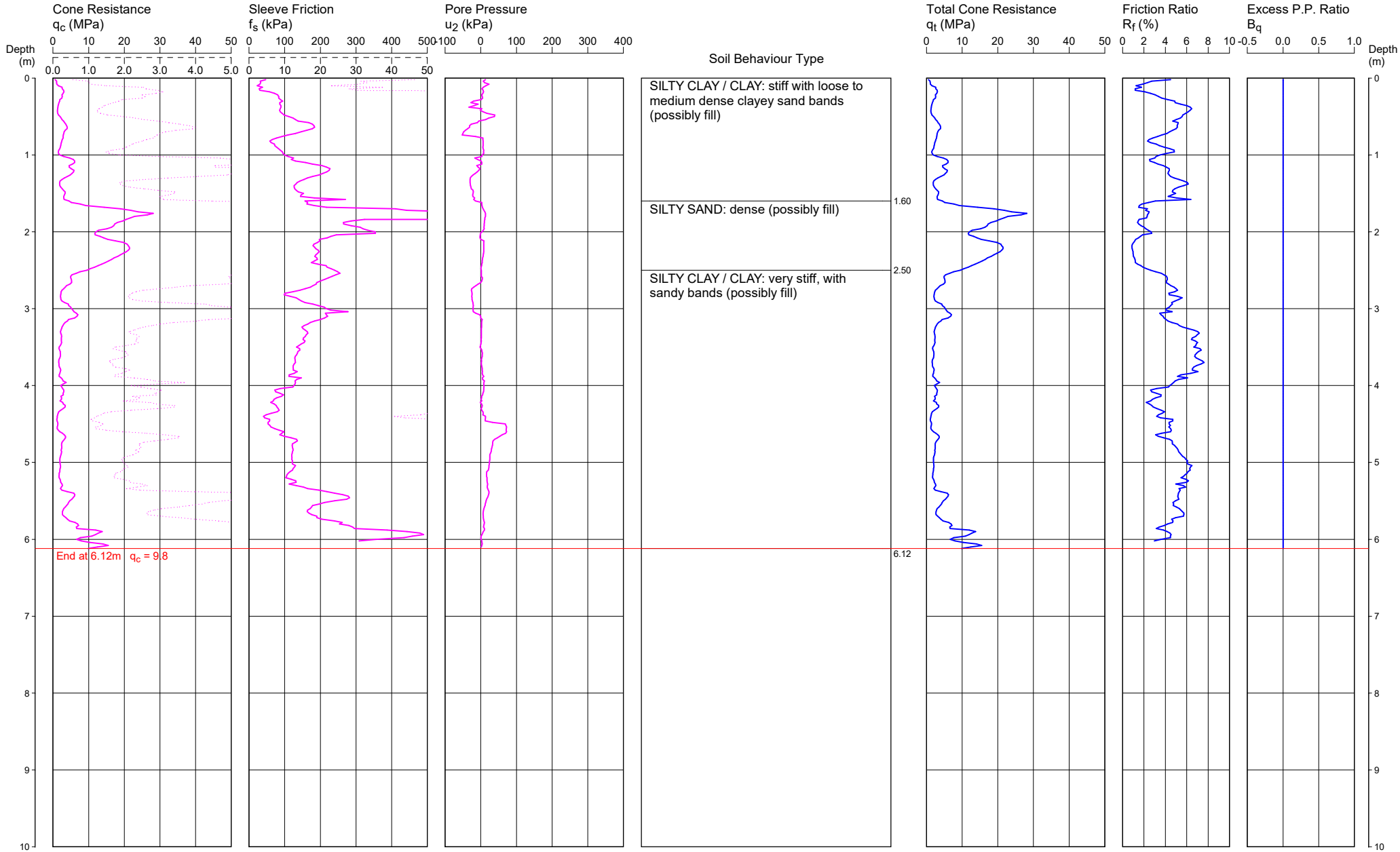
REDUCED LEVEL: 23.3 m AHD

COORDINATES: 285234E 6265635N GDA 94 MGA Zone 56

CPT11

DATE 20/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED AT TARGET DEPTH.
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT11.CP5

Cone ID: 120522 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

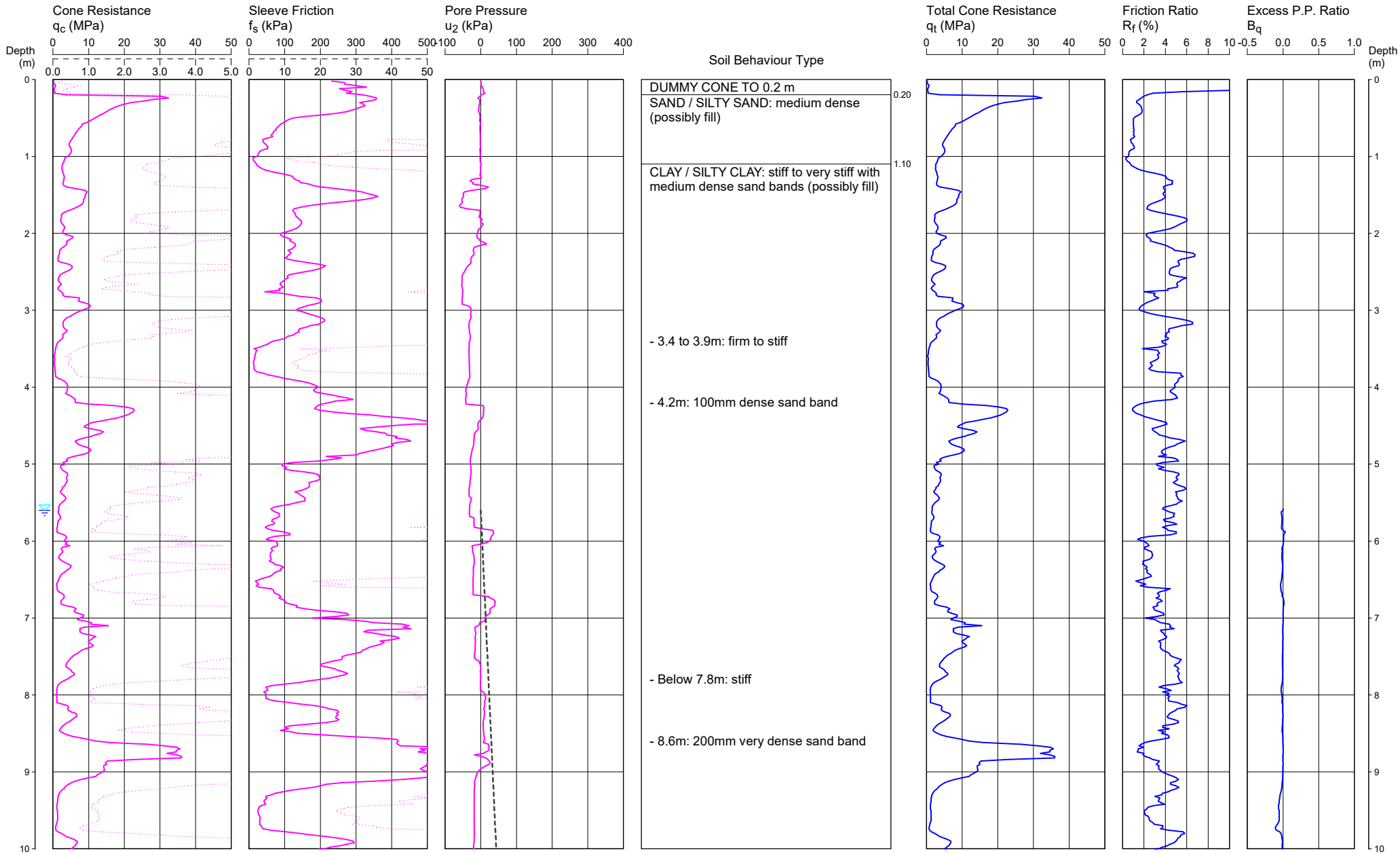
REDUCED LEVEL: 23.5 m AHD

COORDINATES: 285283E 6265638N GDA 94 MGA Zone 56

CPT12

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. DUMMY CONE TO 0.2m. GROUNDWATER OBSERVED AT 5.6m

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT12.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

Water depth after test: 5.6m

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

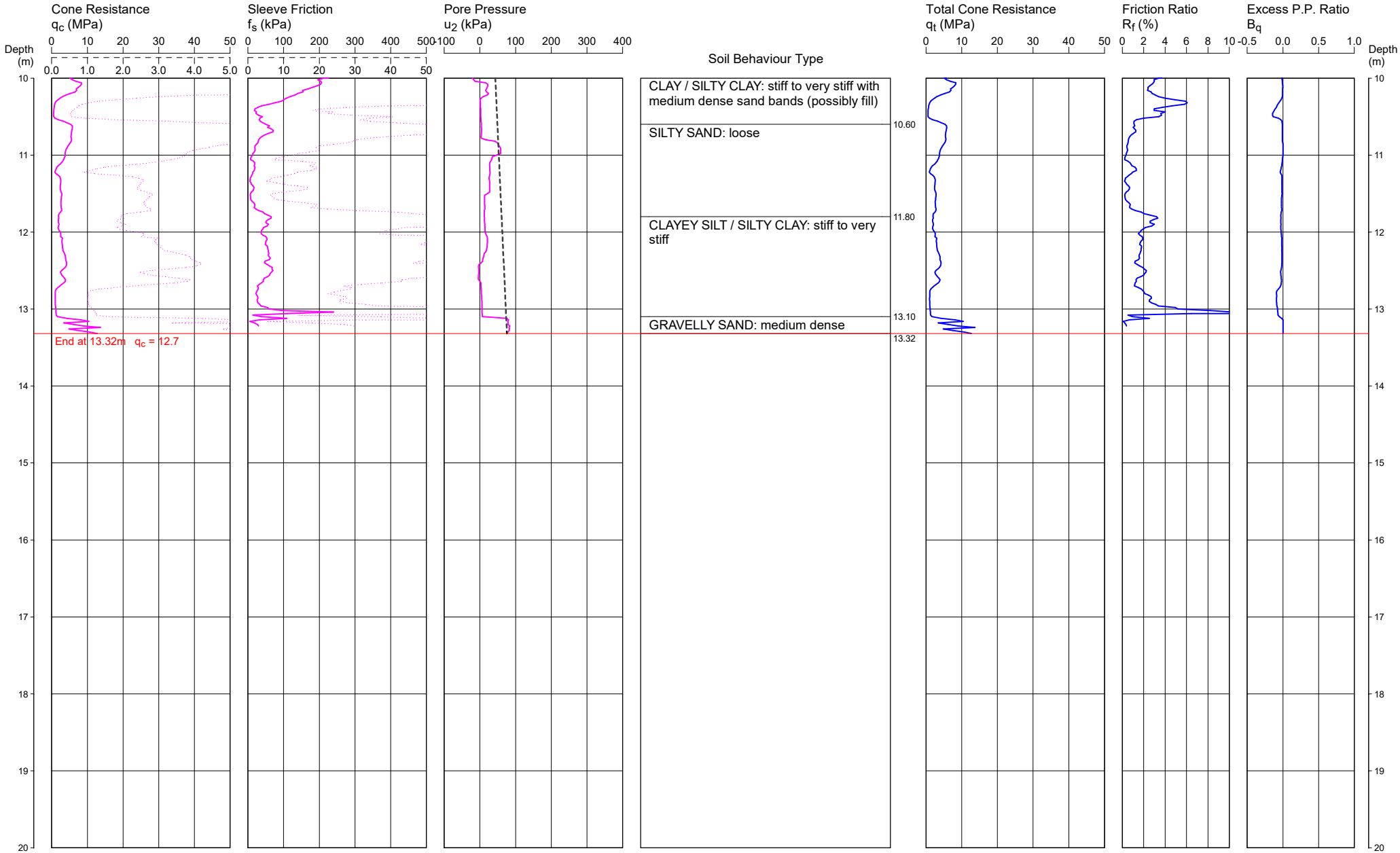
REDUCED LEVEL: 23.5 m AHD

COORDINATES: 285283E 6265638N GDA 94 MGA Zone 56

CPT12

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. DUMMY CONE TO 0.2m. GROUNDWATER OBSERVED AT 5.6m

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT12.CP5

Cone ID: 200309 **Type:** I-CFXYP20-10

Water depth after test: 5.6m

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

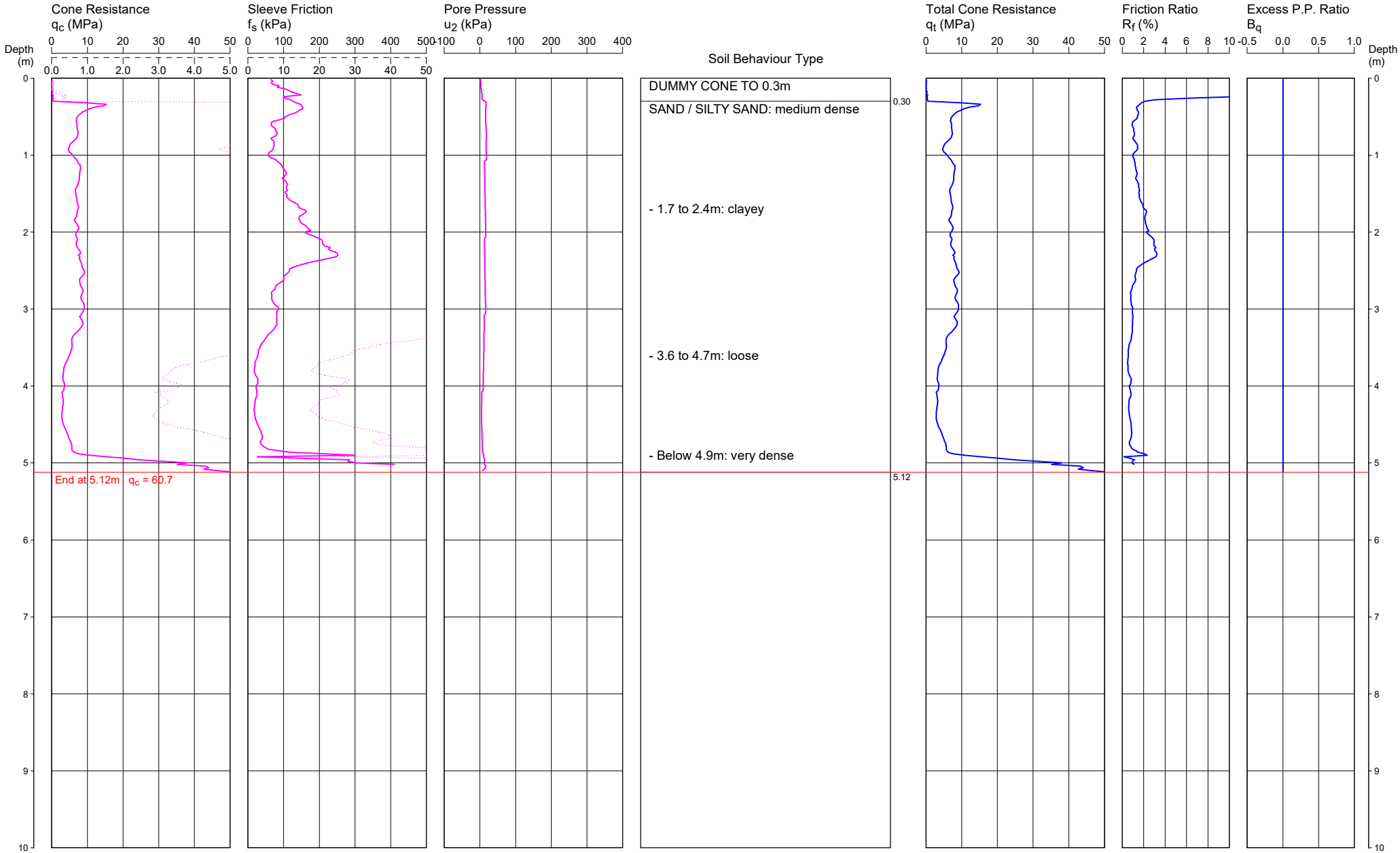
REDUCED LEVEL: 26.2 m AHD

COORDINATES: 285361E 6265664N GDA 94 MGA Zone 56

CPT13

DATE 20/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. DUMMY CONE TO 0.3m. NO GROUNDWATER OBSERVED

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT13.CP5

Cone ID: 120522 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

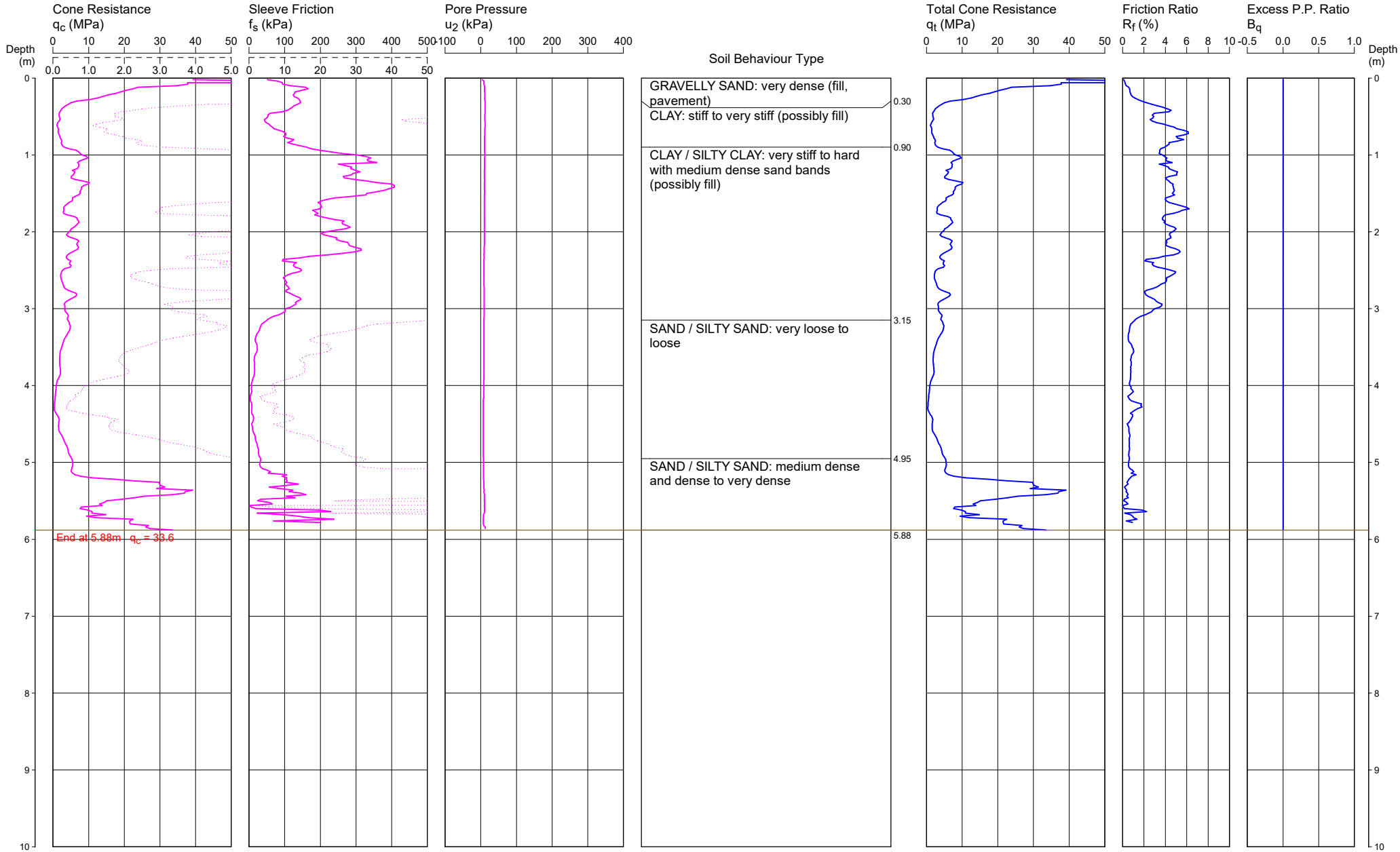
REDUCED LEVEL: 25.1 m AHD

COORDINATES: 285328E 6265665N GDA 94 MGA Zone 56

CPT14

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING.
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT14.CP5

Cone ID: 120522 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

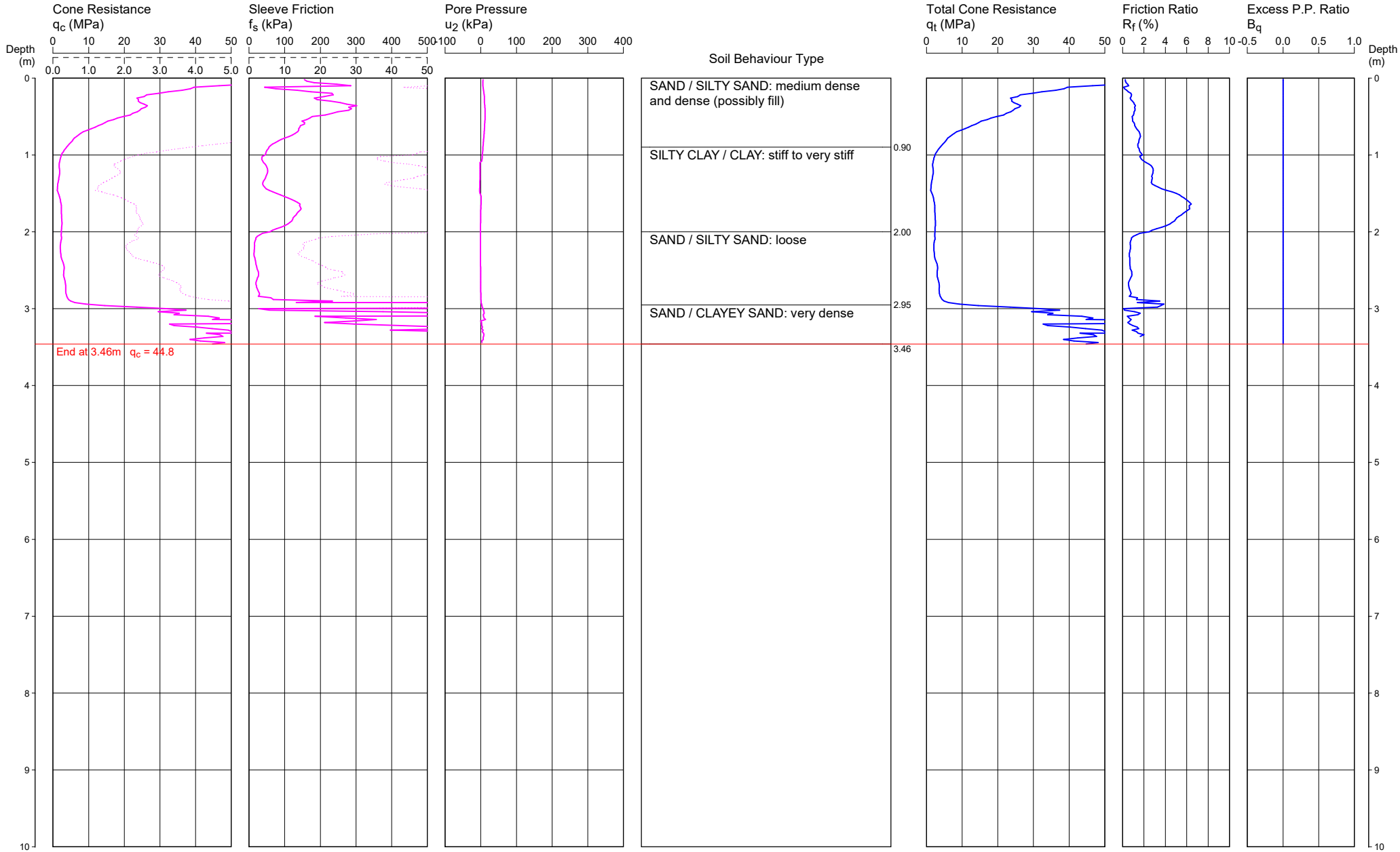
REDUCED LEVEL: 24.3 m AHD

COORDINATES: 285386E 6265685N GDA 94 MGA Zone 56

CPT15

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING.
NO GROUNDWATER OBSERVED AFTER WITHDRAWAL OF RODS

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT15.CP5

Cone ID: 120522 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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PIEZOCONE PENETRATION TEST

CLIENT: COLLIERS INTERNATIONAL PTY LTD

PROJECT: PROPOSED HELICOPTER FACILITY

LOCATION: 100-275 OLD CASTLEREIGH ROAD, PENRITH

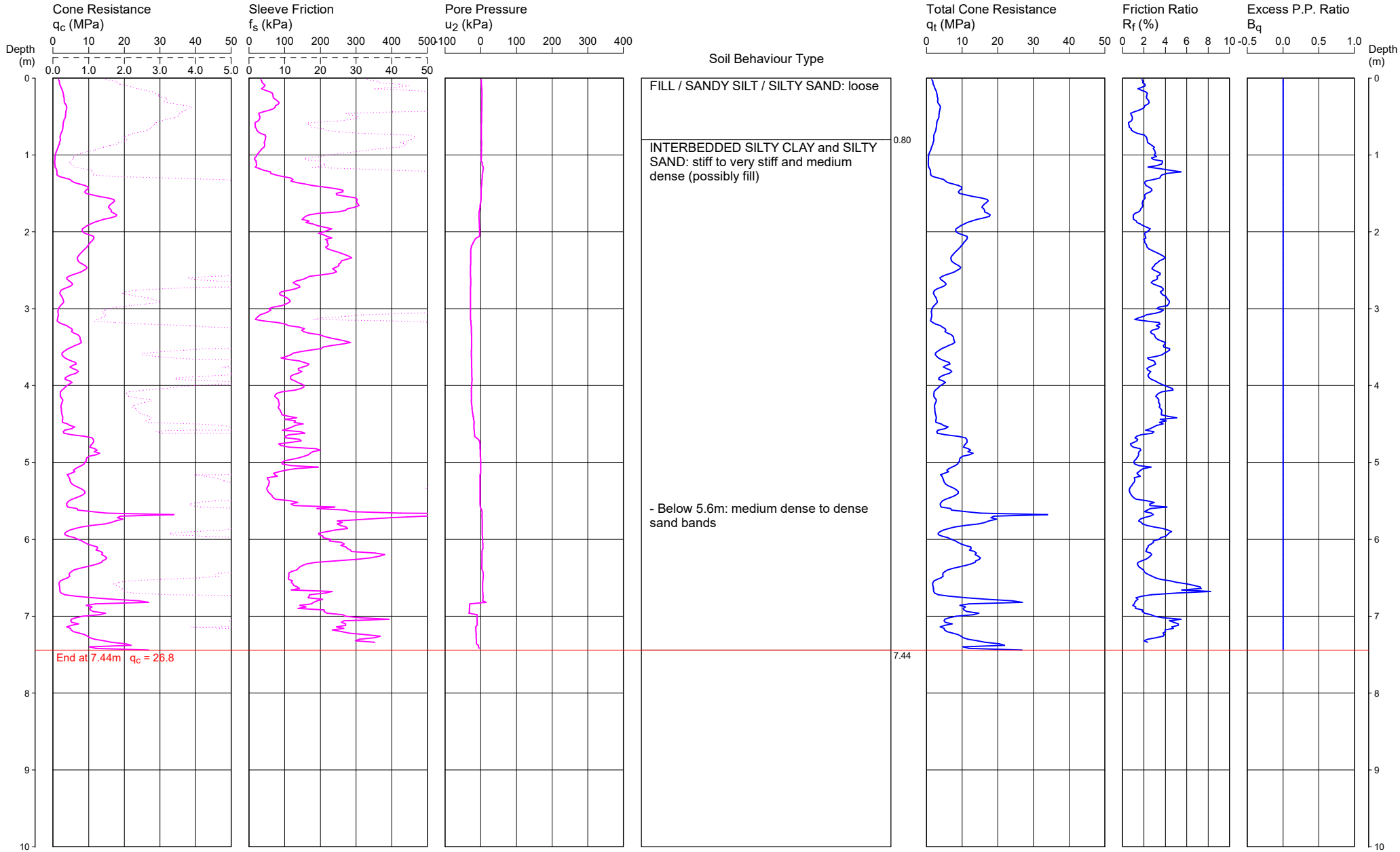
REDUCED LEVEL: 24.1 m AHD

COORDINATES: 285351E 6265728N GDA 94 MGA Zone 56

CPT16

DATE 19/05/2021

PROJECT No: 204635



REMARKS: TEST DISCONTINUED DUE TO EXCESSIVE CONE BENDING. HOLE COLLAPSE AT 3.0m AFTER WITHDRAWAL OF RODS.

File: P:\204635.00 - PENRITH, 100-275 Old Castlereagh Rd,Geo\4.0 Field Work\4.2 Testing\CPT\cp5-inter\CPT16.CP5

Cone ID: 120522 **Type:** I-CFXYP20-10

ConePlot Version 5.9.2

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Appendix D

Laboratory Test Results

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

CERTIFICATE OF ANALYSIS 269957

Client Details

Client	Douglas Partners Pty Ltd
Attention	Rhys McMillan
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	**204635.00, Penrith**
Number of Samples	10 Soil
Date samples received	26/05/2021
Date completed instructions received	26/05/2021

Analysis Details

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

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

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

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

Report Details

Date results requested by	02/06/2021
Date of Issue	01/06/2021

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

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

Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Soil Aggressivity						
Our Reference		269957-1	269957-2	269957-3	269957-4	269957-5
Your Reference	UNITS	BH17	BH18	BH19	BH20	BH21
Depth		0.2-0.3m	2.0m	0.4-0.5m	2.0m	0.5m
Date Sampled		19/05/2021	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	7.2	6.7	7.2	6.8	6.6
Electrical Conductivity 1:5 soil:water	µS/cm	19	44	12	70	14
Chloride, Cl 1:5 soil:water	mg/kg	<10	38	<10	48	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	22	<10	62	<10

Soil Aggressivity						
Our Reference		269957-6	269957-7	269957-8	269957-9	269957-10
Your Reference	UNITS	BH23	BH24	BH25	BH27	BH29
Depth		0.2-0.3m	0.4-0.5m	0.5-0.6m	0.2-0.3m	0.4-0.5m
Date Sampled		19/05/2021	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
pH 1:5 soil:water	pH Units	6.9	6.6	7.1	6.7	8.6
Electrical Conductivity 1:5 soil:water	µS/cm	260	36	68	16	94
Chloride, Cl 1:5 soil:water	mg/kg	230	20	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	130	39	80	<10	10

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

QUALITY CONTROL: Soil Aggressivity						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	269957-3
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	7.2	7.2	0	101	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	19	18	5	104	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	101	95
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	107	91

Result Definitions

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

Quality Control Definitions

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

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

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

Report Comments

pH/EC
Samples were out of the recommended holding time for this analysis.

Material Test Report

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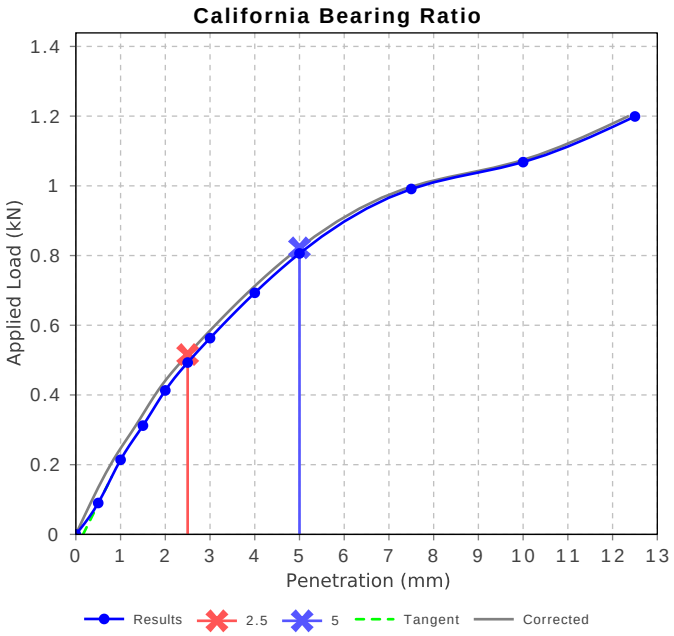
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Andrew Hutchings
Laboratory Manager
Laboratory Accreditation Number: 828

Report Number: **204635.00-1**
Issue Number: 1
Date Issued: 16/06/2021
Client: Colliers International Pty Ltd
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866A
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 08/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP17 , Depth: 0.5-0.8m**
Material: Silty CLAY CL-CI: pale grey mottled grey and brown, with high strength, medium to coarse, rounded and sub-rounded river gravel and cobbles (up to 200mm)

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**4.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.75		
Optimum Moisture Content (%)	18.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	101.5		
Dry Density after Soaking (t/m^3)	1.73		
Field Moisture Content (%)	20.9		
Moisture Content at Placement (%)	18.7		
Moisture Content Top 30mm (%)	22.9		
Moisture Content Rest of Sample (%)	21.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	194.6		
Swell (%)	1.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	4.4		



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	50		
Plastic Limit (%)	19		
Plasticity Index (%)	**31**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	15.0		
Cracking Crumbling Curling	Curling		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	19.3

Material Test Report

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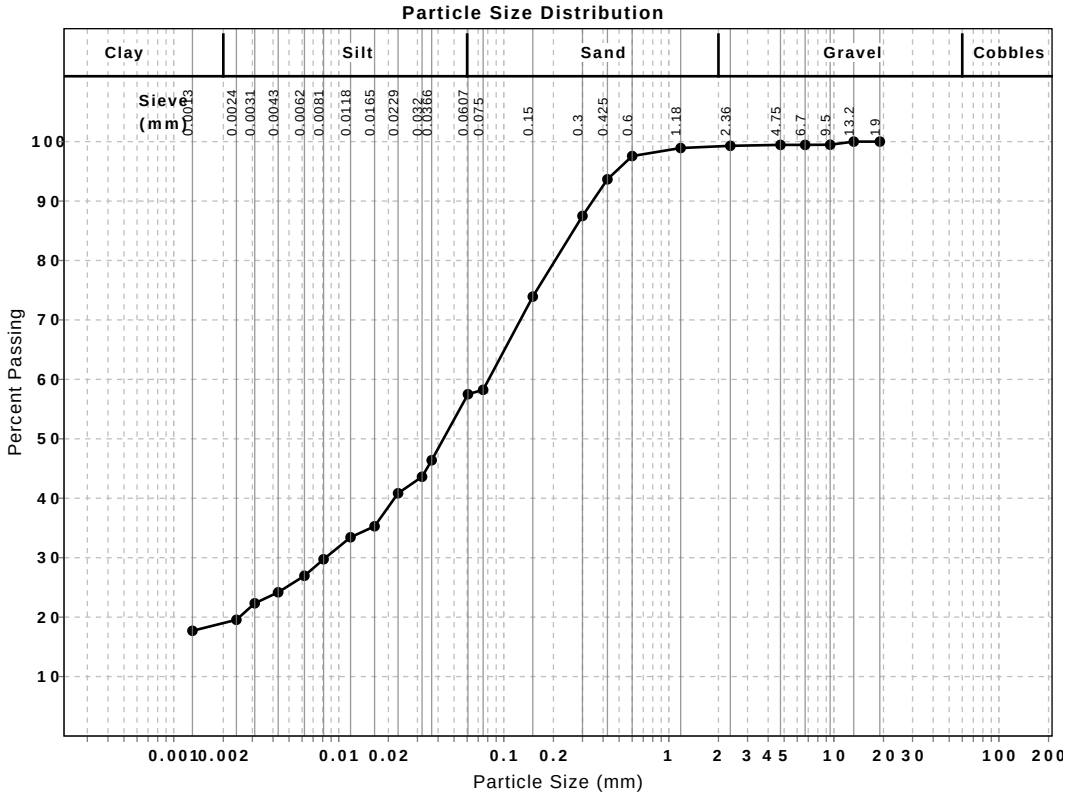
Report Number: **204635.00-1**
Issue Number: 1
Date Issued: 16/06/2021
Client: Colliers International Pty Ltd
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866B
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 27/05/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP18 (1.0m)**
Material: Sandy Clayey SILT : brown mottled red-brown and grey

Fine Analysis using a Hydrometer (AS 1289 3.6.3)	
Method of Dispersion	Mechanical Device
Loss in Pretreatment	-

Particle Size Distribution (AS 1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**99**		
6.7 mm	**99**		
4.75 mm	**99**		
2.36 mm	**99**		
1.18 mm	**99**		
0.6 mm	**98**		
0.425 mm	**94**		
0.3 mm	**87**		
0.15 mm	**74**		
0.075 mm	**58**		

Fine Analysis Using a Hydrometer (AS 1289 3.6.3)	
Particle Size (mm)	Passed %
0.0607	**57.5**
0.0366	**46.4**
0.0320	**43.6**
0.0229	**40.8**
0.0165	**35.3**
0.0118	**33.4**
0.0081	**29.7**
0.0062	**27.0**
0.0043	**24.2**
0.0031	**22.3**
0.0024	**19.5**
0.0013	**17.7**



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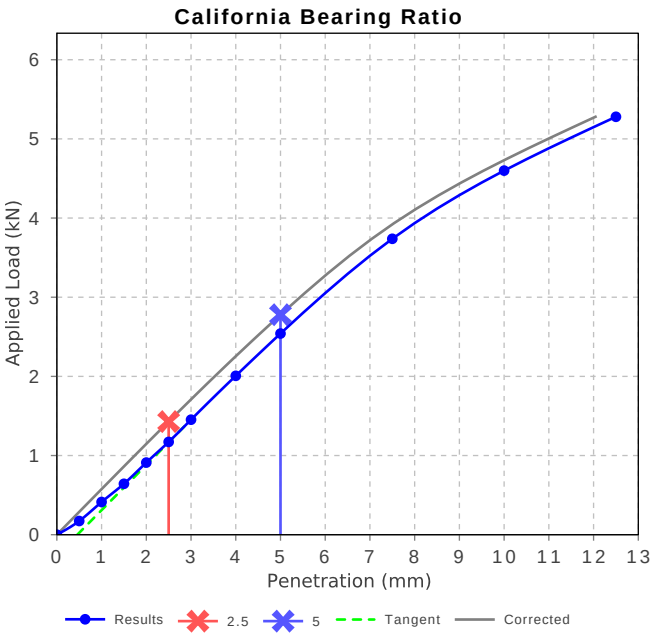
Date Issued: 16/06/2021
Client: Colliers International Pty Ltd
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866C
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 08/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP19 (0.4-0.9m)**
Material: Silty CLAY CL-CI: low to medium plasticity, red-brown

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**14.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.95		
Optimum Moisture Content (%)	11.5		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	102.0		
Dry Density after Soaking (t/m^3)	1.95		
Field Moisture Content (%)	13.8		
Moisture Content at Placement (%)	11.6		
Moisture Content Top 30mm (%)	13.4		
Moisture Content Rest of Sample (%)	12.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	49.6		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		
Placement moisture taken using AS1289.2.1.2			



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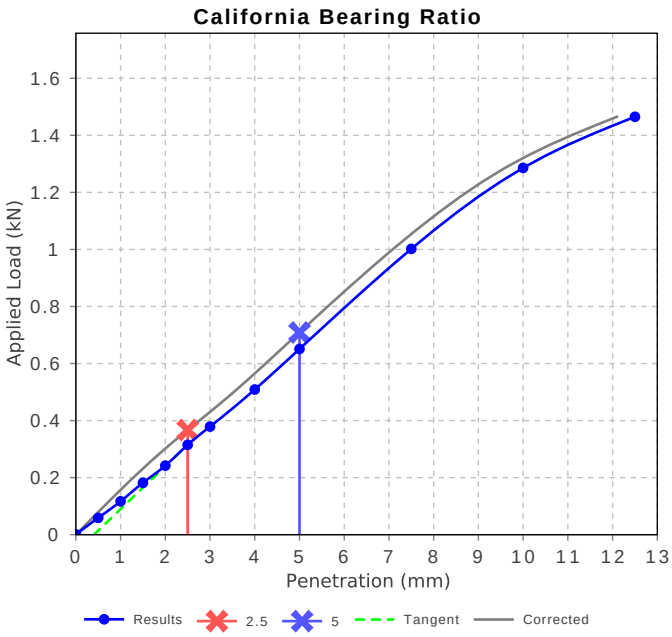
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866D
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 08/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP21 , Depth: 1.0 -1.5m**
Material: Silty CLAY CL-CI: low to medium plasticity, red-brown

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**3.5**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.85		
Optimum Moisture Content (%)	15.5		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.85		
Field Moisture Content (%)	15.5		
Moisture Content at Placement (%)	15.5		
Moisture Content Top 30mm (%)	16.4		
Moisture Content Rest of Sample (%)	15.6		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	187.9		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	38		
Plastic Limit (%)	16		
Plasticity Index (%)	**22**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	11.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	15.5

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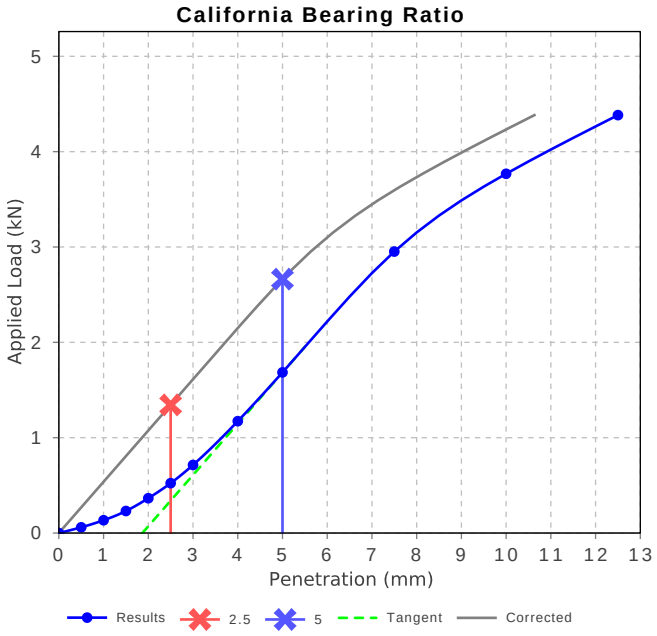
Issue Number: 1
Date Issued: 16/06/2021
Client: Colliers International Pty Ltd
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866E
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 11/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP22 (0.9-1.2m)**
Material: Silty CLAY/Clayey SILT CL-CI: low to medium plasticity, pale brown and pale grey

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**13.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.87		
Optimum Moisture Content (%)	14.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	99.5		
Dry Density after Soaking (t/m^3)	1.86		
Field Moisture Content (%)	17.2		
Moisture Content at Placement (%)	13.8		
Moisture Content Top 30mm (%)	14.5		
Moisture Content Rest of Sample (%)	14.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	122		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



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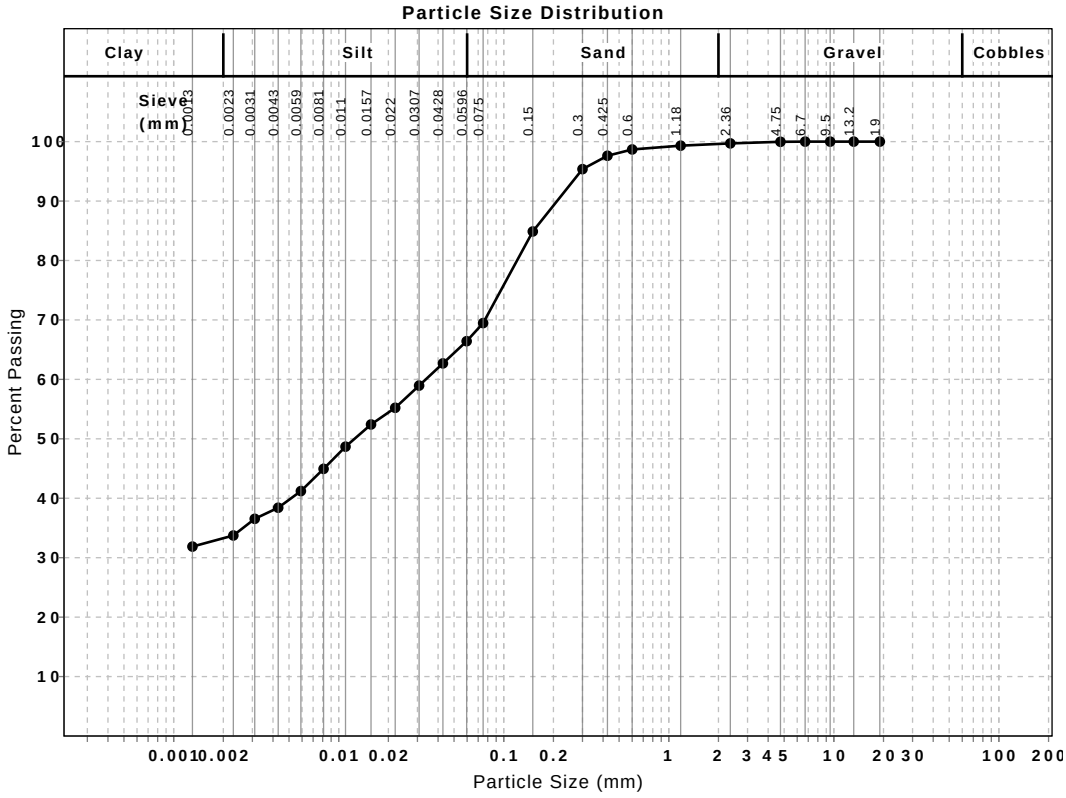
Report Number:	**204635.00-1**
Issue Number:	1
Date Issued:	16/06/2021
Client:	Colliers International Pty Ltd
	Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact:	Scott Anderson
Project Number:	204635.00
Project Name:	Proposed Helicoper Facility
Project Location:	100-275 Old Castlereagh Road, Penrith,
Work Request:	7866
Sample Number:	SY-7866F
Date Sampled:	19/05/2021
Dates Tested:	26/05/2021 - 31/05/2021
Sampling Method:	Sampled by Engineering Department
	The results apply to the sample as received
Sample Location:	**TP22 (1.5m)**
Material:	Sandy Clayey SILT: pale brown and pale grey

Fine Analysis using a Hydrometer (AS 1289 3.6.3)	
Method of Dispersion	Mechanical Device
Loss in Pretreatment	-

Particle Size Distribution (AS 1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**100**		
6.7 mm	**100**		
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**99**		
0.6 mm	**99**		
0.425 mm	**98**		
0.3 mm	**95**		
0.15 mm	**85**		
0.075 mm	**69**		

Fine Analysis Using a Hydrometer (AS 1289 3.6.3)	
Particle Size (mm)	Passed %
0.0596	**66.4**
0.0428	**62.7**
0.0307	**59.0**
0.0220	**55.2**
0.0157	**52.4**
0.0110	**48.7**
0.0081	**44.9**
0.0059	**41.2**
0.0043	**38.4**
0.0031	**36.5**
0.0023	**33.7**
0.0013	**31.9**



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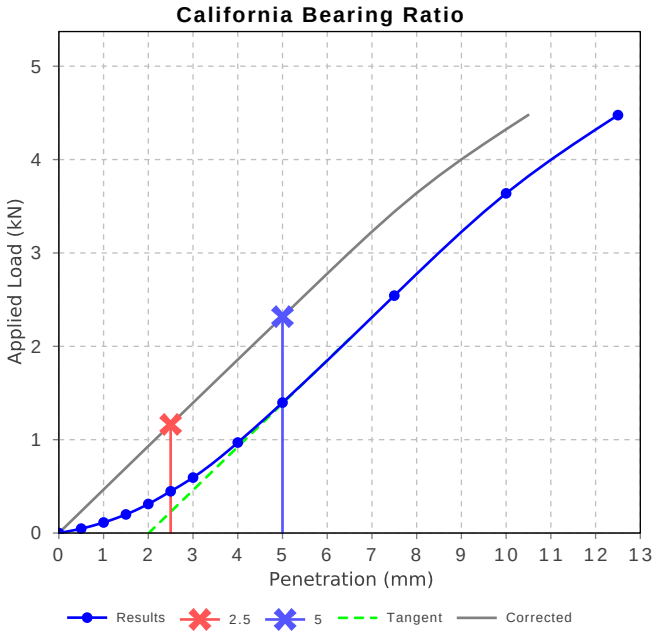
Client: Colliers International Pty Ltd
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866G
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 08/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP23 (0.5-1.0m)**
Material: Silty CLAY CL-CI: low to medium plasticity, brown, trace fine to medium sand

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**12.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.87		
Optimum Moisture Content (%)	13.5		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	97.0		
Dry Density after Soaking (t/m^3)	1.88		
Field Moisture Content (%)	9.8		
Moisture Content at Placement (%)	13.1		
Moisture Content Top 30mm (%)	15.2		
Moisture Content Rest of Sample (%)	13.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	192.3		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		
Placement moisture taken using AS1289.2.1.2			



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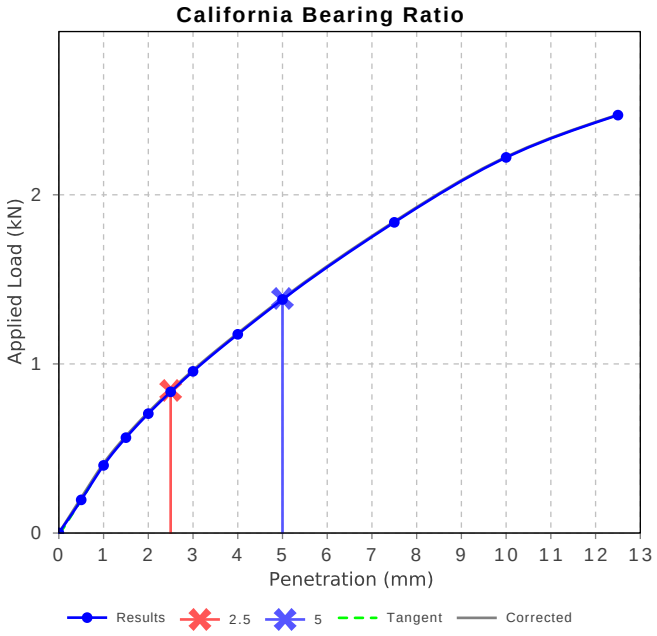
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866H
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 08/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP24 , Depth: 0.5-1.0m**
Material: Silty CLAY CL-CI: low to medium plasticity, brown mottled pale grey

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**7.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.86		
Optimum Moisture Content (%)	15.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	101.5		
Dry Density after Soaking (t/m^3)	1.86		
Field Moisture Content (%)	14.3		
Moisture Content at Placement (%)	15.1		
Moisture Content Top 30mm (%)	16.3		
Moisture Content Rest of Sample (%)	16.1		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	187.4		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		
Placement moisture taken using AS1289.2.1.2			

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	38		
Plastic Limit (%)	16		
Plasticity Index (%)	**22**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	11.5		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	14.2



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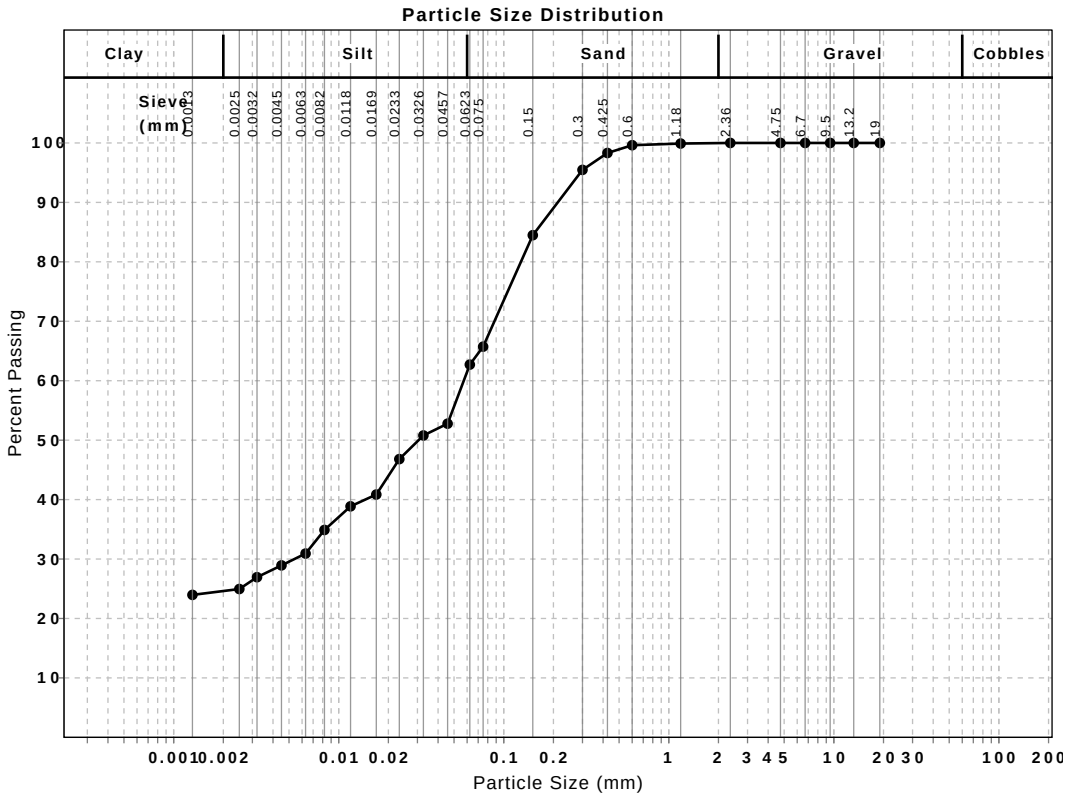
Client: Colliers International Pty Ltd
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866I
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 31/05/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP24 (2.5m)**
Material: Sandy Clayey SILT: low to medium plasticity, pale grey mottled brown

Fine Analysis using a Hydrometer (AS 1289 3.6.3)	
Method of Dispersion	Mechanical Device
Loss in Pretreatment	-

Particle Size Distribution (AS 1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**100**		
6.7 mm	**100**		
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**100**		
0.6 mm	**100**		
0.425 mm	**98**		
0.3 mm	**95**		
0.15 mm	**84**		
0.075 mm	**66**		

Fine Analysis Using a Hydrometer (AS 1289 3.6.3)	
Particle Size (mm)	Passed %
0.0623	**62.7**
0.0457	**52.8**
0.0326	**50.8**
0.0233	**46.8**
0.0169	**40.9**
0.0118	**38.9**
0.0082	**34.9**
0.0063	**30.9**
0.0045	**28.9**
0.0032	**26.9**
0.0025	**25.0**
0.0013	**24.0**



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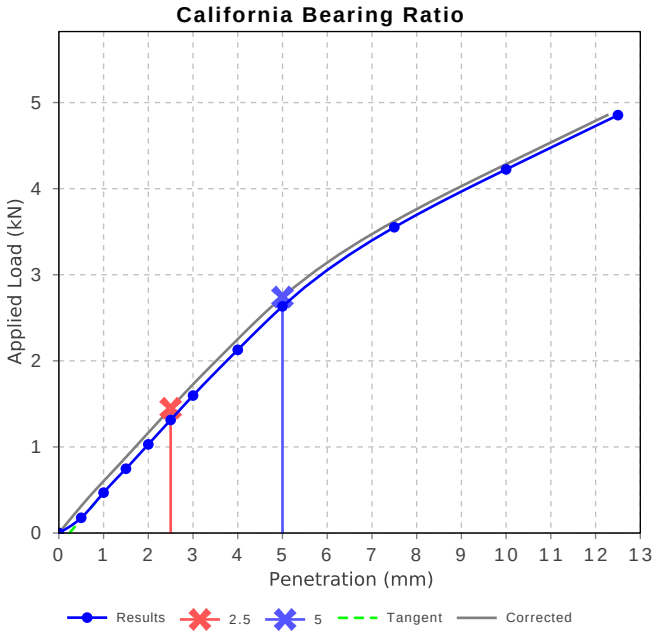
Approved Signatory: Andrew Hutchings
Laboratory Manager
Laboratory Accreditation Number: 828

Report Number: **204635.00-1**
Issue Number: 1
Date Issued: 16/06/2021
Client: Colliers International Pty Ltd
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866J
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 08/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP26 , Depth: 0.8-1.2m**
Material: Silty CLAY CL-CI: low to medium plasticity, grey and dark grey mottled brown, with rootlets

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**14.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.79		
Optimum Moisture Content (%)	15.5		
Laboratory Density Ratio (%)	100.5		
Laboratory Moisture Ratio (%)	96.0		
Dry Density after Soaking (t/m^3)	1.79		
Field Moisture Content (%)	15.7		
Moisture Content at Placement (%)	14.7		
Moisture Content Top 30mm (%)	17.2		
Moisture Content Rest of Sample (%)	16.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	192.1		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	24		
Plastic Limit (%)	18		
Plasticity Index (%)	**6**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	5.5		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	15.9

Material Test Report

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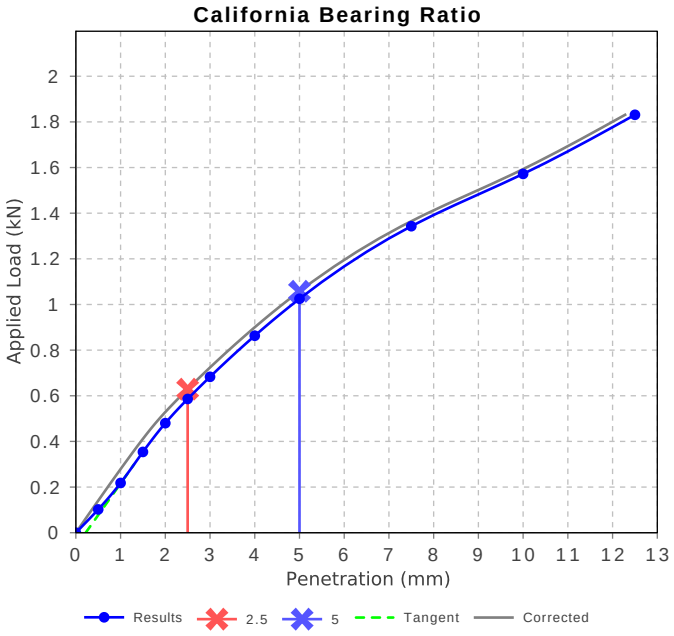
Client: Colliers International Pty Ltd
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866K
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 11/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP27 (1.1-1.4m)**
Material: Silty CLAY: pale grey mottled brown and grey, with dark grey silty clay layers, trace medium to coarse, high strength, rounded and sub-rounded river gravel and cobbles (up to 150mm)

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**5.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Visual Assessment		
Maximum Dry Density (t/m^3)	1.86		
Optimum Moisture Content (%)	16.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	102.0		
Dry Density after Soaking (t/m^3)	1.85		
Field Moisture Content (%)	13.7		
Moisture Content at Placement (%)	16.3		
Moisture Content Top 30mm (%)	17.2		
Moisture Content Rest of Sample (%)	20.4		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	264.1		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0		



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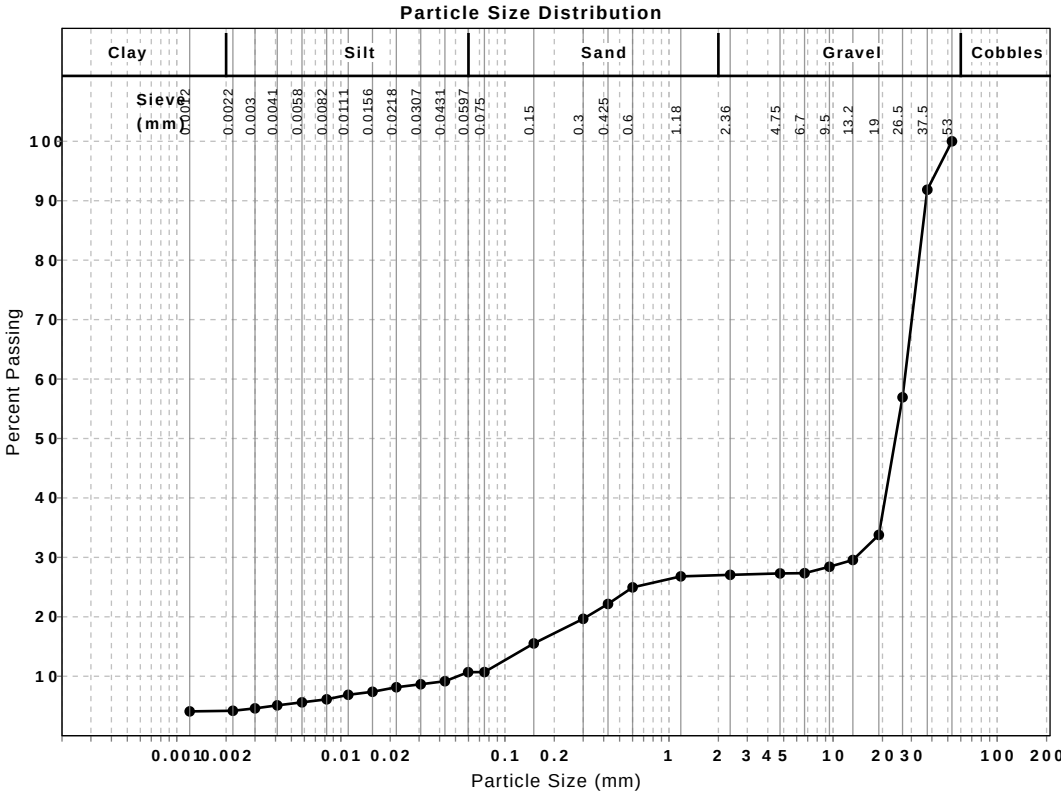
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866L
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 01/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP29 (2.0m)**
Material: GRAVEL GW: rounded and sub-rounded river gravel and cobbles (up to 150mm), with red-brown and brown sand and silt, and trace clay

Fine Analysis using a Hydrometer (AS 1289 3.6.3)	
Method of Dispersion	Mechanical Device
Loss in Pretreatment	-

Particle Size Distribution (AS 1289 3.6.1)			
Sieve	Passed %	Passing Limits	
53 mm	**100**		
37.5 mm	**92**		
26.5 mm	**57**		
19 mm	**34**		
13.2 mm	**30**		
9.5 mm	**28**		
6.7 mm	**27**		
4.75 mm	**27**		
2.36 mm	**27**		
1.18 mm	**27**		
0.6 mm	**25**		
0.425 mm	**22**		
0.3 mm	**20**		
0.15 mm	**16**		
0.075 mm	**11**		

Fine Analysis Using a Hydrometer (AS 1289 3.6.3)	
Particle Size (mm)	Passed %
0.0597	**10.7**
0.0431	**9.2**
0.0307	**8.7**
0.0218	**8.1**
0.0156	**7.4**
0.0111	**6.9**
0.0082	**6.1**
0.0058	**5.6**
0.0041	**5.1**
0.0030	**4.6**
0.0022	**4.2**
0.0012	**4.1**



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Report Number: **204635.00-1**
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Client: Colliers International Pty Ltd
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866M
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 02/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP29 , Depth: 1.4-1.5m**
Material: Silty CLAY CL-CI: low to medium plasticity, red-brown mottled brown and grey, with fine to medium sand

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	34		
Plastic Limit (%)	15		
Plasticity Index (%)	**19**		

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

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	11.3

Material Test Report

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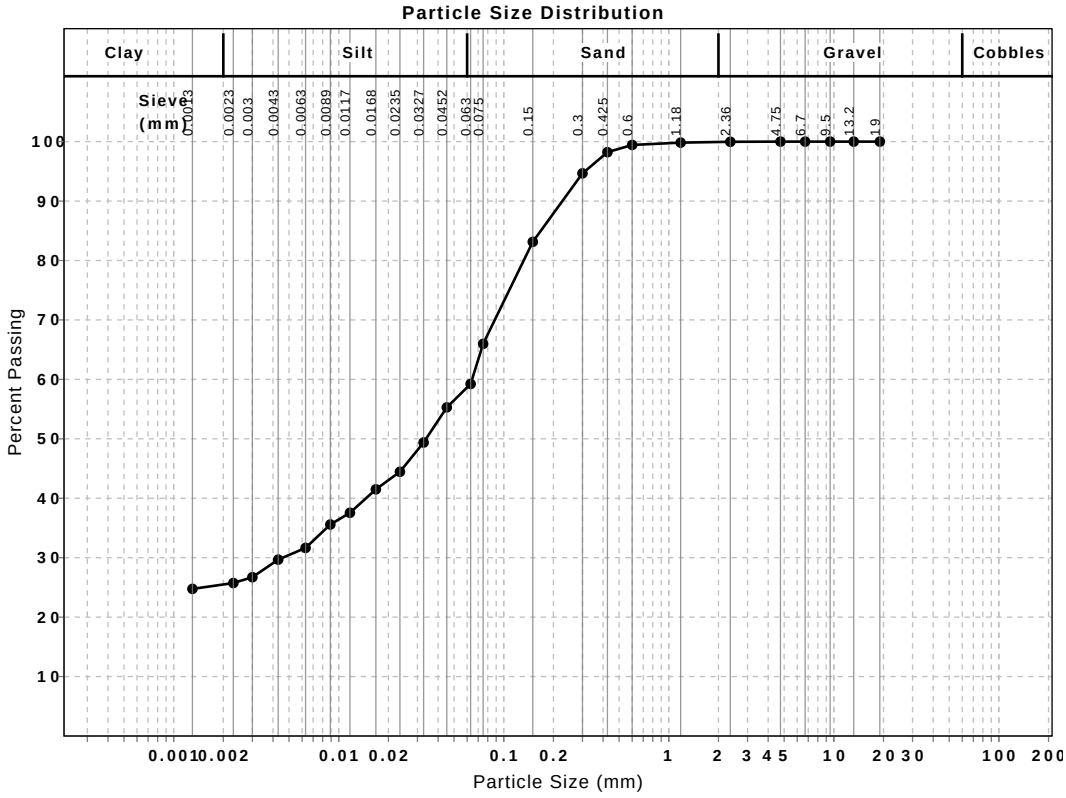
Level 30, Grosvenor Place, SYDNEY NSW 2000
Contact: Scott Anderson
Project Number: 204635.00
Project Name: Proposed Helicoper Facility
Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Sample Number: SY-7866N
Date Sampled: 19/05/2021
Dates Tested: 26/05/2021 - 02/06/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: **TP30 (2-2.1m)**
Material: Sandy Clayey Slit: red-brown mottled brown and grey

Fine Analysis using a Hydrometer (AS 1289 3.6.3)	
Method of Dispersion	Mechanical Device
Loss in Pretreatment	-

Particle Size Distribution (AS 1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**100**		
6.7 mm	**100**		
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**100**		
0.6 mm	**99**		
0.425 mm	**98**		
0.3 mm	**95**		
0.15 mm	**83**		
0.075 mm	**66**		

Fine Analysis Using a Hydrometer (AS 1289 3.6.3)	
Particle Size (mm)	Passed %
0.0630	**59.2**
0.0452	**55.3**
0.0327	**49.4**
0.0235	**44.5**
0.0168	**41.5**
0.0117	**37.6**
0.0089	**35.6**
0.0063	**31.6**
0.0043	**29.7**
0.0030	**26.7**
0.0023	**25.7**
0.0013	**24.7**



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Project Location: 100-275 Old Castlereagh Road, Penrith,
Work Request: 7866
Dates Tested: 26/05/2021 - 31/05/2021

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Moisture Content AS 1289 2.1.1			
Sample Number	Sample Location	Moisture Content (%)	Material
SY-7866A	TP17 , Depth: 0.5-0.8m	19.3 %	Silty CLAY CL-CI: pale grey mottled grey and brown, with high strength, medium to coarse, rounded and sub-rounded river gravel and cobbles (up to 200mm)
SY-7866D	TP21 , Depth: 1.0 -1.5m	15.5 %	Silty CLAY CL-CI: low to medium plasticity, red-brown
SY-7866H	TP24 , Depth: 0.5-1.0m	14.2 %	Silty CLAY CL-CI: low to medium plasticity, brown mottled pale grey
SY-7866J	TP26 , Depth: 0.8-1.2m	15.9 %	Silty CLAY CL-CI: low to medium plasticity, grey and dark grey mottled brown, with rootlets
SY-7866M	TP29 , Depth: 1.4-1.5m	11.3 %	Silty CLAY CL-CI: low to medium plasticity, red-brown mottled brown and grey, with fine to medium sand

Appendix E

Historical Data

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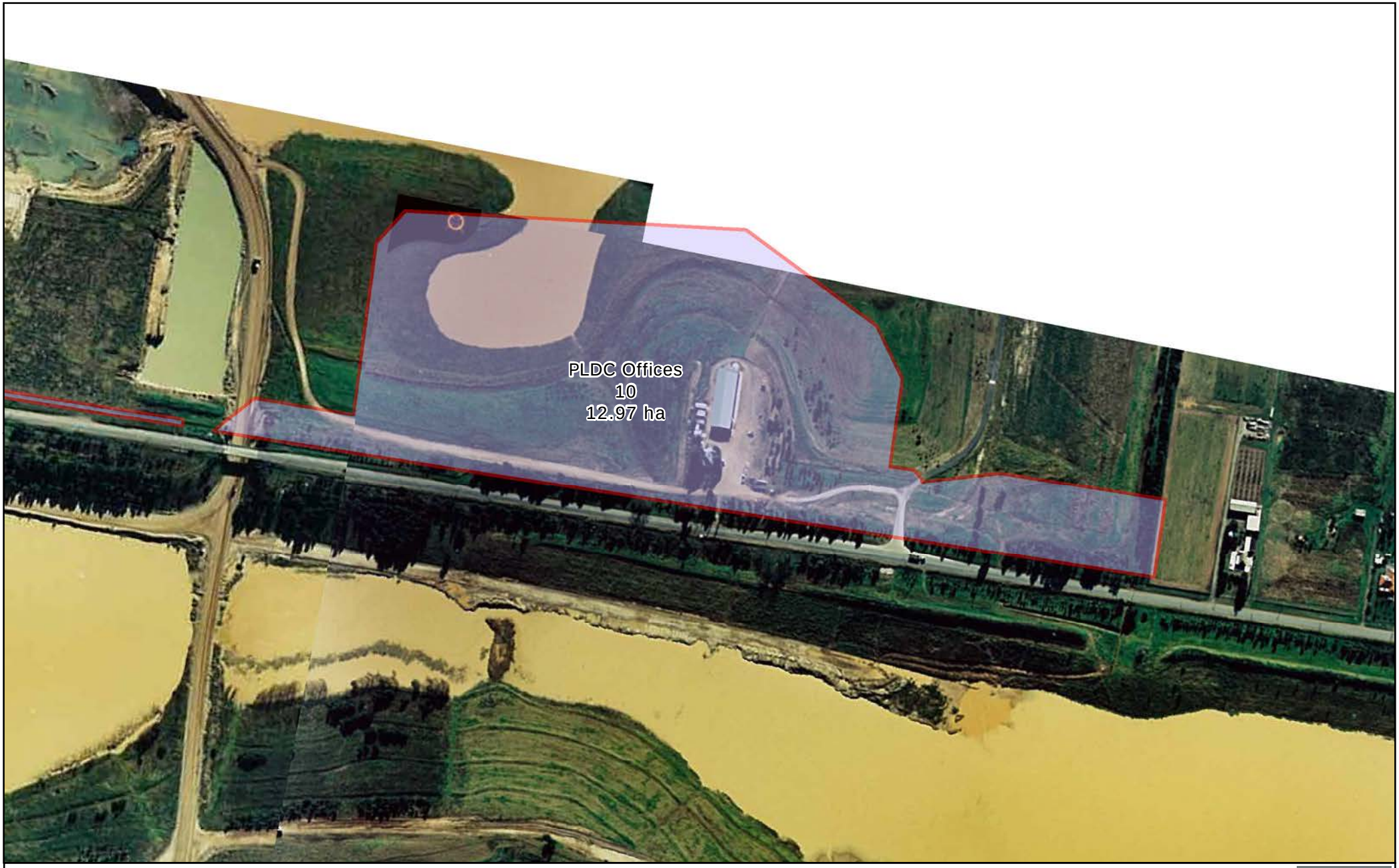

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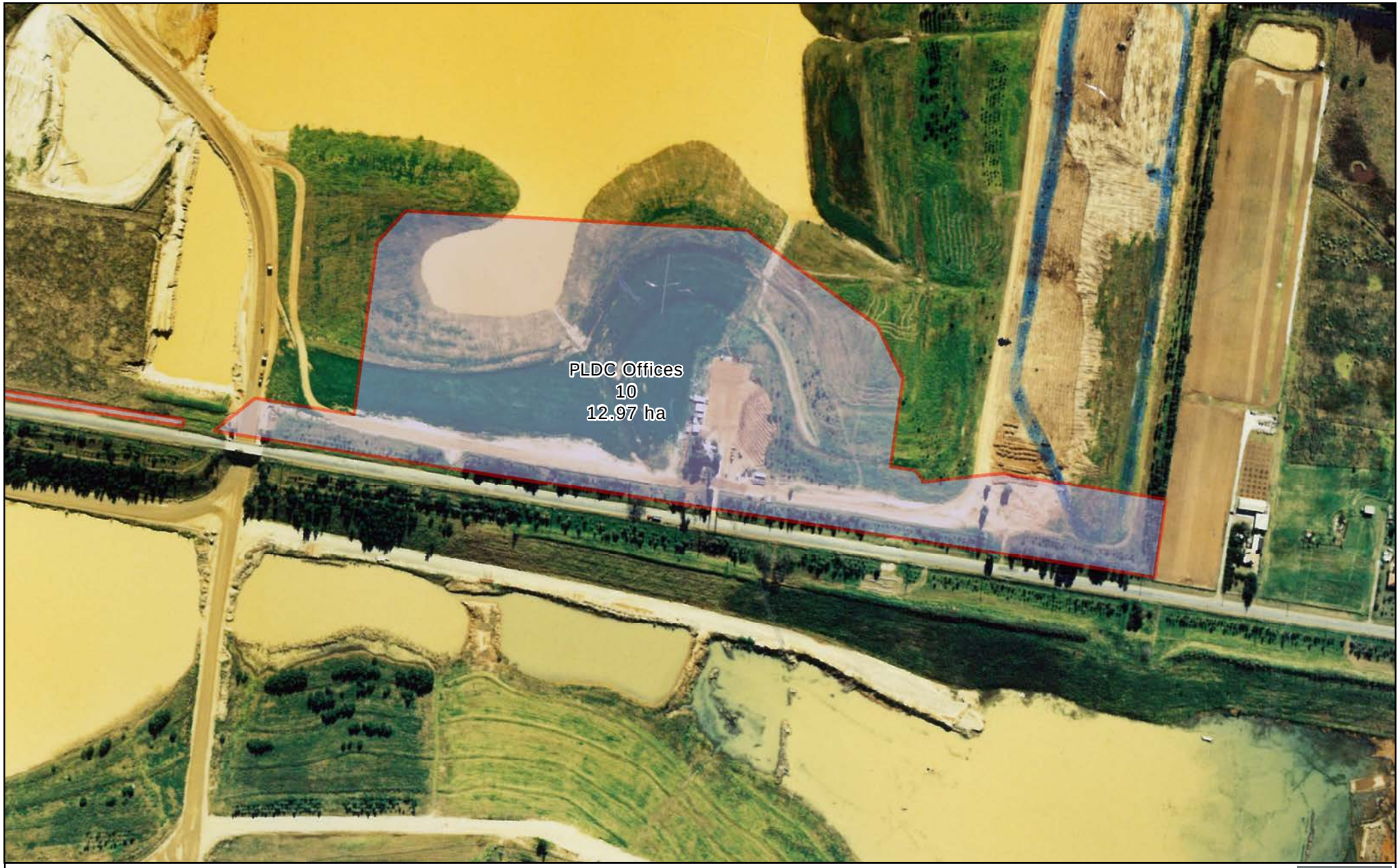

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