GEOTECHNICAL SITE INVESTIGATION REPORT

FOR

PROPOSED EXTENSION

AT

59 CUTLER ROAD, CLONTARF NSW 2093

Report Prepared for: MS JEI CHEN

Project No: SRE/279/CT/17

Date: 25/01/2018

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The undersigned, on behalf of Soilsrock Engineering Pty Ltd, confirm that this document and all attached documents, drawings, and geotechnical results have been checked and reviewed for errors, omissions and inaccuracies.

For and on behalf of

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APPENDICES

1. INTRODUCTION

This document presents the results of a geotechnical investigation carried out by Soilsrock Engineering Pty Ltd (SOILSROCK) for a proposed additional second floor level on top of existing two storey residential house, and alterations and additions to the existing ground-floor and first-floor level.

The investigation was commissioned on 6th December 2017 by Ms. Jei Chen the owner of the proposed dwelling at 59 Cutler Road, Clontarf NSW 2093. The work was conducted in general accordance with the email confirmation of 6th December 2017.

The present report assessment comprised a detailed geotechnical inspection of the property and is based on the documents supplied by YU CACHIA Design & Construction:

- Structural Drawings – "Existing Site", Drawing No. A101; "Existing Ground Floor Plan", Drawing No. A102; "Existing Second Floor Plan", Drawing No. A103; "Demolition of Existing Ground Floor Plan", Drawing No. A104; "Demolition of Existing First Floor Plan", Drawing No. A105; Project No. 0048R, dated 11th Dec 2017, by YU CACHIA;
- Structural Drawings – "Site", Drawing No. A106; "Ground Floor Plan", Drawing No. A107; "First Floor Plan", Drawing No. A108; "Second Floor Plan", Drawing No. A109; "Elevations", Drawing No. A110; "Shadow Sep 22nd 9am", Drawing No. A111; "Shadow Sep 22nd 12noon", Drawing No. A112; "Shadow Sep 22nd 3pm", Drawing No. A113; dated 26th Oct 2017, Project No. 0048R, by YU CACHIA;

This report was prepared to be included in the submission for a Development Application for alterations and additions to the existing building to comply with Northern Beaches Council – Manly.

The purpose of this investigation was to assess the geotechnical subsurface conditions to provide geotechnical recommendations and advice on foundations conditions and design for the proposed development.

The following sections describe the proposed development, scope of works and factual results of the investigation. Comments and recommendations on subsurface conditions, excavation and foundations conditions are given in the second part of the report.

2. PROPOSED DEVELOPMENT

Based on the drawings provided mentioned above it is understood that the walls in the north and west portion of ground-level and first floor will be demolished to construct an extension to both floors, and a second floor on top of the existing two storey house with light structural materials. The new ground floor contains a garage, a cinema, a wine cellar, a laundry room, and a toilet. The first level is proposed to be constructed with a living area, four bedrooms, and a butler's kitchen. The proposed additional second floor level on top of the existing house contains a retreat, a master room and a balcony.

Shallow excavations will be necessary to undertake to construct new footings for the extension of the ground floor level, and if necessary reinforcement/underpinning of the existing footings considering the new extension structure proposed to be constructed on top of the existing foundations depending on the structural design loads considered.

3. SCOPE OF WORKS

The field work for investigation was carried on the 18th December 2017 and consisted of the following:

- Conduct an OH&S and walkover survey to assess local topography, geology, hydrology and existing site conditions, including exposed soil/rock conditions and surface drainage;
- Photographic record of the site conditions;
- Conducted a detailed geotechnical inspection of the site area and adjacent land;
- 4 x Dynamic Cone Penetrometer tests (DCP1 to DCP4) to maximum depth 3.6m were carried out by using a 9kg Dynamic Cone Penetrometer specialised steel cone device. The testing did follow the procedure as per AS 1289.0-2000, method 6.3.2;
- 1 hand auger borehole carried at the same location of the DCP1 to confirm soils materials in situ.

The field work was conducted and supervised in the full-time presence of a senior geotechnical professional engineer and two geotechnical engineering assistants from SOILSROCK office, who carried the testing in-situ and recorded the results. The DCP tests were carried only in areas which was not covered by the existing concrete slab, at locations where surface soils where available to avoid to cut and remove at this stage the existing concrete slab and carry major excavation works.

4. SITE LOCATION AND DESCRIPTION

The subjected site is located in a residential area at 59 Cutler Road, Clontarf NSW 2093 (Lot 29 DP 25654) with total land area approximately 600.7m^2. It is delimited by residential houses No. 57, and No. 61 at East and South respectively.

The front entrance area of the existing residence house is a driveway covered by concrete pavement and at the very front a timber gate joined by a fence of timber strips is provided as a boundary to separate the main road from the residence.

The building neighbours all appeared to be in good conditions, based on a visual cursory inspection from the subjected site and surrounding street, no signs of ground movements or instability were found at the time of the inspection.

Site location is shown in Appendix B and photographs of the area are attached to this report in Appendix D.

5. REGIONAL GEOLOGY

Reference to the Geological Map of Sydney it is indicated that the site is underlain by Hawkesbury Sandstone (*Rh*), described as "*medium to coarse-grained quartz sandstone, very minor shale and laminate lenses".*

A reproduction of the geological map is shown on following Figure no. 1 and is based on a portion of the Sydney 1:100,000 Geological Series Map 9130 (Interactive Resource provided by the Geological Survey of NSW).

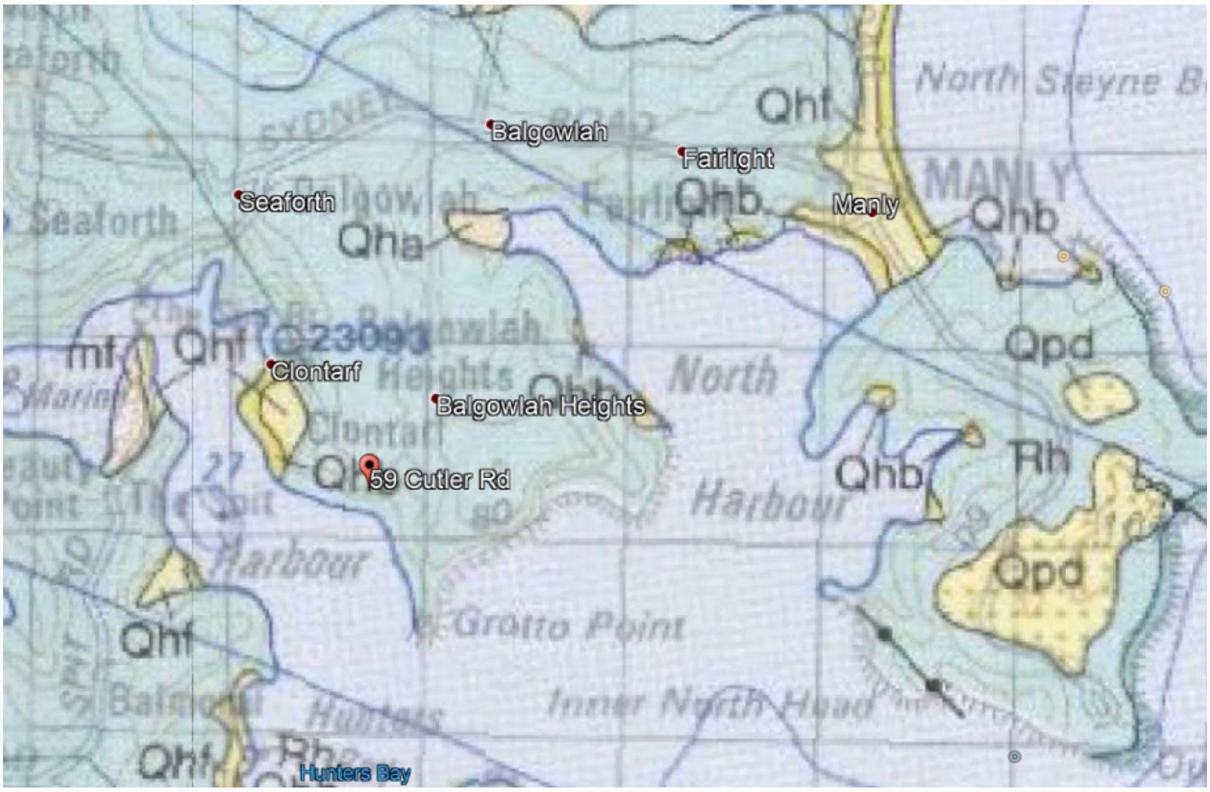

Figure No. 1– Portion of the Sydney 1:100,000 Geological Series map 9130. Site area location highlighted in red/black signal.

6. RESULTS AND ANALYSIS OF THE INVESTIGATION

6.1 Subsurface Investigation

The table no. 1 presents the in-situ DCP test results and table no. 2 describes generically the principle strata sequentially observed and interpreted by the test results carried out on site.

Table No. 1 – Dynamic Cone Penetrometer tests results.

Depth (m)	DCP1 (Blows/ 300mm)	DCP2* (Blows/ 300mm)	DCP3* (Blows/ 300mm)	DCP4 (Blows/ 300mm)
0.0-0.3	28	5	7	13
0.3-0.6	13	23	10	17
0.6-0.9	3**	15	9	40
0.9-1.2	9	40	22	45
1.2-1.5	11	60 Refusal @ 1.35m	60	48
1.5-1.8	3**	-	-	29
1.8-2.1	5**	-	-	80 Refusal @ 2.0m
2.1-2.4	29	-	-	-
2.4-2.7	2**	-	-	-
2.7-3.0	5**	-	-	-
3.0-3.3	23	-	-	-
3.3-3.6	60 Refusal @ 3.6m	-	-	-

Equipment & Procedure Notes:

- Equipment used: 9kg hammer, 510mm drop distance, conical tip: Standard used: AS1289.6.3.2 - 1997; the total number of blows are considered for 300mm penetration steps.

DCP Notes

- *DCP test was carried in the gardening area, which is approximately 1.02m above the concrete pavement driveway;
- ** Void detected at this depth.

Table No. 2 – Geotechnical subsurface interpretation by DCP results

<table>
<tr><th>Depth[1] (m)</th><th>DCP1[4]</th><th>DCP2[1]</th><th>DCP3[1]</th><th>DCP4</th></tr>
<tr><td>0.0-0.3</td><td>Dense Silt</td><td>Loose Silt</td><td>Loose Silt</td><td rowspan="2">Medium Dense Silt</td></tr>
<tr><td>0.3-0.6</td><td>Medium Dense Silt</td><td>Medium Dense Silt</td><td>Medium Dense Silt</td></tr>
<tr><td>0.6-0.9</td><td>Very Loose Silty Sand[2]</td><td>Medium Dense Silty Sand</td><td>Loose Silty Sand</td><td rowspan="2">Dense Silty Sand</td></tr>
<tr><td>0.9-1.2</td><td>Loose Silty Sand[2]</td><td>Dense Silty Sand</td><td>Medium Dense Silty Sand</td></tr>
<tr><td>1.2-1.5</td><td>Medium Dense Silty Sand[3]</td><td>Very Dense Silty Sand (Probably on top of rock at 1.35m)</td><td>Very Dense Silty Sand</td><td>Very Dense Silty Sand</td></tr>
<tr><td>1.5-1.8</td><td>Very Loose Silty Sand[2]</td><td>-</td><td>-</td><td>Dense Silty Sand</td></tr>
<tr><td>1.8-2.1</td><td>Loose Silty Sand[2]</td><td>-</td><td>-</td><td>Very Dense Silty Sand (Probably on top of rock at 2.0m)</td></tr>
<tr><td>2.1-2.4</td><td>Dense Silty Sand[3]</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2.4-2.7</td><td>Very Loose Silty Sand[2]</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2.7-3.0</td><td>Loose Silty Sand[2]</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>3.0-3.3</td><td>Medium Dense Silty Sand</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>3.3-3.6</td><td>Very Dense Silty Sand</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Notes:

- [1]DCP test was carried in the gardening area, which is 1.02m above the concrete pavement driveway.
- [2] Void detected at this depth.
- [3] Probably boulders or underground obstacles detected at this depth due to high DCP blow numbers.
- [4] DCP 1 is probably located at the boundary of a rock mass due to the face that void region presents underneath.

As a result, the table no. 3 below assesses the strength of the relevant materials crossed by the DCP tests, based in situ tests results, soil classification, visual interpretation and extrapolation. For detailed description of the subsurface conditions, explanation sheets about geotechnical parameters are presented in Appendix A.

Table No. 3 – Allowable Bearing Pressure and Strength Interpreted and Extrapolated by test in situ.

Depth Range* (m)	Material Conditions	Extrapolated Bearing Pressure (kPa)	Strength (Cu / UCS - kPa)
0.60-2.70	Very Loose Silty Sand	NR	NR
0.00-3.00	Loose Silty Sand/Silt	50	Cu = 25
0.00-3.30	Medium Dense Silty Sand/Silt	150	Cu = 75
0.00-2.40	Dense Silty Sand/Silt	300	Cu=150
1.20-3.30	Very Dense Silty Sand	500	Cu = 250
1.35-3.60	Top Rock – Sandstone	1,000	UCS = 1,000

Notes:

- * DCP2 and DCP3 were carried in the gardening area; The depth range above are taken down from the presenting level of each test location;
- Top rock material identification, extrapolated bearing pressures and strength values are only indicative, these will need to be properly confirmed in further investigations by diamond rock core drilling samples testing if required;
- The geotechnical parameters interpretation and extrapolation is based and limited to the DCP test carried on site, which are only indicative for design proposes;
- NR is considered not recommended.

6.2 Groundwater

Groundwater was not observed during the Dynamic Cone Penetration tests. The materials attached on the DCP rods and conical tip when extracted were dry.

7. COMMENTS AND RECOMMENDATIONS

7.1 Excavation Conditions

To construct the proposed extension, shallow excavations for new footings construction and reinforce or underpinning the existing footings could be required to be undertaken to maximum 1.0m deep depending on the structural loads considered by the design to support the new extension structure. However, piles depth excavation could range from 2.0-3.6m deep depending also of the structural loads considered within the final design. Based on the in-situ testing carried out, the overall excavation it is expected to intersect very loose to very dense silty sands materials.

It is recommended during the excavation works the use of mini excavators equipped with bucket. It is not expected excavation for footings to be undertake within rock materials. Pile construction could be carried by conventional auger drilling or screw pile installation.

In addition, all excavated materials will need to be disposed in accordance with NSW Environment Protection Authority (EPA) Waste Classification Guidelines Nov 2014, and under the protection of the Environment Operations Act 1997 (POEO Act).

A waste/fill receiving site must be satisfied that materials meet the environmental criteria for proposed land use. This includes filling and excavated natural materials (GSW/VENM/ENM), such as may be removed from site. Accordingly, environmental testing will need to be carried out to classify spoil prior to disposal. The type and extent of testing undertaken will depend on the final use or destination of the spoil, and requirements of the site. Soilsrock Engineering can carry these works if required.

7.2 Foundations – Footings and Slabs

Further to the results above, its concluded that the founding materials depth and conditions varies along the site.

The areas located at East side of the site where the existing building structure is located, probably indicates the existing foundations footings are on top of suitable foundation materials (very dense sand or top of rock) for the present light structural proposed extension, since DCP2 and DCP3 reached refusal at very shallow depths range 0.33-0.48m.

To confirm the foundation materials conditions of the existing footings, where additional loads would be added because of the construction of the proposed extension structure, it is recommended to open pit tests to visualise the depth of the existing footings and confirm allowable bearing pressures of the foundation materials at that specific locations at the start of the construction works. Depending on the results of this work, that would determine the need to reinforce the existing footings and/or underpinning.

The areas located at the West side of the site away from the existing building surrounding the existing concrete driveway and patio, the DCP tests reached refusal probably on top of rock at 2.0m deep at DCP4, and 3.6m on top of very dense sand at DCP1.

For new footings construction at the West side of the site, it is recommended to carry deep footings or a piled footing system by screw piles or CFA piles (Continuous Flight Auger). Depending on the structural loads of the residence, the screw piles option could be more cost effective when comparing with CFA piles, since will not produce spoil waste, is faster to install, don't require pre-excavations prior screw piles installation, and don't present any installation issues when groundwater is present. Founding depths for piles it is expected to be at range of 2-3.6m deep depending on the type of foundation design and loads considered within the structural design.

Once the structural loads and footing and/or piles sizes have been determined, settlements analyses should be carried out to confirm the suitability of the foundations solution adopted.

All footings/piles excavations should have their base clean and free of any loose material prior to pouring to avoid any potential future settlements due to any unappropriated concrete pour.

Also, the end bearing ground pressures should be checked and confirmed on site by a qualified experienced Geotechnical Engineer prior concrete pour during construction works.

Time between footing excavation and concrete pour must be kept to the minimum, if delays are anticipated, it is recommended that the base of the footings be protected with a blinding layer of concrete with minimum strength of 25Mpa.

If slab-on-grade construction is design for the garage ground level floor slab, and according with the materials encountered after removal of the existing concrete pavement/driveway, subgrade preparation maybe could be required. The subgrade must be well compacted by granular course material with soils contain less than 20% by mass of particles coarser than 37.5mm after field compaction. The subgrade layers should be compacted using a vibratory plate or roller to target density ratio of 98% of SMDD. Density/compaction tests should be carried out to confirm the above specification has been achieved.

Above the well compacted subgrade materials a subbase granular course material layer with minimum 150mm thick by crushed concrete or crushed sandstone (DGB20 or similar) should be installed. Subbase layers should be also compacted using the same compaction methods described above.

If the existing concrete pavement it's not removed, the above specifications are not required.

7.3 Engineering Fill

If filling is required shall be placed in a controlled and engineered fill, well compacted by a vibrating plate or vibrating roller in layers not more than 0.3m is deemed to be controlled fill as per AS2870-2011. The engineered fill should be carried comprising 'clean' sandy soils, free of organic matter. The engineered fill should be placed in a controlled and engineered manner compacted using a vibrating plate compactor and/or trench roller in layers not more than 150mm for non-sand materials not containing gravel-sized, or not more than 300mm for sand materials for controlled fill following AS2870-2011. Compaction should achieve minimum density index (ID) of 70%, to be proof tested by “DCP” tests Dynamic Cone Penetrometer with a blow count of 7 or more per 300mm layers as described in AS1289.6.3.3.

7.4 Final Comments

Following the above, further geotechnical input is required at the start of the construction works and summarised as follow:

- Carry pit tests at the start of the construction works on the existing footings location to determine the depth of the footings and allowable bearing pressures of its foundation materials, to confirm if reinforcement or underpinning it will be necessary to undertake.
- Carry Geotechnical site inspections during construction of footings/piles to confirm ground bearing pressures and approve the founding levels.
- Density tests to control all engineered fill material.
- Geotechnical site inspections and compaction tests to confirm density targets for subgrade and subbase preparation below slab-on-grade if required.

Further to the results of the investigations, and geotechnical recommendations above, providing the works are carried accordingly with this report, experienced qualified professional geotechnical engineer inspect the site to approve the founding levels and carry proper in situ tests, and good engineering and building construction practice is maintained the proposed development is suitable for the site.

Regarding the soils and rock depths with the geotechnical bearing capacities recommended above could vary across the site, the founding depth for foundations and geotechnical conditions for excavation support to be constructed could also vary. Therefore, it is recommended, an experienced professional and qualified geotechnical engineer inspect and testing the site from the start of the excavation/underpinning works and foundations installation, to approve the founding levels.

8. LIMITATIONS

The site geotechnical investigation undertaken for the present report is an estimate and interpretation of the characteristics of the soil and rock of subsurface conditions encountered during the test locations investigated. No matter how comprehensive the investigation is, site ground conditions in other test locations investigated can differ and geological conditions can be unpredictable or can reveal unforeseen conditions.

This present report analyses and forms an engineering model interpretation and opinion of the actual subsurface conditions of the points where the tests were carried. The selected in-situ tests results are indicative of actual conditions encountered. Recommendations are given based on the data testing results and visual interpretation carried by professional geotechnical and geological engineers from this office. Interpretation of the present report by others may differ from the interpretation given, there is the risk the report may be misinterpreted and Soilsrock cannot be held responsible for this.

Geotechnical reports rely on factual interpreted and judgement of information based on professional visual interpretation of soils and rock samples, in situ tests and sampling tests, which has some uncertainty due to changing unexpected ground conditions and it is far less exact than other design disciplines. Soilsrock Engineering accepts no responsibility if different unexpected ground conditions occur in locations where the investigations were not carried out.

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APPENDIX A

Geotechnical Explanatory Notes

GEOTECHNICAL EXPLANATORY NOTES

The following geotechnical notes are provided, to give a better understanding of the description and classification methods and field procedures used for the interpretation and compilation of this report which is entirely based on the AS 1726-1993 – Geotechnical Investigations.

INVESTIGATIONS METHODS

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 3m for a backhoe and up to 6m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site. Samples can be taken from the test pits for soils testing and analyses.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 3000mm or large in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5m) 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 90-125mm 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 mixed with soils from the sides of the hole. Information from the drilling (as a 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.

Dynamic Cone Penetromer Tests

Dynamic penetrometer tests (DCP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rood penetrates the soil the number of blows required to penetrate each successive 300mm depth are recorded. Normally there is a depth limitation of 1.2m, but this may be extended in certain conditions by the use of extension rods. A 16mm diameter rod with a 20mm diameter cone end is driven using a 9kg hammer dropping 510mm (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. Also Correlations with SPT tests can be made for Cohesion less and cohesive soils.

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 Proposes – Test 6.3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments equal to 450mm in total. The first 150mm increment it not considered for the so-called “N” value (standard penetration resistance), which is taken from the number of blows of the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm may not be practicable and the test will be discontinued. The results are represented in the following example:

- In the case where full penetration is obtained with successive blow counts for each 150mm as follow:
  - 1 st Increment (150mm) = 2 blows
  - 2 nd Increment (150mm) = 8 blows
  - 3 rd Increment (150mm) = 15 blows
  - Representation – 2,8,15 “N” Value = 23
- In the case where the test is discontinued before the full penetration:
  - 1 st Increment (150mm) = 20 blows
  - 2 nd Increment (100mm) = 40 blows – test interrupted
  - 3 rd Increment (150mm) = not carried – test refusal
  - Representation – 20, 40/100 mm “N” Value = 40

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

Correlation between DCP vs SPT for Cohesionless Soils

DCP (Blows/300mm)	SPT Value (Blows/300mm)	RELATIVE DENSITY
0-3	0-4	Very Loose
3-9	4-10	Loose
9-24	10-30	Medium Dense
24-45	30-50	Dense
>45	>50	Very Dense

Correlation Between DCP vs SPT for Cohesive Soils

DCP (Blows/300mm)	SPT Value (Blows/300mm)	CONSISTENCY
0-3	0-2	Very Soft
3-6	2-5	Soft
6-9	5-10	Medium/Firm
9-21	10-20	Stiff
21-36	20-40	Very Stiff
>36	>40	Hard

Continuous Diamond Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50mm 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.

Sampling

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

DESCRIPTION AND CLASSIFICATIONS METHODS FOR SOILS AND ROCK

Descriptions include strength or density, colour, structure, soil or rock type and inclusions.

SOIL DESCRIPTIONS

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	0.6 – 63
Sand	0.075 – 0.6
Silt	0.002 – 0.075
Clay	<0.002

Type	Sand & Gravel Particle size
Coarse gravel	36mm – 19mm
Medium gravel	19mm – 6.7mm
Fine gravel	6.7mm – 2.36mm
Coarse sand	2.36mm – 600µm
Medium sand	600µm – 212µm
Fine sand	212µm – 75µm

The proportions of secondary constituents of soils are described as:

Coarse grained soils		Fine grained soils	
%Fines	Modifier	%Coarse	Modifier
≤5	Omit, or use ‘trace’	≤15	Omit, or use ‘trace’
>5 - ≤12	Describe as ‘with clay/silt’ as applicable	>15 - ≤30	Describe as ‘with clay/silt’ as applicable
>12	Describe as ‘with silty/clayey’ as applicable	>30	Describe as ‘with silty/clayey’ as applicable

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 specified range;
- Uniformly graded – an excess of a particular particle size;
- Gap graded – a deficiency of a particular particle size with the range.

Cohesive Soils

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

Description	Abbreviation	Undrained shears 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

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basics 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;
- Transported soils – formed somewhere else and transported by nature to the site;
- Filling – moved by man.

Transported soils may be further subdivided into:

- Alluvium – river deposits;
- Lacustrine – lake deposits;
- Aeolian – wind deposits;
- Littoral – beach deposits;
- Estuarine – tidal river deposits;
- Talus – coarse colluvium;
- Slopwash or Colluvium – transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

ROCK DESCRIPTIONS

Rock Strength

Rock strength is defined by the Point Load Strength (Is50) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standards 1726. The terms used to describe rocks strength are as follow:

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

*Assumes a ratio of 20:1 for UCS to Is(50)

Degree of Weathering

The degree of weathering of rocks is classified as follows:

Term	Abbreviation	Description
Residual	RS	Soil developed on extremely weathered rock; the mass structure and substance are no longer evident.
Extremely weathered	XW	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrates or can be remoulded in water, but the texture of the original rock is still evident.
Distinctly weathered	DW	Staining and discolouration of rock substance has taken place.
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	No signs of decomposition or staining.

Degree of Fracturing

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

Term	Description
Fragmented	Fragments of <20mm
Highly fragmented	Core lengths of 20 – 40mm with some fragments
Fractured	Core lengths of 40 – 200mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200 – 400mm with some shorter and longer sections
Unbroken	Core lengths mostly >1000mm

Rock Quality Designation

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

$$RQD\,\% = \frac{cumulative\ length\ of\ 'sound'coresections\ \geq 100mm\ long}{total\ drilled\ lenght\ of\ section\ being\ assessed}$$

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

Rock Quality Designation

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

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

LOG SYMBOLS

Moisture Condition - Cohesive Soils:

MC > PL – Moisture content estimated to be greater than plastic limit
MC = PL - Moisture content estimated to be approximately equal to plastic limit
MC < PL - Moisture content estimated to be less than plastic limit

Moisture Condition - Cohesionless Soils:

D – Dry – Runs freely through fingers
M – Moist – Does not run freely but no free water visible on soil surface
W – Wet – Free water visible on soil surface

Strength (Consistency) - Cohesive Soils:

VS – Very Soft – Unconfined compressive strength less than 25 kPa
S – Soft – Unconfined compressive strength 25-50 kPa
F – Firm – Unconfined compressive strength 50-100 kPa
St – Stiff – Unconfined compressive strength 100-200 kPa
VSt – Very Stiff – Unconfined compressive strength 200-400 kPa
H – Hard - Unconfined compressive strength greater than 400 kPa

Density Index/Relative Density - Cohesionless Soils

Symbol	Density Index (ID)	Range %	SPT “N” Value Range (Blows/300mm)
VL	Very Loose	<15	0-4
L	Loose	15-35	4-10
MD	Medium Dense	35-65	10-30
D	Dense	65-85	30-50
VD	Very Dense	>85	>50

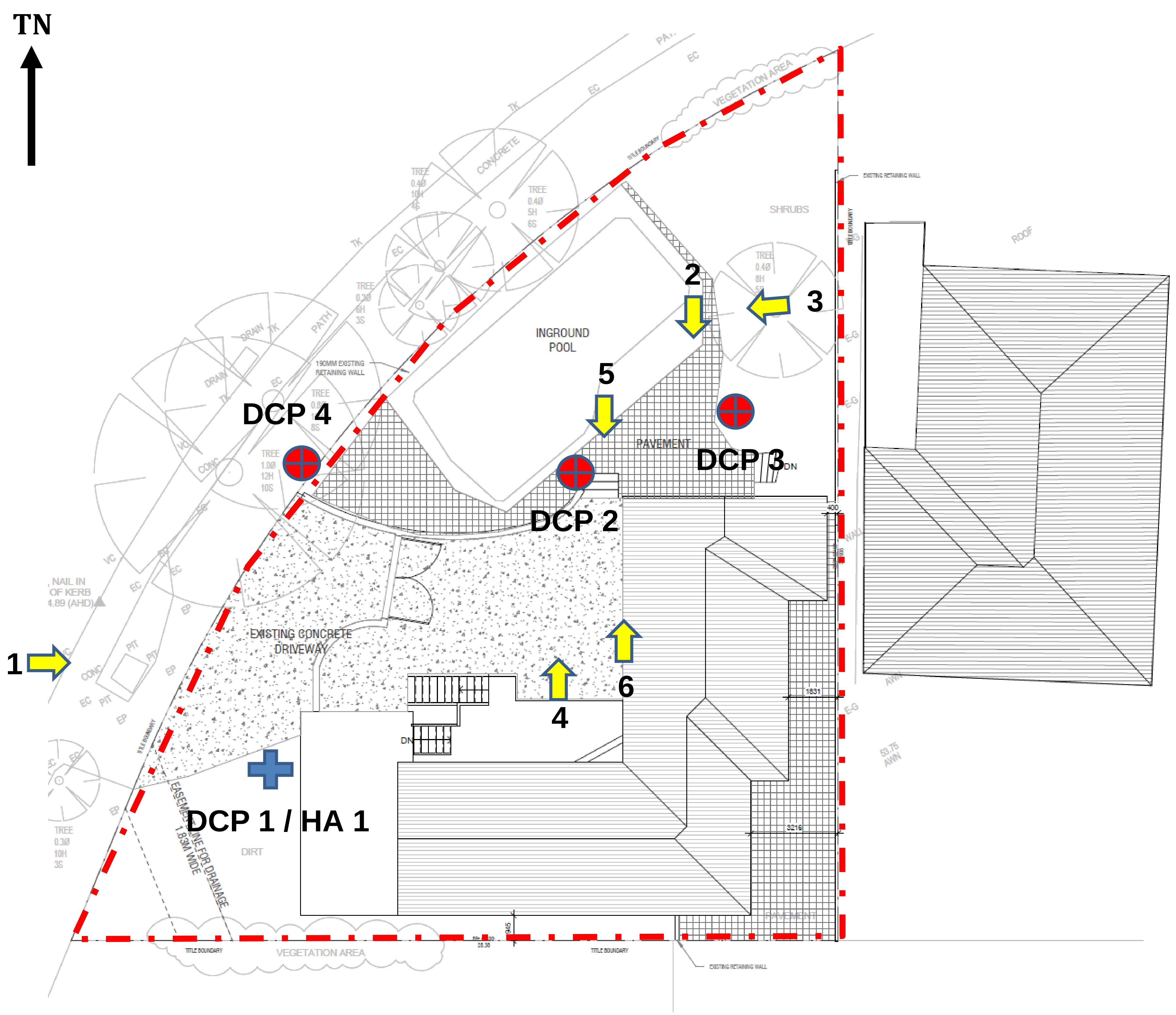
APPENDIX B

DCP Tests, Hand Auger Borehole and Photos Location Plan

DCP TESTS, HAND AUGER BOREHOLE AND PHOTO LOCATION PLAN

GEOTECHNICAL SITE INVESTIGATION REPORT FOR PROPOSED ALTERATIONS & ADDITIONS

59 CUTLER ROAD, CLONTARF NSW 2093



LEGEND

SITE BOUNDARY

DCP TEST LOCATION

HAND AUGER BOREHOLE / DCP TEST LOCATION

1 PHOTO IDENTIFICATION WITH DIRECTION VIEW

soilsrock

Soilsrock Engineering Pty. Ltd

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Email: info@soilsrock.com.au

www.soilsrock.com.au

CLIENT:	Revision	Date	Date: 15/01/2018	Drawn by:	H.C
MS. JEI CHEN			Scale: NTS	Approved by:	J.C
			Project No.: SRE/279/CT/17	APPENDIX	B

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APPENDIX C

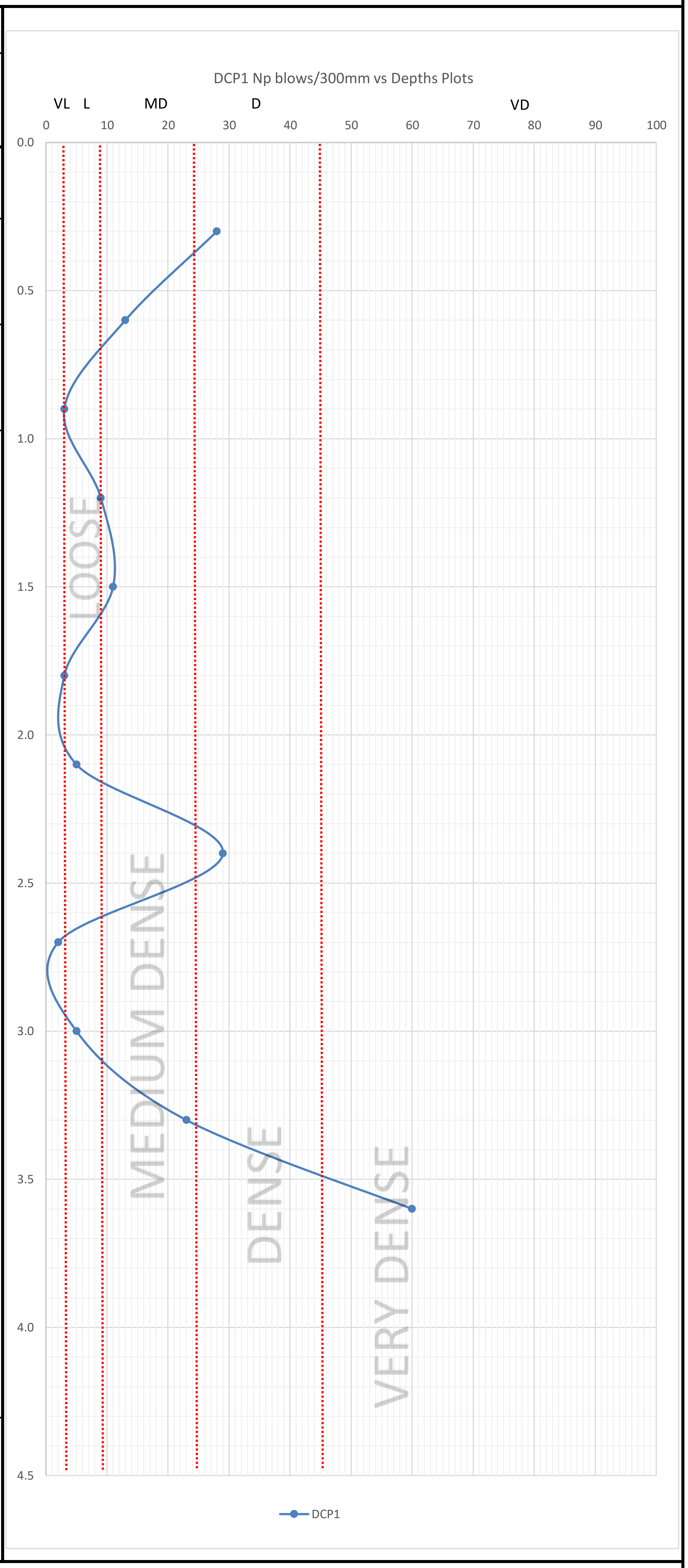
Hand Auger Borehole Log

BOREHOLE LOG

Client:	MS JEI CHEN	BOREHOLE NO.	DCP1 / HA1
Project:	PROPOSED RESIDENTIAL ALTERATION AND ADDITION	Page:	1 of 1
Location:	59 CUTLER ROAD, CLONTARF, NSW 2093	Date Started:	22/12/2017
Date:	18/12/2017	Date Completed:	22/12/2017
Project No.:	SRE/279/CT/17	Logged/Checked by:	S.L/J.C

Equipment:	HA & DCP	Hole Diameter:	0.15m	Coring Size:	NA	RL Surface:	44.2
Driller:	HC	Drilling Method:	Hand Drill Auger / DCP Test	Inclination:	90˚	Datum:	AHD

Method	Groundwater recorded	RL	Depth (m)	Graphic Log	Material Description	Moisture Condition	Strength (Consistency)	Density Index
DCP & HA					**Top Soil:** Brown silt with roots and grass	D	-	D
					Fill: Yellow silt with sandstone fragments.	M	-	MD
		43.7	0.5		**Silty Sand:** Moist brown and orange silty sand.	M	-	VL
					(Hand Auger Terminated at 0.8m)			
		43.2	1.0					
		42.7	1.5					
		42.2	2.0					
		41.7	2.5					
		41.2	3.0					
		40.7	3.5					
					(DCP Terminated at 3.6m)			



Symbols & Abbreviations:

Moisture Condition	Strength	Density Index	Graphic Log Symbols	
D=Dry	Cohesive Soils	Cohesionless Soils	Top Soil	Sandy Clay
M=Moist	VS = Very Soft	VL = Very Loose	Fill	Silty Sand
W=Wet	S = Soft	L = Loose	Clay	Clay Sanc Clayey Sand
	F = Firm	MD = Medium Dense	Silt	Silty Clay
	St = Stiff	D = Dense	Sand	Gravelly Clay
	VSt = Very Stiff	VD = Very Dense	Gravel	Clayey Gravel
	H = Hard			

geotechnical engineering consultants

APPENDIX D

Site Photographs

CLIENT:	MS. JEI CHEN	PAGE:	1 of 1
PROJECT:	PROPOSED ALTERATIONS & ADDITIONS	DATE RECORD:	18/12/2017
LOCATION:	59 CUTLER ROAD, CLONTARF, NSW 2093		
DATE:	22/12/2017	LOGGED BY:	S.L
PROJECT NO	SRE/279/CT/17	CHECKED BY:	J.C

SITE PHOTOGRAPHS

Photo 1 - East view from Cutler Road to DCP1 / HA1 and DCP4 testing locations.

Photo 2 - South view to DCP 3 test location and rear stairs.

Photo 3 - West view to the inground pool and DCP2 test location.

Photo 4 - North view to inground pool and garage entrance.

Photo 5 - South view to the main stairs of the dwelling house and front gate.

Photo 6 - North view to the existing concrete way and entrance to the inground pool.