Douglas Partners
Geotechnics / Environment / Groundwater

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Report on
Geotechnical Investigation

Proposed Aged Care Facility
Lot 1 Haren Street, Mareeba

Prepared for
Croft Developments Pty Ltd

Project 90778.00
October 2018

Douglas Partners
Geotechnics / Environment / Groundwater

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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.

	Signature	Date
Author		26/10/18
Reviewer		

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Report on Geotechnical Investigation
Proposed Aged Care Facility
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1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed aged care facility at Lot 1 Haren Street, Mareeba. The investigation was commissioned in an email dated 21 September 2018 by Clinton Witnish of Croft Developments Pty Ltd, and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal CNS180191 dated 20 September 2018.

The aim of the investigation was to assess the subsurface soil and groundwater conditions at the site in order to provide comment on:

- site classification to AS2870 (Ref 1);
- recommended site preparation earthworks;
- suitability of excavated material for re-use as engineering filling;
- pavement subgrade conditions, including a recommended design California bearing ratio (CBR) value;
- suitable high level footing options and allowable bearing pressures; and
- preliminary assessment on the potential for acid sulfate soils (ASS), based on a desktop study of the site elevation, geological origin of site soils and visual inspection.

The investigation included 12 test pits and this was followed by 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.

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

2. Site Description

The site is located between Haren Street and Kenneally Road, Mareeba. A site locality and layout plan is attached as Drawing 1 in Appendix A. Photographs of the site are presented in Figures 1 and 2.

The site is irregular in shape and approximately 3 ha in area. The site is relatively flat and was undeveloped at the time of the field work and vegetated by short grass and numerous large trees.

A small stockpile was observed approximately mid-way along the eastern site boundary (refer Drawing 1), and long grass and large basalt boulders were observed over its surface.

A Telstra pit is located near the north-western corner of the site, and sewer lines extend along the north-east and south-east site boundaries. An open unlined drain extends along the northern site boundary adjacent to Haren Street.

Figure 1: Looking east from near Pit 3

Figure 2: Looking north from near Pit 1

3. Geology

The Atherton 1:250,000 scale Queensland Department of Mines and Energy Geological Series Sheet (2nd Edition), and accompanying explanatory notes, indicate that the site is underlain by Tertiary to Quaternary aged Atherton Basalt (TQn), described as comprising "vesicular to massive olivine basalt lava".

The field work encountered variably weathered basalt in the base of most of the test pits, consistent with the published mapping. This was overlain by very stiff and hard silty clay soils, with varying proportions of fine subrounded gravel, which is probably residual soil derived from the basalt.

4. Field Work Methods

The field work was carried out on 5 October 2018 and comprised 12 test pits (designated Pits 1 to 12), generally in the locations requested by the client. Pits 1 and 2 were moved slightly from the client nominated locations to avoid existing sewer lines, and Pit 3 was moved to avoid an existing Telstra cable. The approximate test locations are shown on Drawing 1 in Appendix A.

The test pits were excavated by a 5.5 tonne mini-excavator using a 300 mm wide toothed bucket. Representative disturbed samples were collected from the test pits for laboratory testing. 'Undisturbed' tube sampling (U_{50}) was also attempted in the test pits however this was not successful due to the fine gravel content within the upper orange brown silty clay, and the boulders within the

deeper grey silty clay. Regular pocket penetrometer tests (pp) were also carried out on the pit side walls and on relatively undisturbed blocks of soil returned by the backhoe bucket to provide information on the strength consistency of the cohesive soils. Tactile assessment was used to estimate the strength of the basalt. A photograph of the pit trench side wall and stockpile was taken at the completion of excavation and is presented on the logs. The test pits were immediately backfilled using the excavated soil, which was placed in layers and compacted by 'tamping' down with the underside of the backhoe bucket.

All field work was carried out in the presence of an experienced geotechnical engineer, who logged and photographed the subsurface profile, carried out the pp tests and collected representative samples.

A hand-held GPS unit was used to record UTM co-ordinates of the test locations using MGA94 datum, and these are shown on the borehole logs in Appendix B. It is understood that the client will carry out a survey of the site and pick up the 12 test pit locations in order to record their existing ground surface levels.

5. Field Work Results

The subsurface conditions encountered in the test pits are described on the logs in Appendix B. These should be read in conjunction with the general notes preceding them which describe the sampling methods, soil and rock descriptions and symbols and abbreviations used in their preparation.

A summary of the subsurface conditions encountered in the test pits is described below:

Topsoil Topsoil was encountered below the ground surface and extended to depths ranging between 0.05 m and 0.2 m, and comprised grey silty clay with some rootlets.

Silty Clay and Gravelly Silty Clay Hard and generally orange brown silty clay, containing varying proportions of fine subrounded gravel, was encountered below the topsoil. Basalt boulders were encountered in this unit at a number of the test locations as described on the logs, and numerous boulders were encountered in Pit 4. This silty clay unit was generally slightly gravelly, however it was assessed to only contain some gravel in Pit 10 and to contain increased gravel in Pits 4 and 9 where it was logged as gravelly silty clay.

Silty Clay Very stiff (or hard) light grey, grey and grey brown silty clay was encountered below depths ranging between 1.1 m and 1.4 m. Basalt boulders were encountered in this unit at a number of the test locations as described on the logs, and numerous boulders were encountered in Pit 4 and this increased in Pit 7 to become boulders within a silty clay matrix. This deeper unit may possibly be extremely weathered basalt as some remaining zones of dark grey very low strength basalt were observed within Pits 8 and 9. Pit 4 refused at 1.7 m depth on a probable boulder, and Pit 9 was terminated at 2.6 m depth (the limit of investigation).

Basalt (except Pits 4 and 9) Estimated very low to low strength, light grey speckled black vesicular basalt was generally encountered at the base of the test pits, with the exception of Pits 4 and 9, below depths ranging between 1.4 m and 2.0 m. The strength of the basalt was

assessed to generally increase with depth in most of test pits. Pits 5, 8, 9, 10 and 11 were extended to 2.5 m or 2.6 m depth, which was the limit of investigation. Pits 1, 2, 3, 6, 7 and 12 refused on estimated low to medium strength, medium strength or medium to high strength basalt at depths ranging between 1.9 m and 2.3 m.

No free groundwater was encountered during excavation of the test pits. It should be noted, however, that groundwater levels are affected by climatic conditions and soil permeability and may therefore change with time.

6. Laboratory Testing

Laboratory testing comprised the following, and this was carried out by DP's Brisbane Laboratory:

- determination of field moisture content – six tests;
- determination of plasticity index (Atterberg limits) and linear shrinkage – four tests; and
- CBR tests (4 day soaked) on remoulded samples compacted to approximately 100% dry density ratio (Standard compaction) and Standard Optimum Moisture Content – four tests.

The results of these tests are summarised in Table 1 below, and detailed test report sheets included in Appendix C. The results indicate that the upper orange brown silty clay with varying proportions of fine gravel is of medium plasticity, and that the deeper grey silty clay is of high plasticity.

Table 1: Summary of Laboratory Test Results

Test Location	Depth (m)	Material	W (%)	Plasticity Index and Linear Shrinkage				CBR		
				LL	PL	PI	LS	OMC (%)	SMDD (t/m3)	CBR (%)
Pit 4	1.3	Silty clay	16.8	74	25	49	18.5	-	-	-
Pit 6	0.6	Silty clay, slightly gravelly	16.9	47	23	24	11.0	19.5	1.84	20
Pit 8	0.6	Silty clay, slightly gravelly	18.8	-	-	-	-	21.5	1.69	10
Pit 10	0.4	Silty clay with some fine gravel	19.0	49	21	28	13.0	23.0	1.66	15
Pit 11	1.5	Silty clay	17.8	83	32	51	19.0	-	-	-
Pit 12	0.5	Silty clay, slightly gravelly	16.4	-	-	-	-	20.0	1.77	18

Legend: W - Field moisture content; LL - Liquid Limit; PI - Plasticity Index; PL - Plasticity Limit; LS - Linear Shrinkage

CBR = California bearing ratio (4-day soaked and compacted to approximately 100% Standard and OMC)

OMC = Optimum moisture content (Standard compaction)

SMDD = Maximum dry density (Standard compaction)

7. Comments

7.1 Proposed Development

It is understood that construction of an aged care facility is proposed, comprising a number of single storey buildings and associated internal road and car parking pavements. The proposed building structural loads were not available at the time of reporting.

7.2 Site Classification to AS 2870

Site classification of foundation soil reactivity in accordance with AS 2870 – 2011 (Ref 1) provides an indication of the propensity of the ground surface to move with seasonal variation in moisture. The scope of site classification with respect to AS 2870-2011 includes one or two-storey residential structures, or similar.

An in-house computer program, REACTIVE, was used to calculate characteristic surface movement values (y_s) for the site, based on procedures presented in AS 2870-2011, the soil profile revealed at the test locations and in-house correlations based on the laboratory plasticity index results. Based on very approximate in-house correlations, a presumptive shrink swell index (I_{ss}) value of 1.5 % per ζ pF was adopted for the upper orange brown medium plasticity silty clay, and a presumptive I_{ss} value of 4.5 % per ζ pF was adopted for the deeper light grey, grey and grey brown high plasticity silty clay. These values are consistent with the results of previous testing of these silty clay residual soils around Mareeba within the mapped basalt geology, where sampling and shrink-swell laboratory testing was successfully carried out.

It should be noted that AS 2870 provides recommended values of change in suction (ζu) and depth of design suction (H_s) for major and regional centres throughout Australia. Values are not, however, included for North Queensland. Based on previous experience in the area and on published data (Ref 2) relating climatic conditions to suction, a value of 1.2pF was adopted for ζu and 2.3 m for H_s in the REACTIVE calculations. This is based on a 'Temperate' climatic zone.

Based on the results of the investigation, and using the procedures outlined above, a y_s value of approximately 40 mm was obtained for the existing site. This is on the boundary between 'Class M' (Moderately Reactive) and 'Class H1' (Highly Reactive). Where the existing orange brown medium plasticity silty clay (generally encountered in the upper 1.1 m to 1.4 m) is to be removed, moisture conditioned and replaced under controlled engineered conditions during minor fill earthworks, the y_s value is anticipated to be in the order of 55 mm, consistent with a 'Class H1' (Highly Reactive) classification. This is due to the need to consider uncracked conditions in the analysis for the first five years after filling placement and two years after excavation.

If the deeper and more reactive light grey, grey and grey brown high plasticity silty clay (generally encountered below 1.1 m to 1.4 m) is to be excavated and re-used in proposed fill earthworks, then y_s values of greater than 75 mm are anticipated, consistent with a 'Class E' (Extremely Reactive) classification.

It should be noted that no assessment of the effects of trees has been made in this estimation of the y_s values, such as observed at the site, and reference to requirements in AS 2870-2011 should be made by the building designer in this regard.

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

- Recent removal of building or structures likely to affect soil moisture conditions *(potentially likely following demolition of existing structures)*;
- Unusual moisture caused by drains, channels, ponds, dams or tanks *(not likely unless structure is relocated adjacent to pond)*;
- Recent removal of large trees *(possible if trees are removed or left in place)*;
- Growth of trees too close to a structure *(possible if structure is sited against existing trees or extensive planting is undertaken)*;
- Excessive or regular watering of gardens adjacent to the structure *(possible depending on landscaping)*;
- Lack of maintenance of site drainage; and
- Failure to repair plumbing leaks.

7.3 Site Preparation

It is recommended that the following general site preparation be carried out below the proposed building and pavements:

- Remove all existing surface vegetation, 'uncontrolled' filling (if present) and organic topsoil, and any deleterious soft, wet or highly compressible materials. This is anticipated to require excavation to 0.05 m to 0.2 m depth.
- If any basalt boulders are exposed by excavation to the formation levels then these should be removed by over-excavation to prevent the formation of a 'hard spot' and replaced with selected replacement filling (refer below).
- Test roll the complete surface of the natural subgrade with a minimum 12 tonne static weight smooth drum roller (in non-vibratory mode), in order to detect the presence of any soft or loose zones, which should be excavated out and replaced with approved filling.
- Compact the natural foundation soils to a minimum dry density of 98% Standard if cohesive (ie clay or silt), or to a density index of at least 75% if granular (ie sand and gravel).
- Where the formation level is to be raised, all deleterious material should be removed and the natural foundation soils test rolled and prepared as above.
- Approved filling should then be placed in layers not exceeding 200 mm loose thickness. If the filling is cohesive, each layer should be compacted to a minimum dry density ratio of 98% Standard and moisture content maintained within the range OMC –2% (dry) to OMC +2% (wet), during and after compaction. Replacement filling should not contain individual particles greater in size than 75 mm, and should comprise well graded material (ie: have a non-uniform particle size distribution). If the filling is predominantly sand, then each layer should be compacted to a density index of at least 75%.

- 'Level 1' inspection and testing of filling, in accordance with AS 3798–2007 (Ref 3), is recommended if the replacement filling is to be considered 'controlled', sufficient for support of upper level footings.

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

The excavated silty clay soils at the site could be re-used as engineering filling, provided that the topsoil and any oversized material (ie basalt boulders) are removed. Preference should be given to re-using the upper orange brown silty clay of medium plasticity, rather than the deeper light grey residual silty clay of high plasticity to reduce raising the reactivity of the site with respect to site classification to AS2870 (refer Section 7.2) and weakening the pavement subgrade soils (refer Section 7.4).

The near surface medium and high plasticity silty clay may become untrafficable to wheel traffic during construction, particularly during and after periods of rainfall or increases in moisture content. Consideration could be given to using tracked plant, or alternatively a 0.2 m to 0.3 m thick 'bridging' layer of select granular filling (eg fine crushed rock) could be applied over the site surface to improve construction access.

7.4 Pavement Subgrade Conditions

The results of the investigation indicate that near surface pavement subgrade conditions, following removal of topsoil as outlined in Section 7.3, will generally comprise hard orange brown silty clay of medium plasticity and containing varying proportions of fine gravel.

Soaked laboratory CBR testing of the collected orange brown silty clay (slightly gravelly) subgrade samples resulted in a range of CBR values of between 10% and 20%. DP's previous testing experience with a silty clay soil usually returns a CBR value in the range of 4% to 6%, however at this site the fine gravel content appears to be elevating the CBR result. The gravel content within the silty clay was observed to vary between the test pits, and it is possible that there may be some locations with less gravel than the samples tested. In this case it is recommended that a design CBR value of 6% be adopted for the upper orange brown silty clay unless more extensive CBR sampling and testing can demonstrate that use of a higher value is appropriate.

If the deeper high plasticity light grey, grey and grey brown silty clay (with no gravel content) is to be excavated and re-used as filling below proposed pavements, then it is suggested that a lower design CBR value of 3% be adopted to account for this weaker subgrade soil.

These design CBR values are based on the assumption that the pavement subgrade has been prepared as outlined in Section 7.3 and that adequate provision has been made for both surface and subsurface drainage along with maintenance of such drainage.

7.5 High Level Footings

Following site preparation as outlined in Section 7.3 the ground conditions are expected to comprise 'controlled' filling or the natural hard orange brown gravelly silty clay and/or the deeper very stiff light grey, grey and grey brown silty clay.

Tied edge beams and tied internal beams or load support thickenings of the slab founding in the above described founding soils should be designed for a maximum allowable bearing pressure of 100 kPa. Slab panels (if required) should be restricted to 10 kPa applied pressure, unless additional settlement analysis is carried out to check that the additional settlements are within design tolerances. This is with respect to bearing capacity failure, and incorporates a factor of safety of approximately 2.5.

Alternatively, independent pad and strip footings could be adopted, founding a minimum of 0.5 m depth in the above described founding soils and should be designed for a maximum allowable bearing pressure of 150 kPa. This is with respect to bearing capacity failure, and incorporates a factor of safety of approximately 2.5.

Use of the above allowable bearing pressures is contingent upon the base of any such footing excavation being compacted by either rammer, plate vibrator or other appropriate hand guided equipment. This is required to negate the loosening effects of the backhoe/excavator teeth.

The ground conditions encountered at the test locations were entered into an in-house settlement computer program T-REX for the purposes of calculating settlement of above described footings and slab. Based on these methods the estimated settlement of a slab loaded to 10 kPa is estimated to be less than 5 mm, and the settlement of a 1 m square pad footing or a 0.5 m wide strip footing loaded to 150 kPa is estimated to be in the order of up to 5 mm.

7.6 Acid Sulfate Soils

The following comments regarding ASS are preliminary only and will require actual sampling and testing at the site to confirm.

Based on the relatively high elevation of the site (approximately RL 415 mAHD), the mapped Basalt geology, and the observed soil profiles at the test locations it is considered unlikely that ASS are present at the site.

8. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at this site in accordance with DP's proposal CNS180191 dated 20 September 2018 and Croft Developments Pty Ltd Purchase Order No. 2018MAR0001 dated 21 September 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Croft Developments Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss

or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

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

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

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

9. References

1. Australian Standard AS 2870–2011 "Residential Slabs and Footings – Construction", Standards Australia.

2. Fox, E. “A Climate-Based Design Depth of Moisture Change Map of Queensland and the Use of Such Maps to Classify Sites under AS 2870-1996”, Australian Geomechanics, Vol 35, Number 4, December 2000.

3. Australian Standard AS 3798-2007, “Guidelines on Earthworks for Commercial and Residential Developments”, Standards Australia.

Douglas Partners Pty Ltd

Appendix A

About This Report
Drawing 1

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

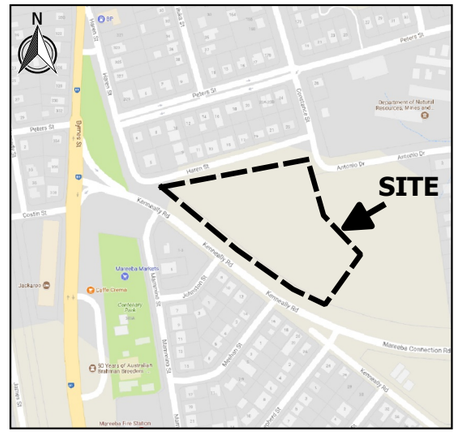
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later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



LOCALITY

Legend

- Test Pit
- site

Notes:
1. Base image from Queensland Globe.
2. Locality image from Google Maps.
3. Test locations are approximate only and are based on the recorded GPS locations.

0 50 100 150 200 m

Douglas Partners Geotechnics • Environment • Groundwater	CLIENT: Croft Developments Pty Ltd	TITLE: Site Locality and Test Location Plan Proposed Aged Care Facility Lot 1 Haren Street, Mareeba	PROJECT No: 90778
	OFFICE: Cairns / DRAWN BY: KJR		DRAWING No: 1
	SCALE: as shown / DATE: 25 October 2018		REVISION: 0

Appendix B

Sampling Methods
Soil Descriptions
Rock Descriptions
Symbols and Abbreviations
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.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. 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	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

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

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

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	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

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; or
- 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 - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) 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 Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate 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 $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	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 stained	Fs	Rock substance unaffected by weathering but staining visible along defects
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 <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

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

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

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 of RQD.

Stratification Spacing

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

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

Symbols & Abbreviations

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

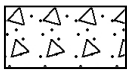
Symbols & Abbreviations

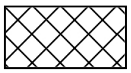
Graphic Symbols for Soil and Rock

General

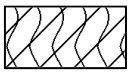

Asphalt

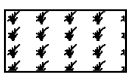

Road base

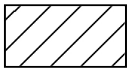

Concrete

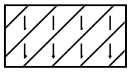

Filling

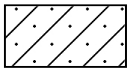
Soils


Topsoil

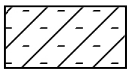

Peat

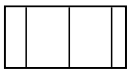

Clay

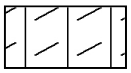

Silty clay

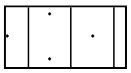

Sandy clay

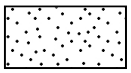

Gravelly clay

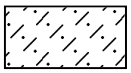

Shaly clay

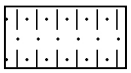

Silt


Clayey silt


Sandy silt

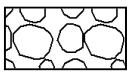

Sand

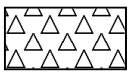

Clayey sand


Silty sand


Gravel

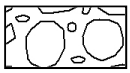

Sandy gravel


Cobbles, boulders

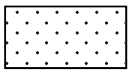

Talus

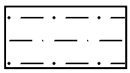
Sedimentary Rocks

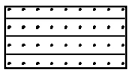

Boulder conglomerate

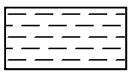

Conglomerate


Conglomeratic sandstone

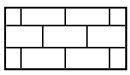

Sandstone


Siltstone

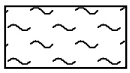

Laminite

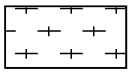

Mudstone, claystone, shale

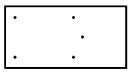

Coal


Limestone

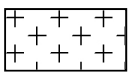
Metamorphic Rocks

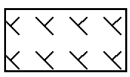

Slate, phyllite, schist

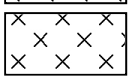

Gneiss

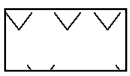

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332673
NORTHING: 8118648

PIT No: 1
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.15	TOPSOIL - grey silty clay topsoil with some rootlets; M<Wp							
		SILTY CLAY - hard orange brown silty clay, slightly gravelly. Gravel fine and subrounded; M<Wp		D	0.6		pp >600		
		- rounded basalt boulder at 0.8 m depth (0.4 m size)			0.9		pp >600		
1	1.1	SILTY CLAY - hard grey and grey brown silty clay; M<Wp		D	1.2		pp = 500		1
	1.4	- estimated very high strength basalt (possibly large boulder) in middle of pit at approximately 1.25 m depth (moved pit to near end of trench)		D	1.5				
		BASALT - estimated very low to low strength light grey speckled black vesicular basalt - generally low to medium strength below 1.5 m depth							
2	1.9	- zone of very stiff silty clay at far end of pit trench at 1.9 m depth. Pit discontinued at 1.9m depth - refusal							

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Prior attempt with push tube sampling rig refused at 1.25m depth; M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332647
NORTHING: 8118668

PIT No: 2
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.1	TOPSOIL - grey silty clay topsoil with some rootlets; M<Wp							
		SILTY CLAY - hard orange brown silty clay, slightly gravelly. Gravel fine subrounded; M<Wp			0.3		pp >600		
		- tree root at 0.2 m depth							
		- subrounded basalt boulder (0.5 m size) at 0.6 m depth			0.7		pp >600		
	1				1.0		pp >600		1
	1.1	SILTY CLAY - very stiff to hard light grey silty clay; M<Wp. Vesicular basalt structure			1.2		pp = 450		
	1.7	BASALT - estimated very low to low strength light grey vesicular basalt		D	1.8				
	2	- estimated low to medium strength below 1.9 m depth							2
	2.1	- estimated medium strength at 2.1 m depth		D	2.1				
		Pit discontinued at 2.1m depth - refusal							

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Prior attempt with push tube sampling rig refused at 1.0m, 0.35m and 0.35m depth with the last attempt terminated at 2.7m

☐ 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: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332469
NORTHING: 8118795

PIT No: 3
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.05	TOPSOIL - grey silty clay with some rootlets; M<Wp							
		SILTY CLAY - hard orange brown silty clay, slightly gravelly (almost gravelly silty clay). Gravel fine subrounded; M>Wp		D	0.5		pp >600		
	1			D	1.0		pp >600		1
	1.1	SILTY CLAY - very stiff grey brown silty clay; M<Wp		D	1.3		pp = 300-350		
	1.5	BASALT - estimated very low to low strength light grey speckled black vesicular basalt							
		- estimated low to medium strength below 1.7 m depth		D	1.8				
	1.9	- estimated medium strength at 1.9 m depth							
	2	Pit discontinued at 1.9m depth - refusal							

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: Prior attempt with push tube sampling rig refused at 1.6m depth; M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332669
NORTHING: 8118701

PIT No: 4
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.1	TOPSOIL - grey silty clay with some rootlets; M<Wp							
		GRAVELLY SILTY CLAY - hard orange brown gravelly silty clay (almost silty clayey gravel) with numerous rounded to subrounded basalt boulders up to 0.8 m size. Gravel fine subangular; M<Wp			0.3		pp >600		
				B	0.4		(2 bags)		
				D	0.7		pp >600		
	1								1
	1.1	- refusal at 1.0 m depth in middle of pit trench			1.05		pp >600		
		SILTY CLAY - very stiff light grey silty clay with numerous rounded to subrounded basalt boulders 0.3 m to 0.5 m size; M~Wp		D	1.3		pp = 300		
		- refusal at 1.5 m depth at far end of pit trench							
	1.7	Pit discontinued at 1.7m depth - refusal on probable boulders			1.7		pp = 300		
	2								

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332606
NORTHING: 8118672

PIT No: 5
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.1	TOPSOIL - dark grey silty clay topsoil with some rootlets; M<Wp							
		SILTY CLAY - hard orange brown silty clay, slightly gravelly; M<Wp		D	0.5		pp >600		
	1			D	1.0		pp >600		1
	1.2	SILTY CLAY - hard light grey and brown silty clay; M<Wp		D	1.4		pp >600		
	2 2.0	BASALT - estimated very low strength grey speckled black vesicular basalt		D	2.1				2
	2.5	- estimated very low to low strength below 2.4 m depth		D	2.5				
		Pit discontinued at 2.5m depth - refusal and limit of investigation							

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332542
NORTHING: 8118725

PIT No: 6
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.1	TOPSOIL - dark grey silty clay topsoil with some rootlets; M<Wp							
		SILTY CLAY - hard orange brown silty clay, slightly gravelly (almost gravelly silty clay). Gravel fine and subrounded; M<Wp		B	0.6		(2 bags)		
	1.2	SILTY CLAY - very stiff light grey and brown silty clay; M<Wp		D	1.4				
	1.8	BASALT - estimated very low strength grey speckled black vesicular basalt							
		- estimated low strength below 2.0 m depth							
	2.3	- estimated medium to high strength at 2.3 m depth		D	2.3				
		Pit discontinued at 2.3m depth - refusal							

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332596
NORTHING: 8118736

PIT No: 7
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.1	TOPSOIL - grey silty clay topsoil with some rootlets; M<Wp							
		SILTY CLAY - hard orange brown silty clay, slightly gravelly with some rounded to subrounded basalt boulders up to 0.4 m size. Gravel fine and subrounded; M<Wp			0.5		pp >600		
1	1.1	BOULDERS and SILTY CLAY - estimated very high strength rounded to subrounded basalt boulders (up to 0.8m size) in a very stiff to hard light grey and grey silty clay matrix		D	1.6		pp = 400		1
	1.7	BASALT - estimated low strength grey speckled black vesicular basalt							
2	2.0	- estimated low to medium strength at approximately 2.0 m depth Pit discontinued at 2.0m depth - refusal		D	2.0				2

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

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TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332654
NORTHING: 8118754

PIT No: 8
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.1	TOPSOIL - grey brown silty clay topsoil with some rootlets; M<Wp							
		SILTY CLAY - hard orange brown silty clay, slightly gravelly. Gravel fine and subrounded; M<Wp			0.3		pp >600		
		- refusal at far end of pit trench on probable basalt boulder at 0.4 m depth		B	0.6		pp >600 (2 bags)		
		- red brown mottled grey below 0.7 m depth		D	0.8		pp >600		
1	1.1	SILTY CLAY - very stiff light grey silty clay, with some zones of dark grey estimated very low strength vesicular basalt; M<Wp		D	1.4		pp = 350		1
	1.8	BASALT - estimated very low to low strength light grey speckled black vesicular basalt							
2		- estimated low to medium strength below 2.2 m depth							2
	2.5	Pit discontinued at 2.5m depth - limit of investigation		D	2.5				

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
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TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332610
NORTHING: 8118767

PIT No: 9
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.1	TOPSOIL - grey brown silty clay with some topsoil; M<Wp							
		GRAVELLY SILTY CLAY - hard orange brown gravelly silty clay (almost silty clayey gravel). Gravel fine to medium and subrounded; M<Wp			0.4		pp >600		
				D	0.8		pp >600		
	1			D	1.0		pp >600		1
	1.2	SILTY CLAY - hard grey mottled red brown silty clay; M<Wp		D	1.3		pp >600		
		- very stiff and light grey below 1.5 m depth with some gravel to cobble sized remaining zones of estimated very low strength dark grey vesicular basalt			1.6		pp = 300		
	2								2
				D	2.3		pp = 350		
	2.6	Pit discontinued at 2.6m depth - limit of investigation							

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

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Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332624
NORTHING: 8118815

PIT No: 10
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.2	TOPSOIL - grey silty clay with some rootlets; M<Wp							
		SILTY CLAY - hard red brown silty clay with some fine subrounded gravel; M<Wp - tree root at 0.2 m depth		B	0.4		pp >600 (2 bags)		
					0.7		pp >600		
		- orange brown below 0.8 m depth							
1				D	1.0		pp >600		1
	1.3	SILTY CLAY - very stiff grey and grey brown silty clay; M<Wp - rounded to subrounded basalt boulders in near end of pit at 1.4 m depth		D	1.5		pp = 350		
2	2.0	BASALT - estimated very low to low strength dark grey vesicular basalt		D	2.3				2
	2.5	Pit discontinued at 2.5m depth - limit of investigation							

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332536
NORTHING: 8118756

PIT No: 11
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
	0.2	TOPSOIL - grey silty clay with some rootlets; M<Wp							
		SILTY CLAY - hard orange brown silty clay, slightly gravelly. Gravel fine and subrounded; M<Wp		D	0.5		pp >600		
		- light orange brown with some gravel below 0.7 m depth		D	1.0		pp >600		1
	1.2	SILTY CLAY - very stiff light grey and grey brown silty clay; M<Wp		D	1.5		pp = 300		
	1.9	BASALT - estimated very low strength grey speckled black vesicular basalt		D	2.0				2
		- estimated low to medium strength below 2.4 m depth							
	2.6	Pit discontinued at 2.6m depth - refusal and limit of investigation		D	2.6				

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Croft Developments Pty Ltd
PROJECT: Proposed Aged Care Facility
LOCATION: Lot 1 Haren Street, Mareeba

SURFACE LEVEL: --
EASTING: 332556
NORTHING: 8118798

PIT No: 12
PROJECT No: 90778.00
DATE: 5/10/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
	0.2	TOPSOIL - grey silty clay topsoil with some rootlets; M<Wp							
		SILTY CLAY - hard orange brown silty clay, slightly gravelly. Gravel fine and subrounded; M<Wp		B	0.5		pp >600 (2 bags)		
	1			D	1.0		pp >600		1
	1.4	SILTY CLAY - very stiff grey and grey brown silty clay; M<Wp		D	1.5				
	1.7	BASALT - estimated very low to low strength light grey speckled black vesicular basalt							
	2	- estimated low to medium strength below 2.0 m depth		D	2.0				2
	2.3	- estimated medium strength at 2.3 m depth Pit discontinued at 2.3m depth - refusal		D	2.3				

RIG: 5.5 tonne mini-excavator with 300mm wide bucket

LOGGED: Roberts

SURVEY DATUM: GDA94 Zone 55K

WATER OBSERVATIONS: No free groundwater observed

REMARKS: M= Moisture content, Wp= Plastic limit

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

Appendix C

Results of Laboratory Testing

Material Test Report

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

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Serge Jajcanin
NATA Accredited Laboratory Number: 828

Report Number: **90778.00-1**
Issue Number: 1
Date Issued: 23/10/2018
Client: Croft Developments Pty Ltd
59 Wangara Road, Cheltenham VIC 3192
Contact: Clinton Witnish
Project Number: 90778.00
Project Name: Proposed Aged Care Facility
Project Location: Lot 1 Haren Street, Mareeba
Work Request: 4510
Sample Number: 18-4510A
Date Sampled: 05/10/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **Pit 4 (1.30m)**
Material: Silty Clay

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	74		
Plastic Limit (%)	25		
Plasticity Index (%)	**49**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	18.5		
Cracking Crumbling Curling	Curling		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	16.8

Material Test Report

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

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Serge Jajcanin
NATA Accredited Laboratory Number: 828

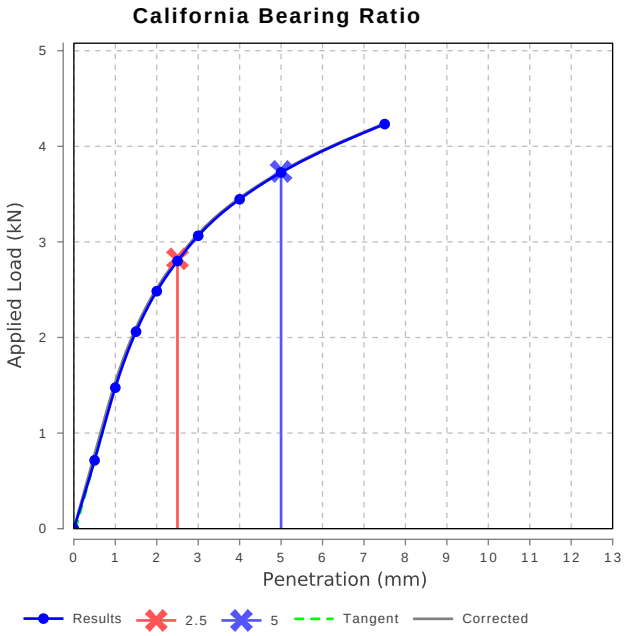
Report Number: **90778.00-1**
Issue Number: 1
Date Issued: 23/10/2018
Client: Croft Developments Pty Ltd
59 Wangara Road, Cheltenham VIC 3192
Contact: Clinton Witnish
Project Number: 90778.00
Project Name: Proposed Aged Care Facility
Project Location: Lot 1 Haren Street, Mareeba
Work Request: 4510
Sample Number: 18-4510B
Date Sampled: 05/10/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **Pit 6 (0.60m)**
Material: Silty Clay, Slightly Gravelly

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**20**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	AS1289 3.1.2		
Maximum Dry Density (t/m^3)	1.84		
Optimum Moisture Content (%)	19.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	100.0		
Dry Density after Soaking (t/m^3)	1.83		
Field Moisture Content (%)	16.9		
Moisture Content at Placement (%)	19.4		
Moisture Content Top 30mm (%)	21.8		
Moisture Content Rest of Sample (%)	19.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	132		
Swell (%)	0.0		
Oversize Material (mm)	19		
Oversize Material Included	0.0		
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 (%)	47		
Plastic Limit (%)	23		
Plasticity Index (%)	**24**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	11.0		
Cracking Crumbling Curling	None		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	16.9



Material Test Report

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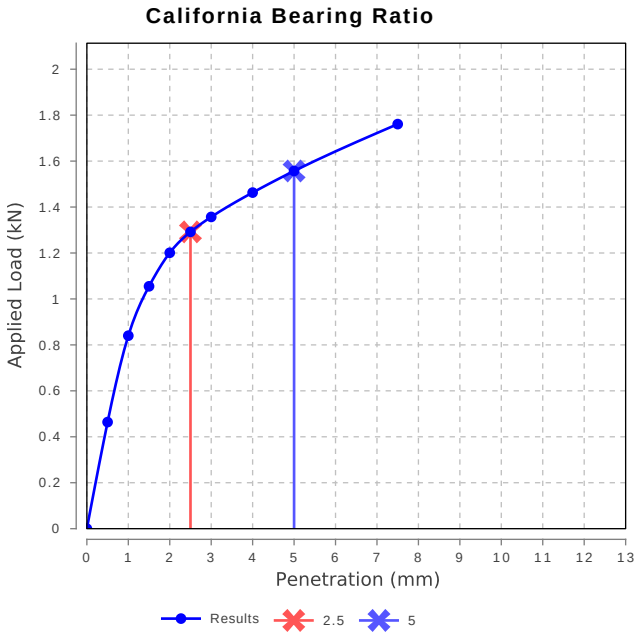
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Serge Jajcanin
NATA Accredited Laboratory Number: 828

Report Number: **90778.00-1**
Issue Number: 1
Date Issued: 23/10/2018
Client: Croft Developments Pty Ltd
59 Wangara Road, Cheltenham VIC 3192
Contact: Clinton Witnish
Project Number: 90778.00
Project Name: Proposed Aged Care Facility
Project Location: Lot 1 Haren Street, Mareeba
Work Request: 4510
Sample Number: 18-4510C
Date Sampled: 05/10/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **Pit 8 (0.60m)**
Material: Silty Clay, Slightly Gravelly

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**10**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	AS1289 3.1.2		
Maximum Dry Density (t/m^3)	1.69		
Optimum Moisture Content (%)	21.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	99.5		
Dry Density after Soaking (t/m^3)	1.68		
Field Moisture Content (%)	18.8		
Moisture Content at Placement (%)	21.4		
Moisture Content Top 30mm (%)	26.2		
Moisture Content Rest of Sample (%)	24.0		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	132		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	0.0		
Oversize Material (%)	0		



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NATA
WORLD RECOGNISED ACCREDITATION

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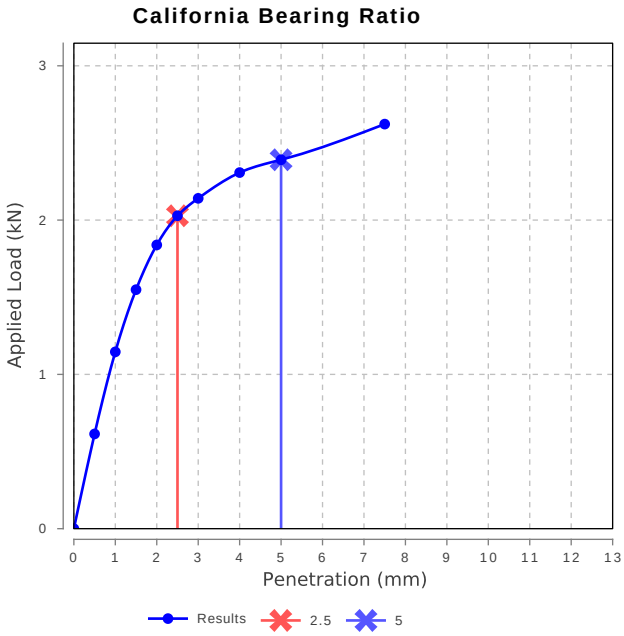
Report Number: **90778.00-1**
Issue Number: 1
Date Issued: 23/10/2018
Client: Croft Developments Pty Ltd
59 Wangara Road, Cheltenham VIC 3192
Contact: Clinton Witnish
Project Number: 90778.00
Project Name: Proposed Aged Care Facility
Project Location: Lot 1 Haren Street, Mareeba
Work Request: 4510
Sample Number: 18-4510D
Date Sampled: 05/10/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **Pit 10 (0.40m)**
Material: Silty Clay with some fine Gravel

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**15**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	AS1289 3.1.2		
Maximum Dry Density (t/m^3)	1.66		
Optimum Moisture Content (%)	23.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	99.0		
Dry Density after Soaking (t/m^3)	1.65		
Field Moisture Content (%)	19.0		
Moisture Content at Placement (%)	22.8		
Moisture Content Top 30mm (%)	24.5		
Moisture Content Rest of Sample (%)	24.3		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	132		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	0.0		
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 (%)	49		
Plastic Limit (%)	21		
Plasticity Index (%)	**28**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	13.0		
Cracking Crumbling Curling	Curling		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	19.0



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Client: Croft Developments Pty Ltd
59 Wangara Road, Cheltenham VIC 3192
Contact: Clinton Witnish
Project Number: 90778.00
Project Name: Proposed Aged Care Facility
Project Location: Lot 1 Haren Street, Mareeba
Work Request: 4510
Sample Number: 18-4510E
Date Sampled: 05/10/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **Pit 11 (1.50m)**
Material: Silty Clay

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	83		
Plastic Limit (%)	32		
Plasticity Index (%)	**51**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Linear Shrinkage (%)	19.0		
Cracking Crumbling Curling	Cracking & Curling		

Moisture Content (AS 1289 2.1.1)	
Moisture Content (%)	17.8

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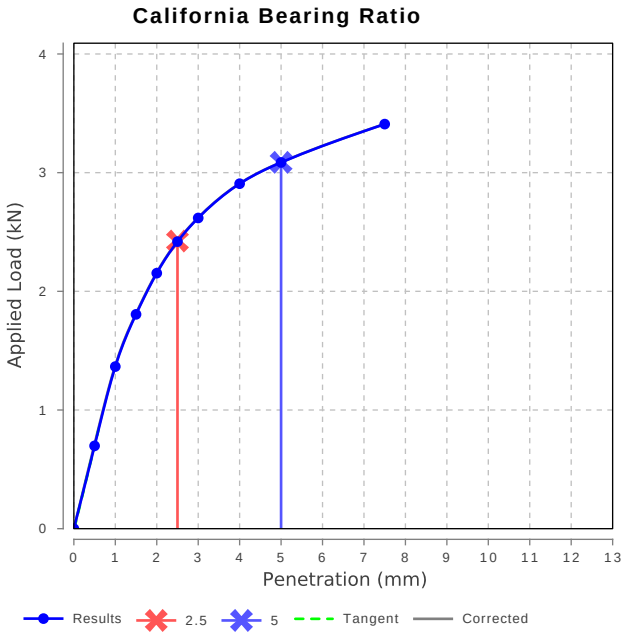
Report Number: **90778.00-1**
Issue Number: 1
Date Issued: 23/10/2018
Client: Croft Developments Pty Ltd
59 Wangara Road, Cheltenham VIC 3192
Contact: Clinton Witnish
Project Number: 90778.00
Project Name: Proposed Aged Care Facility
Project Location: Lot 1 Haren Street, Mareeba
Work Request: 4510
Sample Number: 18-4510F
Date Sampled: 05/10/2018
Sampling Method: Sampled by Engineering Department
Sample Location: **Pit 12 (0.50m)**
Material: Silty Clay, Slightly Gravelly

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**18**		
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)	1.77		
Optimum Moisture Content (%)	20.0		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	102.5		
Dry Density after Soaking (t/m^3)	1.76		
Field Moisture Content (%)	16.4		
Moisture Content at Placement (%)	20.5		
Moisture Content Top 30mm (%)	22.7		
Moisture Content Rest of Sample (%)	22.2		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	132		
Swell (%)	0.5		
Oversize Material (mm)	19		
Oversize Material Included	0.0		
Oversize Material (%)	0		



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Issue Number: 1
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Client: Croft Developments Pty Ltd
59 Wangara Road, Cheltenham VIC 3192
Contact: Clinton Witnish
Project Number: 90778.00
Project Name: Proposed Aged Care Facility
Project Location: Lot 1 Haren Street, Mareeba
Work Request: 4510
Date Sampled: 05/10/2018
Sampling Method: Sampled by Engineering Department

Moisture Content AS 1289 2.1.1

Sample Number	Sample Location	Moisture Content	Material
18-4510A	Pit 4 (1.30m)	16.8 %	Silty Clay
18-4510B	Pit 6 (0.60m)	16.9 %	Silty Clay, Slightly Gravelly
18-4510D	Pit 10 (0.40m)	19.0 %	Silty Clay with some fine Gravel
18-4510E	Pit 11 (1.50m)	17.8 %	Silty Clay