SOIL SURVEYS

PROJECT NO. 208-8487

APRIL, 2009

LEIGHTON PROPERTIES PTY LIMITED

PRELIMINARY GEOTECHNICAL INVESTIGATION

REVISION 3

THE KINGSCLIFF RESORT
CASUARINA WAY
KINGSCLIFF

Soil Surveys Engineering Pty Limited
Specialists in Applied Geotechnics
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Gold Coast Office
Job No: 208-8487
REF: 2-8487BRrev3
Author: Peter Elkington

21st April, 2009

Leighton Properties Pty Limited
Level 12, 259 Queen Street
BRISBANE QLD 4000

ATTENTION: MR ANDREW MABIN

Dear Sir,

RE: PRELIMINARY GEOTECHNICAL INVESTIGATION - THE KINGSCLIFF RESORT - CASUARINA WAY, KINGSCLIFF

Enclosed is a copy of our report for the above project dated April, 2009. One bound, one unbound and an electronic copy of the report have been issued.

Should you have any queries regarding this report, please do not hesitate to contact Peter Elkington at our Gold Coast Office.

Yours faithfully,

P. ELKINGTON (RPEQ 7226)

for and on behalf of
SOIL SURVEYS ENGINEERING PTY LIMITED

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1.0 INTRODUCTION

This report presents the results of the preliminary geotechnical investigation carried out by Soil Surveys Engineering Pty Limited on the 26th September, 2008 for the proposed "Kingscliff Resort" development at Casuarina Way, Kingscliff.

The objectives of this investigation were to assess subsurface conditions at the site in accordance with the Scope of Services detailed in Section 2.0.

2.0 SCOPE OF GEOTECHNICAL SERVICES

The scope of geotechnical services provided by Soil Surveys Engineering Pty Limited was directed towards preliminary evaluation the following items as detailed in our proposal 2-8487P dated 22nd September, 2008.

- The nature and type of subsurface material noting depth and condition of soils.
- Earthwork recommendations
  - suitability of cut for use as fill
  - traffickability
  - batter slopes
  - densification options for the upper loose sands
  - compaction standards
- Broadscale foundation guidelines:
  - Foundation types
  - Allowable bearing capacities
  - Settlement characteristics
- Indicative pavement recommendations.
- Construction recommendations, where applicable.

3.0 PROPOSED DEVELOPMENT

It is understood the proposed development is to consist of 180 resort style units and various community facilities as part of an environmentally sensitive resort.

The majority of the development is to consist of residential type structures with loads typical for residential developments of up to two storeys.

Earthworks are excepted to consist of minor cut to fill operations to create the required building platforms across the site. A maximum depth of earthworks operations is expected to be 1.5m.

The general development layout is indicated in Figure 1.

Figure 1

4.0 GEOTECHNICAL INVESTIGATION

4.1 Field Investigation

Subsurface conditions were investigated by the following field work:-

- Drilling and sampling of 5 boreholes each to a depth of 6m using a 4WD mounted Jacro 105 drilling rig. All boreholes were augmented by Dynamic Cone Penetrometer (DCP's) tests adjacent the boreholes.

Borehole locations from GPS coordinates are indicated.

The soil classification descriptions and field testing were carried out in general accordance with Australian Standards.

AS.1726 - 1993	Geotechnical Site Investigations
AS.1289	Methods of Testing Soils for Engineering Purposes

Notes relating to this report, borehole records and a site plan showing the location of the boreholes are included in the Appendices.

4.2 Site Description

The subject site of the proposed development is described as Lot 490 on DP1095234 and part of Lot 489 on DP47021 and part of Lot 500 on DP1095235 and is located between Cudgen Creek and the Pacific Ocean, to the north of the Salt Development.

The site is understood to have been previously mined.

Vegetation consisted of a dense covering of medium sized trees with a couple of tracks cross the site.

The site is indicated in the below site photo.

5.0 GEOTECHNICAL MODEL

5.1 Subsurface Profile

It is understood the site has been mined in the past, possibly to depths of up to 10m.

Sand backfilling utilised after the mining operation appears to be of a similar nature to the natural sand material encountered across the site, and it was difficult to distinguish natural materials from fill.

Generally a full sand subsurface profile was encountered across the development site. Some surficial silty sand strata were encountered across the site.

The sands encountered were variable in density but typically loose to medium and generally increased in density with depth to become medium dense towards the termination depths of most bores.

However, some very loose sands were encountered at depth in some boreholes, typified by BH3.

The encountered subsurface profile is presented in borehole and DCP test results in the Appendix B.

5.2 Groundwater

Groundwater was noted in several boreholes across the development, at depths of between 1.2m and 5.0m, and was not encountered in Borehole 5.

On the basis of groundwater levels on the adjacent development, typically the standing groundwater level in coastal areas is expected to be at about RL0.5m to 1.0m with fluctuations of ±0.5m under normal conditions (non-flood). Under heavy and prolonged rainfall (flood conditions) rises in groundwater level could well be expected in this coastal area. Groundwater levels may fluctuate with climatic conditions and may show a damped response with tidal variations close to the foreshore and adjacent to Cudgen Creek

Table 1 presents a summary of the groundwater intersection levels.

TABLE 1

Borehole	Groundwater Depth (m)
1	5.0
2	1.2
3	3.6
4	1.6
5	Not observed

Note: All depths in metres below the existing ground surface levels as at 26th September, 2008.

6.0 ENGINEERING ASSESSMENT

6.1 Traffickability and Site Preparation

At the time of the field investigation, some problems with traffickability were encountered in areas where sands were exposed at the surface. However, access was restricted across the majority of the site due to existing vegetation, etc.

Problems with traffickability could arise across the site following disturbance of the upper soil layers and as a result of removal of vegetation, ie. grass and tree roots etc. No major problems are envisaged for the use of tracked equipment. Once surface vegetation has been stripped, traffickability for wheeled equipment will be difficult without use of prepared tracks.

The contractors should fully inform themselves of the ground conditions on site prior to commencement of earthworks. This requirement should be explicit in any earthworks specifications or contract.

6.2 Earthquake Considerations

The following details are provided with respect to the requirements of AS.1170.4 'Earthquake Loads',

Liquefaction occurs as a result of pore pressures increasing and reducing the effective stress to zero with consequent loss of strength.

The development of shear strains causing liquefaction are controlled by the character of ground motion (acceleration and frequency content). For the same acceleration higher magnitude earthquakes are more damaging because of the higher number of applications of cyclic strain.

A Category A earthquake consists of an earthquake of Intensity 6.3 (Modified Mercalli) for a return period of 300 years, rising to Intensity 6.3-7.2 M.M. for a return period of 1500 years, rising to an intensity between 7 and 8 M.M. for a return period of 6000 years. There are various approximate relationships between maximum horizontal ground acceleration and earthquake intensity. Considering the 300 year return period intensities, the average ground acceleration is approximately 0.05g. This will be considered in foundation options. Literature reviews indicate that the likelihood of liquefaction for an earthquake can be related to sand density. For an acceleration of 0.05g, the following assessments as shown in Table 2 were made.

TABLE 2

Liquefaction Potential	Density Index (%)
Very Likely	<35 (very loose to loose)
Likely	35 - 54 (medium dense)
Unlikely	>54 (medium dense to very dense)

Note that for higher ground accelerations, higher density indices are required.

In accordance with AS.1170.4 'Earthquake Loads', the site may be designated as earthquake design Category A, based on the following:-

Acceleration Coefficient (a)	0.06 (Table 2.3)
Site Factor (S)	1.0 (Table 2.4)
Structure Classification	Type I (Appendix A).

Generally the very loose and loose sands encountered are likely to be subject to liquefaction under earthquake conditions.

6.3 Earthworks

It is understood that filling of the lower lying areas of the site to heights of up to 1.5m, together with cuts of up to 1.5m from the higher of the site are proposed as part of the bulk earthworks operation.

Earthwork procedures should be carried out in a responsible manner in accordance with AS.3798-1996 "Guidelines on Earthworks for Commercial and Residential Developments".

Earthwork procedures should include the following:-

- Clearing, stripping and grubbing should be carried out in areas subject to earthworks. Also all soils containing organic matter should be stripped from the construction area. This material is not considered suitable for use as structural fill. Depth to the base of the root zone (stripping depth) was observed to be approximately 100 to 200mm. However, it is envisaged that thicker layers may be encountered in the lower lying areas of the site.
- Existing sloping ground, trench backfill, etc. should be benched to "key in" fill material and optimise compaction. Benches of sufficient width to accommodate the roller may need to be adopted in some situations. Figure 2 refers.

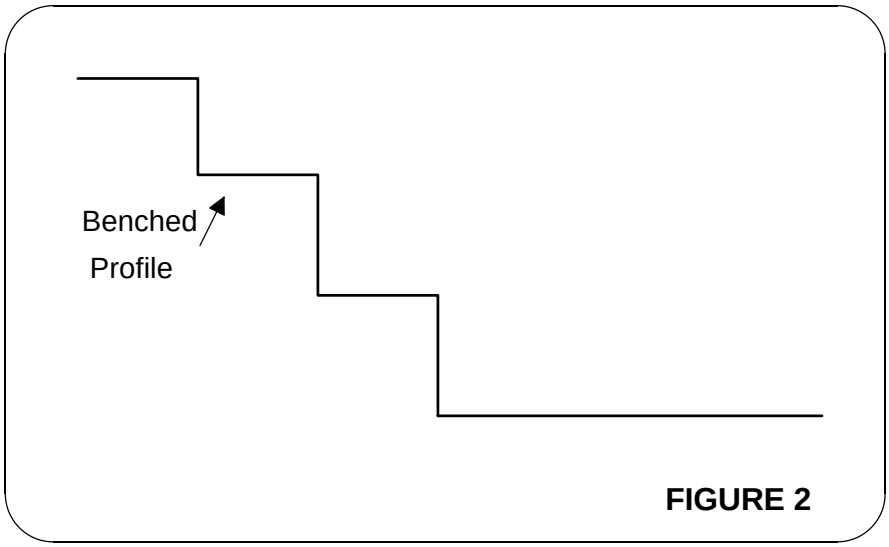

FIGURE 2

- Depressions formed by the removal of vegetation, underground elements etc. should have all disturbed weakened soil cleaned out and be backfilled with compacted select material in a controlled manner.
- Following stripping, the exposed ground surface should be proof rolled under the supervision of an experienced geotechnical engineer to detect any soft or loose material and to compact the surficial sands. Soft/Loose soils, particularly soft clays and loose surface silty sands, should preferably be removed. In areas of cut, proof rolling shall be deferred until after the cut operation and sufficient compaction should be achieved. The insitu soils, where free of organic and deleterious material, may be used for structural fill. Mimimal difficulties are envisaged to be encountered in compacting the clean sands encountered in the higher level areas of the site, using conventional earthworks techniques.
- Guidelines for minimum relative compaction values for insitu soils and imported fill for the building and pavements are presented in Table 3 below.

TABLE 3 MINIMUM RELATIVE COMPACTION

Location	Minimum Density Index (%)
Building Areas - residential houses	65%
Pavement Area	
a) >0.3m below pavement subgrade	65
b) ≤0.3m below pavement subgrade	75

- Field density testing in the form of Dynamic Cone Penetrometer tests should be carried out to check the standard of compaction achieved. The frequency and extent of testing should be as per guidelines in AS.3798-1996, Section 8.0.
- Backfilling for service trenches, etc. should use good quality clean sand material. The backfill should be placed in uniform layers over the full width of the excavations with the layers not exceeding 200mm loose thickness. The backfill material should be compacted to the specifications outlined above. Testing to confirm that the required degree of compaction has been achieved should be undertaken during the backfilling operation.
- Most soils encountered on site should be within the excavation limits of a small dozer (eg. Cat D4 or similar) in bulk earthworks and a medium sized backhoe (eg. Case 580 or similar) in trench excavations, however, consideration as to the use of larger equipment should be given based on the earthworks quantities involved.

Dynamic Compaction

Consideration could be given to the use of high energy impact rollers or dynamic compaction to compact insitu soils (where required, ie. in areas of unit buildings) and to compact large thickness fill lifts.

The decision to use dynamic compaction will depend on the availability of equipment and the effectiveness of the various options. It is essential that compaction trials be carried out to determine the effectiveness of any proposed dynamic compaction method.

Laboratory testing carried out to date indicates that the majority of sands are “clean”, ie. less than 1 to 2% fines (clay and silt) and on this basis, loose sands would be considered suitable for dynamic compaction.

Of the above mentioned options, high energy impact rolling is expected to be the fastest option to achieve the required densification.

It is recommended that companies specialising in high energy impact compaction be approached as to the suitability and effectiveness of high energy impact compaction methods on this site.

However, suitably programmed trials should be undertaken to determine the depth and degree of densification achievable. This will also indicate whether high energy impact compaction can achieve the required densification from existing surface level or whether some prior excavation of loose material is required to achieve densification at depth.

It is understood that recent results of impact rolling on similar “clean” sand sites have produced results indicating compaction up to depths in the order of 5m have been achieved. However, it is strongly recommended that a suitably monitored and tested trial area be undertaken using impact rolling to confirm the effectiveness of this technique on this site.

If impact rolling is adopted, it is suggested that a trial program could take the following form:-

- Identify a suitable trial area on site,
- Strip and prepare the selected area,
- Test the existing soil consistency using a combination of DCP's and CPT's,
- Place the required bridging/access layer to allow the impact roller to traffic the site. This layer is likely to be required to be a 400 to 500mm thick imported roadbase/rock material,
- Perform the impact compaction,
- Test the trial area, using a combination of DCP's and CPT's to determine the effects of the compaction, with respect to depth and densification results.

Batters

Considering the proposed maximum height of cut and fill (less than 2m), maximum batter angles of 18^0 (1V:3H) long term, and 30^o short term are recommended. Steeper batters are possible by use of retaining structures. Fill batter slopes are dependent on suitable compaction being achieved.

All fill batters should be overfilled and trimmed back to design profile, no steeper than 1V:2H, to ensure compaction is achieved.

It is essential that batters be suitably protected from erosion and scour by the establishment of ground cover and shrubs, installation of surface drains, etc. Runoff should not be allowed to discharge directly across the batters.

Earthworks Supervision

Given the nature of the earthworks operation, "engineering supervision" of the earthworks operations is recommended.

It is recommended that the following "objectives" (as a minimum) are incorporated into the earthworks specification:-

- Certification that all general earthworks operations (ie. stripping, proof rolling of subgrade, etc.) have been carried out in accordance with the earthworks specification.
- Certification that fill has been placed and compacted to the required minimum density in accordance with the earthworks specification.
- Certification that the controlled fill is suitable for support of conventional high level footings and has a minimum bearing capacity of 150kPa and that suitable compaction has been achieved to prevent potential liquefaction in the event of earthquake conditions, as required.
- Certification that the quality of any fill complies with the earthworks specification requirements.
- Certification that the earthworks have been undertaken in a controlled manner.

It is recommended that all "certification" be signed off by an RPEQ.

6.4 Broadscale Foundation Recommendations

6.4.1 General

It is understood the majority of the proposed development is to generally consist of a typical residential development, with buildings up to two storeys. The building are to be raised off the ground, with suspended timber floors.

In the areas of typical residential construction up to two storeys, where fill is to be placed, the existing surface after stripping should be proof rolled as delineated in Section 6.3; where no fill is to be placed, densification to at least 65% density index to a depth of at least 1.0m should be achieved.

6.4.2 Residential Type Development

It is considered likely that provided suitable control of the bulk earthworks operation is undertaken, in accordance with the recommendations outlined in Sections 6.1, 6.2 and 6.3 the development site will be suitable for the use of high level footings for the support of residential type structures.

Some recompaction of the footings etc. may be required at the time of excavation.

Indicative site classifications of Class 'M' are likely to result for typical residential structures, subject to individual site investigations site specific for each site/structure.

7.0 CONSTRUCTION INSPECTIONS

Inspection and testing of the bulk earthworks should be carried out by Soil Surveys Engineering Pty Limited or a duly qualified and experienced Geotechnical Engineer. Should subsurface conditions other than those described in this report be encountered, Soil Surveys Engineering Pty Limited should be consulted immediately and appropriate modifications developed and implemented if necessary.

8.0 LIMITATIONS

We have prepared this report for the use of **LEIGHTON PROPERTIES PTY LIMITED**, for design purposes in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has not been prepared for use by parties other than **LEIGHTON PROPERTIES PTY LIMITED** or their associated design consultants, ie. Architect and Civil/Structural Engineers. It may not contain sufficient information for purposes of other parties or for other uses.

Soil Surveys Engineering offer a documentation review service to verify that the intent of geotechnical recommendations is properly reflected in the design. It is recommended that clients avail themselves of this service; our standard rates will apply.

P. ELKINGTON (RPEQ 7226)

for and on behalf of
SOIL SURVEYS ENGINEERING PTY LIMITED

APPENDICES

APPENDIX A

NOTES RELATING TO THIS REPORT

INTRODUCTION

These notes are provided by Soil Surveys Engineering Pty Limited (the Company) to complement the geotechnical report in regard to classification methods and field procedures. Not all notes are necessarily relevant to all reports.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Geotechnical engineering involves gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and at the time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

Soils - The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726-1993 (Geotechnical Site Investigations), where appropriate. In general, descriptions cover the following properties - soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geotechnical practice.

Soil types are described according to the dominant particle size and behaviour as set out in AS 1726-1993.

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, shear vane, laboratory testing or engineering examination. The strength terms are defined in AS1726-1993 Table A4.

Non-cohesive soils are classified on the basis of relative density usually based on insitu testing or engineering examination (see AS1726-1993 Table A5).

Rocks - Rock types are classified by their geological names (AS1726-1993 Table A6), together with descriptive terms regarding weathering (AS1726-1993 Table A9), strength (refer Table 1 below), defects (AS1726-1993 Table A10), etc. Where strength testing (ie Point Loads) is carried out, AS1726-1993 Table A8 is used. Where relevant, further information regarding rock classification is attached.

Table 1 Estimated strength descriptions given to rock based on engineering examination

Strength Term	Approximate Qu (MPa)
Extremely Weak	< 1.0
Very Weak	1.0 - 5.0
Weak	5.0 - 25
Medium Strong	25 - 50
Strong	50 - 100
Very Strong	100 - 250
Extremely Strong	> 250

Ref ISRM "Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses"

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon sample disturbance, (information on strength and structure).

Undisturbed samples are taken by pushing a thin walled sample tube, usually 50mm diameter (U50), into the soil and withdrawing it with a sample of the soil contained in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength, volume change potential and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling used are given on the attached logs.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application.

Test Pits - These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling - A borehole of 50 to 100mm diameter is advanced by manually operated equipment. Refusal of the augers can occur on a variety of materials such as hard clay, gravel or rock fragments and does not necessarily indicate rock level.

Continuous Spiral Flight Augers - The borehole is advanced using 75 to 300 mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the augers. Information from the drilling (as distinct from specific sampling) is of relatively lower reliability due to remoulding, inclusion of cuttings from above or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table has a lower reliability than augering above the water table. Various drill bits are attached to the base of the augers during the drilling. The depth of refusal of the different bit types can provide information as to the strength of the material encountered. Generally two different bit types are used. The 'V' bit is a V shaped steel bit and the 'TC' bit is a tungsten carbide tipped screw type bit.

Wash Boring - The borehole is usually advanced by a rotary bit with water or fluid pumped down the hollow drill rods and returned up in the space between the rods and the soil or casing, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from "feel" and rate of penetration. More accurate information on soil strata is gained by regular testing and sampling using the Standard Penetration Test (SPT) and undisturbed thin walled tube samples (U50).

Mud Stabilized Drilling - Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilize the borehole. The term "mud" encompasses a range of products ranging from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from regular intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling - A continuous core sample is obtained using a diamond or tungsten carbide tipped core barrel. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable method of investigation. In rocks, NMLC coring (nominal 52 mm diameter) is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses is determined on site by the supervisor. If the location of the loss is uncertain, it is placed at the top end of the run, when the core is placed in a storage tray and recorded on the log.

Standard Penetration Tests - Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength. 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 50mm diameter split sample tube with a tapered shoe, 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, the upper 150 mm being neglected due to possible disturbance from the drilling method. In dense sands, very hard clays or weak rock, the full 450 mm

penetration may not be practicable and the test is discontinued at a reduced penetration.

In the case where full penetration is obtained with successive blow counts for each 150 mm of, say 4, 6 and 7 blows, the record shows,

4, 6, 7 N = 13

In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm, the record shows:

15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, it is noted on the borehole logs.

A modification to the SPT test is where the same driving system is used with a solid 60^0 tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid SPT are shown as "N_c" on the borehole logs, together with the number of blows per 150 mm penetration.

Cone Penetration Tests - Test Method - Cone Penetration Tests (CPT) are carried out in accordance with AS 1289 Test 6.5.1-1977, using an electrical friction-cone penetrometer.

The test essentially comprises the measurement of resistance to penetration of a cone of 35.7 mm diameter pushed into the soil at a rate of 10-20 mm per second by hydraulic force. The resistance to penetration is recorded in terms of pressure on the end area of the cone (cone resistance, q_c, in MPa) and friction on the side of the 135 mm long sleeve immediately above the top of the cone (friction resistance, f_s, in kPa). These forces are measured by electrical transducers (strain gauges) within the cone device. The ratio between friction resistance and cone resistance is also calculated as a percentage, ie.-

$$Friction\ Ratio\ (FR) = \frac{Friction\ Resistance, f_s\ (kPa) \times 100}{cone\ resistance,\ q_c\ (kPa)}$$

The friction ratio, FR, is generally low in sands (less than 1% or 2%) and generally higher in clays (say 3% or more). The interpretation of sandy clays, clayey sands and material with a high silt content is more difficult, but intermediate values (between 1% and 3%) would be expected. Highly organic clays and peats generally have a friction ratio in excess of 5%.

Static cone data is recorded in the field on disc for later presentation using computer aided drafting.

The equipment can be operated from any conventional drill rig. A total applied load in the range of 4 to 10 tonnes is required for practical purposes, although lighter loads may be used. The cone penetrometers are available with various capacities of cone resistance ranging up to 100 MPa for general purpose investigations, while a range of 0 to 10 MPa can be used where more sensitive investigations of soft clay are required.

The cone resistance value provides a continuous measure of soil strength or density, and together with the friction ratio, provide very useful indications of the presence of narrow bands of geotechnically significant layers such as thin, soft clay layers or lenses of sand which might otherwise be missed using conventional drilling methods.

The lithology of the encountered soils is interpreted from static cone data and is generally presented on the static cone log sheets.

It is important to note that the lithology is interpreted information and is based on research by Schmertmann (1970), Sanglerat (1972), Robinson and Campinalli (1986), modified to suit local conditions as indicated by borehole information and laboratory testing.

As soils generally change gradually it is sometimes difficult to accurately describe depths of strata changes, although greater accuracy is obtained with the static cone compared with conventional drilling. In addition, friction ratios decrease in accuracy with low cone resistance values, and in desiccated soils. As a result, some overlap and minor discrepancies may exist between static cone and nearby borehole information.

Portable Dynamic Cone Penetrometers - Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 100mm increments of penetration.

The DCP comprises a Cone of 20 mm diameter with 30 degree taper attached to steel rods of smaller section.

The cone end is driven with a 9 kg hammer falling 510 mm (AS. 1289 Test 6.3.2). The test was developed initially for pavement subgrade investigations, and empirical correlations of the test results with California Bearing Ratio have been published by various Road Authorities. The Company has developed their own correlations with Standard Penetration tests and Density Index tests in sands.

LOGS

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

The attached explanatory notes define the terms and symbols used in preparation of the logs.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than "straight line" variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

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

- Although groundwater may be present in lower permeability soils, it may enter the hole slowly or perhaps not at all during the time the hole is open.
- A localized 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 and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be bailed out of the bore and mud must be washed out of the hole or "reverted" if water observations are to be made.

More reliable measurements can be made by use of standpipes which are read after stabilizing at periods ranging from several days to 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 perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc.) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse engineering characteristics or behaviour. If the volume and quality of fill is important to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms and the attached explanatory notes summarize important aspects of the Laboratory Test Procedures adopted.

ENGINEERING REPORTS

Engineering reports are prepared by qualified personnel and are based on the information obtained and on 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, the Company 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 aspects and recommendations or suggestions for design and construction. Since the test sites in any exploration represent a very small proportion of the total site and since the exploration only identifies actual ground conditions at the test sites, even under the best circumstances actual conditions may vary from those inferred to exist. No responsibility is taken for:-

- Unexpected variations in ground and/or groundwater conditions.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of other persons.
- Any work where the company is not given the opportunity to supervise the construction using the Companies designs/recommendations.

If differences occur, the Company will be pleased to assist with investigation or advice to resolve any problems occurring.

SITE ANOMALIES

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

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation 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. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer. We would be happy to assist in this regard as an extension of our investigation commission.

SITE INSPECTION

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related.

i) Site visits during construction to confirm reported ground conditions

ii) Site visits to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, the stability of a filled or excavated slope; or

iii) Full-time engineering presence on site.

In the vast majority of cases it is advantageous to the principal for the geotechnical engineer who wrote the investigation report to be involved in the construction stage of the project.

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LEGEND SHEET

Information

DRILLING TYPES
V - open hole drilling using augers and a steel "V" bit
TC - open hole drilling using augers and a Tungsten Carbide bit
WB - wash boring using a drag or blade bit
RR - wash boring using a rock roller bit
NMLC - coring using a NMLC core barrel
Casing - steel casing in hole

DEPTH
Expressed in metres below the surface unless otherwise noted

ROCK DESCRIPTION
Rock name, grain size, colour, texture, fabric and any other relevent comments

WEATHERING GRADES
XW - Extremely Weathered
DW - Distinctly Weathered
SW - Slightly Weathered
FR - Fresh

STRENGTH
(estimate of UCS)
EW- extremely weak <1.0 MPa
VW - very weak 1.0 to 5.0 MPa
W - weak 5.0 to 25.0 MPa
MS - medium strong 25 to 50 MPa
S - strong 50 to 100 MPa
VS - very strong 100 to 250 MPa
ES - extremely strong >250 MPa

CORING DETAILS
Rec - core recovery in each run expressed as a %
RQD - Rock Quality Description expressed as a %

Defect Description

3.00m;J45;p,s,o,z

Depth in metres; Defect Type and angle with the core axis;planarity,roughness,aperture, infill

Defect Type	Planarity	Roughness	Aperture	Infill
J - Joint	p - Planar	s - Smooth	o - Open	z - Clean
F - Foliation	s - Sub-planar	r - Rough	c - Closed	c - Clay
B - Bedding	c - Curvi-linear	v - Very Rough		q - Quartz
V - Vein	u - Undulating	l - Slickensides		k - Calcite
S - Shear Zone				w - Weathered Rock
T - Fault				l - Limonite
C - Clay Seam				
Z - Contorted Zone				
RJ - Relict Joint				

Testing

SPT 10,15,15	SPT testing N value Blows/150mm or as noted
U50 (50) PP = 500 kPa	U50 Tube Samples (% Recovery) Pocket penetrometer reading
VS 1,30,5 : 25	Vane Shear Testing Seating, peak and residual : Corrected value
DIST	Disturbed Samples

Water Intersections

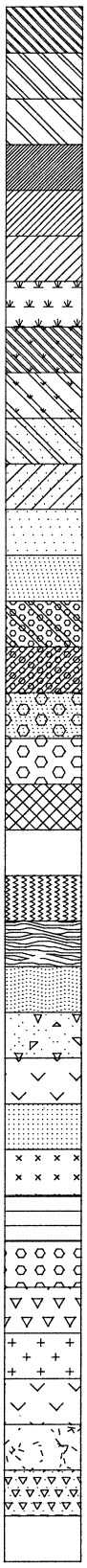
Water steady level

Water first noted

Testing Results

Is50=4 (A) Corrected Point Load Test Result
A - Axial, D - Diametral

Graphic Legend



CH - CLAY of high plasticity

CI - CLAY of intermediate plasticity

CL - CLAY of low plasticity

MH - SILT of high plasticity

MI - SILT of intermediate plasticity

ML - SILT of low plasticity

Pt - PEAT

OH - Organic SILTS and CLAYS of high plasticity

OL - Organic SILTS and CLAYS of low plasticity

SC - Clayey SAND

SM - Silty SAND

SP - poorly graded SAND

SW - Well graded SAND

GC - Clayey GRAVEL

GM - Silty GRAVEL

GP - poorly graded GRAVEL

GW -well graded GRAVEL

Fill

Core loss

Phyllite

Meta-Siltstone

Meta-Sandstone

Greywacke

Tuff

Sandstone

Siltstone

Mudstone

Conglomerate

Breccia

Granite

Basalt

VOLCANIC ASH

VOLCANIC AGGOLMERATE

MARINE DEPOSITS

APPENDIX B

BOREHOLE RECORDS

Soil Surveys Engineering Pty. Limited

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BOREHOLE RECORD SHEET

Borehole Number : 1

Project Number : 208-8487

Project Name : The Kingscliff Resort

Location : Casurina Way, Kingscliff

Client : Leighton Propties

Date : 26/09/2008

Easting : 556977 Northing : 6872947 RL :

Logger : CW Driller : CW Drilling Rig : J105

Drilling Method (V / TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 5 10 15 20 25	Samples and Remarks
	0.40		Silty SAND (SM) Very loose, fine to medium grained, dark brown, fine size gravel, organics, moist.		D
	1.00		SAND (SP) Loose, fine to medium grained, light brown, moist.		D
			SAND (SP) Medium dense, fine to medium grained, light brown, trace of fine shells, moist.		D D D D D
	5.00		SAND (SP) Loose to medium dense, fine to medium grained, light brown, trace of fine shells, wet.		D
	6.00		Borehole Terminated 6.00m		

1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0

COMMENTS

1) Groundwater was observed at 5m.

▼ Water First Noted ▽ Water Steady Level

Approved : _____

Date : / /

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BOREHOLE RECORD SHEET

Borehole Number : 2

Project Number : 208-8487

Project Name : The Kingscliff Resort

Location : Casurina Way, Kingscliff

Client : Leighton Propties

Date : 26/09/2008

Page : 1

Easting : 556716 Northing : 6872849 RL :

Logger : CW Driller : CW Drilling Rig : J105

Drilling Method (V / TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 5 10 15 20 25	Samples and Remarks
	0.00		SAND (SP) Very loose, fine to medium grained, light brown, moist.		D
	0.50		Silty SAND (SM) Very loose, fine to medium grained, dark brown, fine size gravel, moist.		D
	1.0				D
	1.20 ▼		SAND (SP) Loose to medium dense, fine to medium grained, brown, wet.		D
	1.50		SAND (SP) Loose to medium dense, fine to medium grained, light grey brown, trace of fine shells, wet.		D
	2.0				D
	3.0				
	4.0				
	5.0				D
	6.0				
	6.00		Borehole Terminated 6.00m		
	7.0				
	8.0				
	9.0				
	10.0				

COMMENTS

1) Groundwater was observed at 1.2m.

▼ Water First Noted ▽ Water Steady Level

Approved :

Date : / /

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BOREHOLE RECORD SHEET

Borehole Number : 3

Project Number : 208-8487

Project Name : The Kingscliff Resort

Location : Casurina Way, Kingscliff

Client : Leighton Propties

Date : 26/09/2008

Easting : 556777 Northing : 6872796 RL :

Logger : CW Driller : CW Drilling Rig : J105

Drilling Method (V / TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 5 10 15 20 25	Samples and Remarks
	1.0		SAND (SP) Very loose to loose, fine to medium grained, light brown, trace of fine shells, moist.		D D D D D D
	2.0				
	3.0				
	3.60 ▼				
	4.0		SAND (SP) Very loose to loose, fine to medium grained, light brown, trace of fine shells, wet.		D
	5.0				
	6.0				
	6.00		Borehole Terminated 6.00m		
	7.0				
	8.0				
	9.0				
	10.0				

COMMENTS

1) Groundwater was observed at 3.6m.

▼ Water First Noted ▽ Water Steady Level

Approved : _____

Date : ___/___/___

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BOREHOLE RECORD SHEET

Borehole Number : 4

Project Number : 208-8487

Project Name : The Kingscliff Resort

Location : Casurina Way, Kingscliff

Client : Leighton Propties

Date : 26/09/2008

Easting : 556636 Northing : 6872749 RL :

Logger : CW Driller : CW Drilling Rig : J105

Drilling Method (V / TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 5 10 15 20 25	Samples and Remarks
	0.35		Silty SAND (SM) Very loose, fine to medium grained, dark brown, fine size gravel, organics, moist.		D
	0.80		SAND (SP) Loose, fine to medium grained, light brown, moist.		D
	1.60		SAND (SP) Loose to medium dense, fine to medium grained, light brown, trace of fine shells, moist.		D
			SAND (SP) Loose to medium dense, fine to medium grained, light grey brown, trace of fine shells, wet.		D
					D
					D
	4.50		SAND (SP) Loose to medium dense, fine to medium grained, dark grey, trace of fine shells, wet.		D
	6.00		Borehole Terminated 6.00m		

1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0

COMMENTS

1) Groundwater was observed at 1.6m.

▼ Water First Noted ▽ Water Steady Level

Approved : _____

Date : / /

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BOREHOLE RECORD SHEET

Borehole Number : 5

Project Number : 208-8487

Project Name : The Kingscliff Resort

Location : Casurina Way, Kingscliff

Client : Leighton Propties

Date : 26/09/2008

Easting : 556964 Northing : 6872683 RL :

Logger : CW Driller : CW Drilling Rig : J105

Drilling Method (V / TC / WB / RR / NMLC / Casing)	Depth	Graphic	Description	DCP Test (blows/100mm) 5 10 15 20 25	Samples and Remarks
	0.0		SAND (SP) Medium dense, fine to medium grained, mottled light brown and dark brown, organics, moist.		D
	1.0				D
	1.30		SAND (SP) Medium dense, fine to medium grained, light brown, trace of fine shells, moist.		D
	2.0				D
	3.0				D
	4.0				D
	5.0				D
	6.0				
	6.00		Borehole Terminated 6.00m		
	7.0				
	8.0				
	9.0				
	10.0				

COMMENTS

1) Groundwater was not observed. 2) DCP refusal at 1.1m.

▼ Water First Noted ▽ Water Steady Level

Approved : _____

Date : ___/___/___

APPENDIX C

SITE PLAN

LEGEND

	Resort internal circulation lanes	B2	2 Bedroom Bungalow
	On ground pedestrian and ciclyng pathways	B2A	2 Bedroom Fully Accessible Bungalow
	Suspended walkways	B3	3 Bedroom Bungalow
	Fully accessible bungalows	BSB	Beach Side Bungalow
	Asset Protection Zone	MA	Maintenance Area
UP	Unit Pod		
UPA	Fully Accessible Unit Pod		

Supply 10 upgraded car parks See Dwg MP 01-2

CUDGEN CREEK REHAB PRECINCT

CREEKSIDE PATHWAY AS IDENTIFIED BY ECOLOGIST

BH1 BH2 BH3 BH4 BH5

LOT 490

LOT 500

0 50M 75M 100M 125M

AMENDMENTS

REV:	DATE:	DESCRIPTION:	ISSUED BY:
A	02.04.09	NSW DEPT OF PLANNING - DA	NK
B	25.08.09	RE LOCATE PONTOON	TK
C	07.10.09	ADJ. MAIN ROAD TO TRAFFIC ENG. REQ	TK
D	16.10.09	ADJ. ROAD TO MAINTENANCE AREA	TK
E	15.03.10	MP - UPDATE	PL

NOTES:
Verify all dimensions on site before the commencement of any new construction work, alterations or shop drawings - take measured dimensions in preference to any scaled dimensions

Comply to the following or any other relevant codes:
- Building Code of Australia
- Local Authorities Rules and Guidelines
- covenants manual
- Apply all applicable AUSTRALIAN STANDARDS where relevant, including:
- Termite Barrier AS 3660.1
- Access and Mobility Codes AS 1428.1 & 1428.2
Larger Scale Drawings Take Precedence to smaller scale

Kingscliff Resort DEVELOPMENT

LEIGHTON PROPERTIES

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CLIENT.	LEIGHTON PROPERTIES
JOB	THE KINGSCLIFF RESORT
LOCATION	CASUARINA WAY KINGSCLIFF 2487
PROPERTY DESCRIPTION	

JOB No.	1040
DATE.	OCT 09
SCALE.	1:1000@A1 50%@A3
DRAWN.	NK
CHECKED	JMA Architects

DRAWING SET	MASTER PLAN
DRAWING TITLE	SITE PLAN
DRAWING No:	1040 MP-01-3
ISSUE	E
PRINT DATE	16/03/2010

FOR SUBMISSION