Cardno
Geotech Solutions
Shaping the Future

File Reference: CGS2221-004.0

Date: 6 February 2015

Johnson Property Group Pty Ltd
C/- ADW Johnson
Unit 7 / 335 Hillsborough Rd
Warners Bay, NSW 2282

Attention: Sandra Hutton

Cardno (NSW/ACT) Pty Ltd
trading as
Cardno Geotech Solutions
ABN 95 001 145 035

4/5 Arunga Drive
Beresfield NSW 2322
PO BOX 4224
Edgeworth NSW 2285
Australia

Phone: +61 2 4949 4300
geotech@cardno.com.au
www.cardno.com.au

Trinity Mixed Use Development & Marina Project
Modification 5
Trinity Point

Cardno Geotech Solutions is in receipt of the following documents, copies of which are attached to this letter:

1. **NSW Planning & Environment** – Trinity Point Mixed Use Development – Request for Response to Submissions (MP06_039) MOD 5, Undated
2. **NSW Department of Primary Industries, Office of Water** - Subject: Environmental Assessment – Modification Application for Trinity Point Mixed Use Development (MP06_0309 MOD5) ref. ER20178 dated 19 December 2014

Response to Item 1, Clause 5 – Acid Sulfate Soils:

With respect to acid sulfate soils, the proposed development concept is similar in scope to the development concept which has already been approved. In any event, management of acid sulfate soils and management of any acidic water encountered during construction would remain the same for either concept regardless of the footprint of the buildings.

The Acid Sulphate Soils Management Plan attached to our report (*Geotechnical Assessment for Development Application, Commercial, Residential and Marina Development, Trinity Point, Lake Macquarie*, Ref CGS2221-003.0, dated 15 October 2014, Rev 1 dated 6 February 2015) is considered to be appropriate for the proposed development. Please see also comments in section 5.11 in the referenced report.

Response to Item 1, Clause 8 - Construction, dot-point 3:

Based on review of the available documents, the elevations of the under croft car parking areas for the structures in the low-lying northern portion of the site (hotel / marina facility, the restaurant / function centre and portion of Building A) will be from 200 to 400 mm lower than earlier designs.

The lowering of the floor levels for under croft parking will not increase the impact on the groundwater regime or groundwater quality above that of the previously approved design. Water quality and water management during construction are discussed in Sections 5.4 and 5.11 of the referenced report.

Response to Item 2

The geotechnical report (referenced above) addresses the comments in the request for information from the Office of Water. Please refer to Section 5.4 of the referenced report.

It is noted that all future bores will require licence / approval from the Office of Water.

Please note that comment on groundwater based ecosystems is beyond the scope of our expertise.

Yours faithfully,

Jules Darras
Senor Engineering Geologist
For Cardno Geotech Solutions

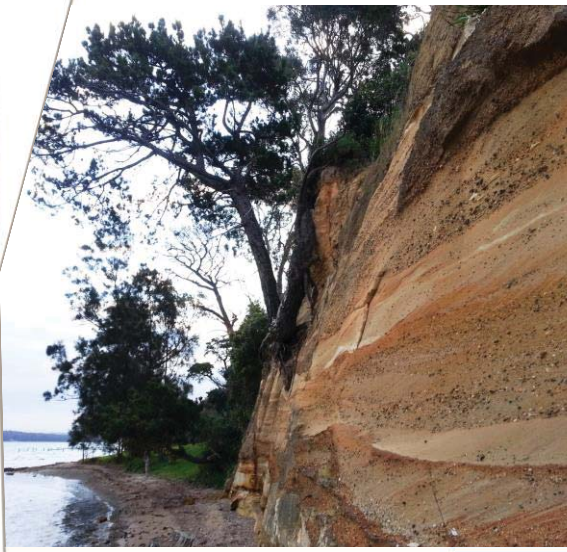
Attachments:

Request for Information Letters

Geotechnical Assessment for Development Application

Commercial Residential and Marina Development, Trinity Point Lake Macquarie

CGS2221



Prepared for
Johnson Property Group Pty Ltd
C/- Squillace Architects

February 2015

Cardno Geotech Solutions
Shaping the Future

Contact Information

Cardno (NSW/ACT) Pty Ltd
Trading as Cardno Geotech Solutions
ABN 95 001 145 035

4/5 Arunga Drive
Beresfield NSW 2322
PO Box 4224
Edgeworth NSW 2285
Australia

Telephone: 02 4949 4300
Facsimile: 02 4966 0485
International: +61 2 4949 4300

geotech@cardno.com.au
www.cardno.com.au

Document Information

Prepared for	Johnson Property Group Pty Ltd C/- Squillace Architects
Job Reference	CGS2221
Project Name	Commercial Residential and Marina Development, Trinity Point Lake Macquarie
File Reference	CGS2221-003.0
Date	February 2015

Document Control

Version	Date	Description of Revision	Prepared By	Prepared (Signature)	Reviewed By	Reviewed (Signature)
0	15/10/14	Initial issue	JD		PB	
1	6/02/15	Minor Revisions	JD		PB	
2	02/03/15	Revision to Table 2-1	JD		PB	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
0	First issue to client	JD		15/10/14
1	Minor Revisions	JD		6/02/15
2	Minor Revision	JD		02/03/15

Table of Contents

Appendices

Tables

1 Introduction

This report presents the results of geotechnical assessment undertaken by Cardno Geotech Solutions (CGS) on the proposed Commercial, Residential and Marina Development at Trinity Point. It is understood that this report will be submitted in support of Development Applications for various stages of the project.

It is understood that the proposed development comprises a commercial complex, a residential complex and a 188 berth marina with associated breakwater. The residential complex comprises eight three and four-storey buildings and the commercial complex comprises a four story hotel/marina facilities building and a two storey restaurant/function centre. Under croft parking is planned for all buildings, and an above ground parking lot and hardstand area are planned as a part of the marina complex. The project concept design is illustrated on the Proposed Concept Plan prepared by Squillace Architects [1]. Additional documents reviewed as a part of this report are summarised in Section 7.

The work was commissioned by Johnson Property Group Pty Ltd C/- Squillace Architects and has been conducted under the terms and conditions of our proposal dated 9 May 2014 (CGS2221-001.0)

1.1 Purpose

The purpose of this report is to summarise available geotechnical data in light of the proposed development concept and to provide preliminary advice for the current design concept including:

- surface and subsurface conditions;
- suitable footing types along with comments on founding levels and preliminary design parameters;
- groundwater and how it may affect the development;
- site preparation and earthworks;
- preliminary pavement thickness design; and
- potential or actual Acid Sulfate Soils.

1.2 Scope of Work

The scope of work undertaken by CGS in preparation of this report includes:

- review of previously prepared geotechnical reports for the site provided by the client;
- review of information from our files from adjacent sites; and
- a walkover site inspection.

2 Proposed Development

The proposed development will include:

- A 188 berth floating dock marina and breakwater with associated access drive, parking area, hardstand area and administration offices. The breakwater will enclose the southern and eastern parts of the marina and will likely be formed by a barrier comprising driven tubular steel piles. Dredging for the marina is not required.
- A commercial precinct comprising one three-four story hotel / marina facilities building and one two-story restaurant / function centre / café with associated intersection and pavement works at the site entrance to Trinity Point Drive.
- A residential precinct comprising six four-story and two three-story buildings. The buildings are nominated on the plans as Buildings A through H.

Under croft parking within the eight buildings in the residential precinct and the two buildings in the commercial precinct is proposed. Parking levels are shown on the project plan ranging from RL 0.8 to RL 4.0. It is anticipated that spoil from excavations to achieve carpark elevations in the southern part of the site will be used to raise the level of the northern part of the site. Miscellaneous

The general layout of the proposed development is illustrated in Figure 1, and the approximate depths of cut required to achieve the levels indicated for the under croft parking is summarised in Table 2-1.

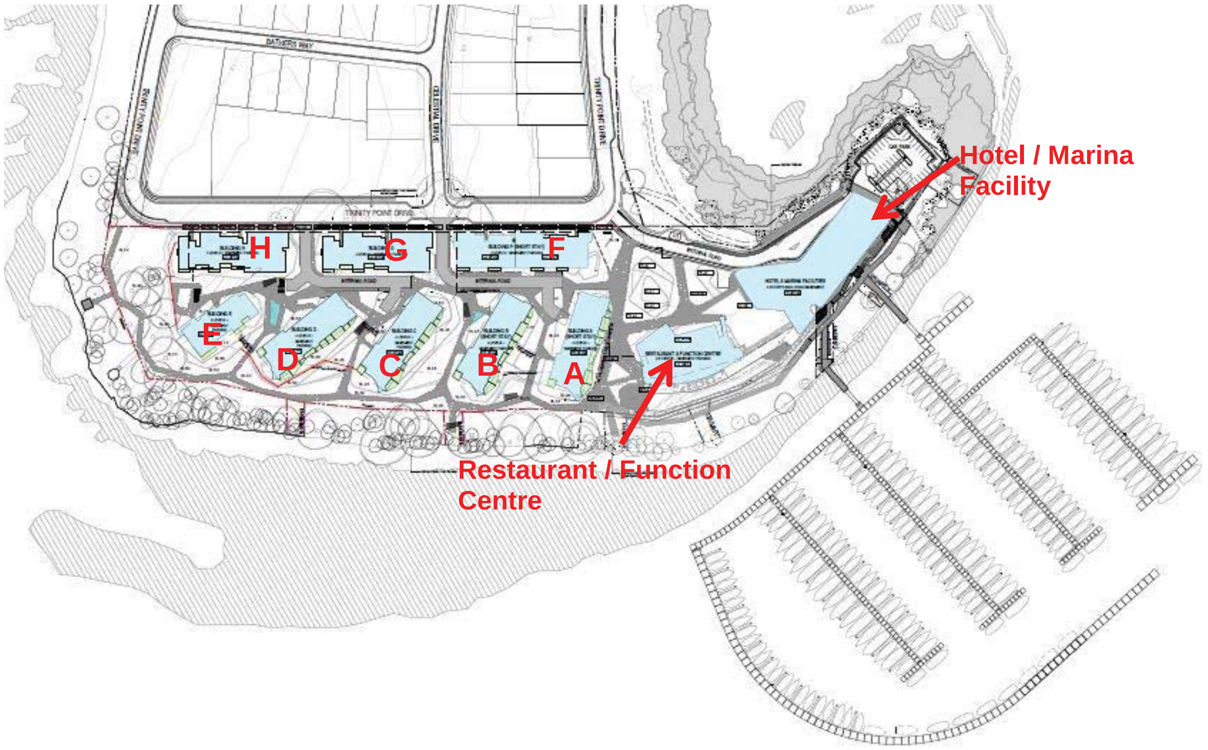


Figure 1: General layout for the proposed development. (Squillace **[1]**)

Table 2-1 Proposed Depth of Cut to Achieve Parking Subgrade Levels

Location	Approximate Ground Elevation (RL) mAHD	Approx. Carpark Elevation (RL) mAHD	Approx. Maximum Cut to Achieve Subgrade (m)[1]
Hotel / Marina Facilities	1.0	0.8	0.7
Restaurant / Function Centre	1.0	0.8	0.7
Residential A	2.0	1.0	1.5
Residential B	2.5 – 3.0	1.0	2.5
Residential C	3.0 – 4.0	1.0	3.5
Residential D	3.5 – 5.0	2.5	3.0
Residential E	6.0 – 7.5	2.5	5.5
Residential F	2.0 – 4.0	1.0	3.5
Residential G	4.0 – 6.5	2.5	4.5
Residential H	6.5 – 8.0	2.5	3.0

Notes to Table
1 – Subgrade level is assumed to be 0.5 m below carpark RL

3 Site Description and Regional Mapping

A walkover site inspection was undertaken on 11 August 2014 by a senior engineering geologist from CGS.

The site is identified on the survey plans as Lot 1, DP 1117408. The site is located in Morisset, on Bluff Point, which is situated on the eastern end of the Morisset Peninsula which extends into Bardens Bay on the western side of Lake Macquarie. The site is approximately 450 m in length (from north to south) and approximately 110 m wide. Elevations range between approximate RL 8.6 mAHD in the south (Bluff Point) to approximately RL 0.5 mAHD in the northern part. The site slopes gently to the north and northeast from Bluff Point which is defined on the southerly side by near-vertical cliffs exposing conglomeritic sandstone. The cliffs are up to approximately 8 m high and are in places undercut by approximately one metre at lake level. The upper portion exposes loose material including soils and blocks up to about 0.5 m least dimension. Boulders along the shoreline at the base of the cliffs are evidence of past rock falls from the cliffs.

The site supports grass and several mature trees, particularly along the shore line. A stockpile of uncontrolled fill including some construction rubble is located along the southwest site boundary.

Historical Google Earth® imagery from 2005 (Figure 2) indicates that the site formerly contained several buildings, a pool and a small dam. The buildings have been demolished; however remnants of slabs and footings along with a garden wall and a survey benchmark remain at the crest of the bluff at Bluff Point. The pool and dam have been infilled. Current conditions are illustrated in Figure 3.

The Gosford-Lake Macquarie 1:100 000 Geological Map Sheet [2] indicates that the site is underlain by rocks mapped as Munmorah Conglomerate, a part of the Clifton Subgroup of the Narrabeen Group. The rocks are described as conglomerate, pebbly sandstone and gray to green shale. There are no faults mapped within the site or projecting directly toward the site, however a dyke is mapped just to the east of the site. No other structural data is indicated on the regional geological mapping.

Outcrops observed at Bluff Point expose near horizontally bedded pebbly sandstone (conglomerate) with occasional internal cross bedding. The conditions exposed on site are consistent with the regional mapping.

The Lake Macquarie City Council Property Enquiry Webpage [3] indicates that the site is located in Geotechnical Zone T0. Geotechnical Zone T0 is not defined; the geotechnical zones normally range between T1 through T6.

The Lake Macquarie City Council Property Enquiry Webpage [3] indicates the site is within areas mapped as Acid Sulfate Soils (ASS) Class 1, Class 2 and Class 5. The areas of the various Classes are not indicated. The implications of ASS classes are summarised as follows:

> Class 1: Council Consent is required for any works.

> Class 2: Council Consent is required for works below natural ground surface and works by which the water table is likely to be lowered beyond one meter below natural ground surface.

> Class 5: Council Consent is required for works within 500 metres of adjacent Class 1, 2, 3, or 4 land, which are likely to lower the water table below one metre AHD on adjacent Class 1, 2, 3 or 4 land.

Figure 2: Google Earth® image circa 2005 illustrating historical site conditions. Approximate north is indicated. Not to Scale.

Figure 3: Google Earth® image circa 2013 illustrating current site conditions. A stockpile of uncontrolled fill including some construction debris is located in the highlighted area. Not to Scale.

4 Previous Investigations

Previous work conducted on the site for a similar earlier development concept included investigations to provide data for:

- A geotechnical report [4];
- an Acid Sulfate Soils report [5] including an Acid Sulfate Soils Monument Plan (ASSMP) [6];
- a geochemical assessment of lakebed sediment and lake water in the area of the Marina [7]; and
- sampling / testing of groundwater from land based piezometers [8].

Previous reports are attached as Appendices B through F of this report.

4.1 Previous Field Work

4.1.1 September 2007

An investigation was undertaken by Douglas Partners in September 2007 and included:

- Six Cone Penetration Tests (CPT) within the proposed marina area (CPT 1 to 6);
- Seven on-land bores (Bores 101, 101A, 102, 102A and 103 to 105);
- Three over-water bores within the proposed marina area (Bores 201 to 203); and
- Ten test pits across the site (Pits 301 to 310).

The CPTs comprise hydraulically pushing a 35 mm diameter instrumented cone and friction sleeve assembly into the ground from a ballasted truck. The CPTs were pushed to refusal, which varied from 9.6 m depth (CPT 3) to 13.1 m depth (CPT 4) below the surface.

Bores 101 to 105 were drilled using a truck mounted drilling rig. Standard penetration tests (SPTs) were undertaken at regular depth intervals in soils. The target depth for Bores 101 and 102 was 6 m into rock, while the target depth for Bores 103 to 105 was 5 m or refusal. Groundwater monitoring wells were installed in each of these bores on completion.

Bores 101A and 102A were drilled with hollow flight augers for the purpose of installing a second, monitoring well adjacent to each of Bores 101 and 102, respectively.

The over-water bores (201-203) were drilled using a truck mounted drilling rig on a barge. The target depth for the over-water bores was 3 m into rock. Bore 201 was abandoned before reaching the target depth due to adverse weather conditions.

The test pits were excavated using a backhoe to target depths of between 2 m and 3 m.

The locations of the previous bores, CPT and test pits are illustrated on Drawing 1 attached in Appendix A of this report.

4.1.2 May 2008

Additional investigation was undertaken in May 2008 by Douglas Partners comprising sampling and testing water recovered from the piezometers that were installed as a part of the 2007 field work.

4.2 Subsurface Conditions

The subsurface conditions comprise sandstone overlain by residual soils in the south elevated portion of the site. The central and northern portions of the site are underlain by alluvium comprising variable mixtures of sand, silt and clay. The surficial alluvial soils thin toward the south.

Alluvium depth in the far northern portion of the site was encountered to a depth of 12.8 m in BH101 and 11.4 m in Bore 102. Groundwater was within 1 m of the ground surface in the lower elevations of the site at the time of the investigation and very soft/loose to firm conditions were encountered in alluvial soils to a depth of approximately 5.5 m below ground surface in Bores 101 and 102. Below approximately 5 m depth, the consistency of the soils was logged as firm to very stiff.

In the central portion of the site, Bore 103 encountered alluvium comprising medium dense to dense sand and very stiff clay to the target depth of 6 m. Water was encountered at a depth of 4 m. Similar conditions were encountered in Bore 104, however bedrock was encountered at a depth of 4.2 m. Fill was encountered to a depth of approximately 1 m deep in Bores 103 and 104.

Bore 105 located in the southern elevated portion of the site was logged as Silty Sandy Clay to a depth of 5.0 m; however, based on review of the log for Bore 105 and inspection of nearby outcrops, it is considered that the material encountered in the bore was likely extremely weathered bedrock overlain by residual soil approximately 2 m thick. Fill approximately 1 m deep was encountered in Bore 105.

The over-water bores in the marina area encountered very loose/soft lake deposits overlying alluvium comprising soft to very stiff clay and loose to very stiff [sic] clayey sand. Bedrock was encountered at depths of RL -11.7 mAHD in BH 201, RL -12.0 mAHD in BH 202 and RL – 13.2 mAHD in BH 203. The bedrock is described in B 203 as having soil like properties to a depth of RL -16.5 mAHD at which depth the conglomerate attained a very low to low strength.

Test pits encountered fill and natural alluvial soils and in the northern portion of the site and fill and residual soils overlying extremely weathered bedrock in the southern portion.

Depth to rock is summarised in Table 4-1, and the locations of the exploratory holes are illustrated on Drawing 1 in Appendix A.

The logs from the previous subsurface investigation are included in the report for earlier investigations appended to this report.

4.3 Groundwater

Groundwater (standing or seepage) was observed in most of the land based bores and test pits as summarised in Table 4-1. Groundwater monitoring wells were installed as part of the previous investigations in Bores 101 to 105, 101A and 102A for groundwater level monitoring and to recover samples for chemical analysis.

Only one badly damaged piezometer was located during our recent walkover inspection, and groundwater levels could not be confirmed as a part of this study.

Table 4-1 Summary of Subsurface Conditions

Test Location	Approximate Surface Elevation (mAHD)	Depth to Rock (m)	AHD Rock (m) (mAHD)	Depth to Water (m)	Water (mAHD)
CPT 1	0.67	11.4[1]	-10.73	0.5	0.2
CPT 2	0.81	12.6[1]	-11.79	0.5	0.3
CPT 3	0.92	9.6[1]	-8.86	0.9	0.0
CPT 4	0.99	13.1[1]	-12.11	0.8	0.2
CPT 5	0.78	10.6[1]	-9.82	0.4	0.4
CPT 6	1.05	10.6[1]	-9.55	0.7	0.4
Bore 101	1.27	12.8	-11.53	1.2	0.7
Bore 101 A	1.27	NE (3.5)[2]	NE	1.15	0.12
Bore 102	0.89	11.4	-10.51	0.88	0.01
Bore 102 A	0.89	NE (3.7)[2]	NE	0.83	0.06
Bore 103	2.47	NE (5.95)[2]	NE	1.63	0.84
Bore 104	3.82	4.2	0.38	2.93	0.89
Bore 105	6.62	1.5[3]	5.12	dry	dry
Bore 201[4]	-5.86	5.8	-11.66	NA[4]	NA[4]

Test Location	Approximate Surface Elevation (mAHD)	Depth to Rock (m)	AHD Rock (m) (mAHD)	Depth to Water (m)	Water (mAHD)
Bore 202[4]	-5.15	6.9	-12.05	NA[4]	NA[4]
Bore 203[4]	-5.35	7.9	-13.25	NA[4]	NA[4]
Test Pit 301	0.96	NE	NE	1.5	0.54
Test Pit 302	0.97	NE	NE	1.3	0.33
Test Pit 303	1.21	NE	NE	1.4	0.19
Test Pit 304	1.16	NE	NE	1.0	0.16
Test Pit 305	1.15	NE	NE	1.0	0.15
Test Pit 306	1.12	NE	NE	1.1	0.02
Test Pit 307	1.78	NE	NE	1.5	0.28
Test Pit 308	2.6	1.3	1.3	NE	NE
Test Pit 309	3.0	1.0	2.0	NE	NE
Test Pit 310	4.4	0.8?	3.6	NE	NE

Notes to table:
1 – Depth of CPT refusal, inferred to be top of rock
2 - Total depth drilled shown in parenthesis
3 – Inferred depth to extremely weathered rock
4 – Over water borehole depth to water not applicable
NE – Not encountered

4.4 Laboratory Testing

Geotechnical testing undertaken during previous investigations included:

- Particle Size Distribution tests;
- Plasticity Index and linear shrinkage tests;
- Soil Aggressivity tests; and
- Point load testing of recovered rock core.

Chemical testing undertaken during previous investigations included:

- Acid sulfate screening; and
- Contamination screening of the lake sediments, lake water and water from the borehole piezometers.

In Summary, the results of the geotechnical testing undertaken fall within the range of normal conditions for the materials encountered on site.

Environmental screening tests of groundwater obtained from the onshore borehole locations indicate that detectable amounts of several analytes were encountered; however, the data was not compared to any guidelines. The data was collected to provide a background water quality data for future reference [8].

Statistical analysis of the laboratory results of the geochemical testing of lake sediments indicates that while individual results exceed trigger values for both arsenic and cadmium, the calculated 95% UCL for each was below the ANZECC ISQG low-trigger values [7].

Acid Sulfate Soils tests indicate that Actual and Potential Acid Sulfate Soils are present in the low-lying areas of the site including the lake sediments [5].

Test results and further details of laboratory testing are contained in the reports appended to this document.

5 Comments and Recommendations

5.1 General

Based on our site visit and review of the data available, it is considered that the site is suitable for the proposed development from a geotechnical viewpoint provided that the comments in the following sections are considered in the design and construction. The comments below assume that detailed investigation tailored to specific building requirements and / or conditions of the DA will be undertaken during the detailed design stage of project development.

Bedrock is present near the surface in the southern elevated portion of the site. Bold outcrops of sandstone and conglomerate are exposed in the near-vertical cliffs at Bluff Point in the southern extremity of the site. The northern portion of the site is characterised by poor ground conditions as a result of alluvial soils up to 12.8 m deep and shallow groundwater.

5.2 Footings

5.2.1 Deep Footings

The alluvial soils in the northern portion of the site in their current condition are not considered suitable for support of structures or pavement. It is anticipated that piles founded on bedrock will be required for all structures in the central and northern portion of the site. Pile design parameters outlined in the previous geotechnical report [4] are considered to be reasonable, but subject to review and confirmation by further structure specific geotechnical investigation during the detailed design phase.

Due to the saturated condition of the alluvial soils in the northern portion of the site, unsupported bored piles are not recommended unless supported by temporary or permanent liners. Casing will likely need to be driven ahead of the boring to the bedrock. Installation of concrete by the tremie method will be required.

Concrete screw cast piles / CFA piles (e.g. Frankipiles®) and driven piles are considered suitable alternatives to bored piles. Driven piles could generally be anticipated to be driven easily to bedrock, although gravely bands in the alluvium may be locally problematic. The effects of ground vibration on adjacent properties must be considered if driven piles are employed.

The preliminary pile design parameters provided in the previous investigation [4] are considered to be reasonable for planning purposes and are reproduced in Table 5-1.

Detailed pile design parameters should be provided specific to the proposed development once detailed plans become available. Additional subsurface investigation may be required to reduce the level of uncertainty in strata levels and design parameters.

Table 5-1 Preliminary Pile Design Parameters

Unit	Allowable Shaft Adhesion (kPa)	Allowable End Bearing Pressure (kPa)
Alluvial and residual soils	-	-
Extremely low strength rock	40	550
Low strength rock	120	1200
Medium strength rock	280	2800

5.2.2 Marina Piles

It is anticipated that the marina structures including the breakwater and docks will be supported on tubular steel piles. Vertical loads for the marina piles are anticipated to be relatively light.

The critical design aspect of the marina piles will be the lateral loading imposed by wind, wave/current and impact loading due to potential collision. Wind loading on moored vessels transferred to the piles through the dock structure will be substantial and must be considered. Wave action on the breakwater piles will also need to be considered. Piles for the marina should be designed in accordance with the Engineering Standards and Guidelines for Maritime Structures [9].

Materials encountered in the marina area include soft lake sediments (1.7 to 3.0 m thick) overlying stiff/dense clay, silty clay or clayey sand (approximately 3 to 5 m thick) in turn overlying highly weathered bedrock [4]. The RL of the top of rock in the marina area is summarised in Table 4-1.

The preliminary pile design parameters for the marina given in the previous report [4] are considered to be reasonable for the rock, however the stiff clayey materials overlying the rock will contribute to resisting lateral loads and should also be considered in pile design.

Cathodic protection may be required to resist corrosion of steel elements.

Preliminary design parameters for marina piles are given in Table 5-2.

Table 5-2 Marina Preliminary Pile Design Parameters

Unit	Range of base of unit (RLm)	Allowable Shaft Adhesion (kPa)	Allowable End Bearing Pressure (kPa)	Undrained Shear Strength (kPa)
Soft sediments	-7.3 to -8.3	-	-	-
Stiff Clay, silty clay or clayey sand	-11.6 to -13.2	25	100	40 (clay or silty clay) 80 (clayey sand)
Extremely low strength rock	-12.5 to -13.8 or deeper	40	550	
Very low strength rock	na	120	1200	

5.2.3 Shallow / High Level Footings

Shallow footings are not recommended for any structure in the northern portion of the site.

The previous report [4] suggests that raft slabs designed on an allowable bearing pressure of 10 kPa and placed over a 0.5 m thick bridging layer may be suitable in some cases to avoid the use of piles in parts of the low-lying areas. Settlement due the loading imposed by a raft slab on 0.5 m of filling was estimated at 50 mm with a potential of differential settlement or up to 33 mm as a result of variable ground conditions.

Buildings in the southern elevated portion of the site may likely be supported on conventional strip and pad footings subject to additional site-specific investigation.

Strip or pad footings for buildings in the southern elevated portions of the site that are founded in very stiff clay or weathered bedrock may be proportioned based on an allowable bearing pressure of 200 kPa or 500 kPa respectively. All footings for a single structure should bear on strata of similar composition, consistency and reactivity. Footings should not span a transition between varying bearing material unless the structural design can accommodate differential settlement.

5.3 Settlement

The alluvial soils in the central and northern portions of the site will settle as a result of any load imposed by structures or filling. Although not indicated on the current concept plans, it is anticipated that excavated material from the under croft parking in the southern portion of the site will be used to raise the elevation of the northern portion of the site.

Previous reports estimated settlement of up to 50 mm under loading imposed by a raft slab overlying 0.5 m of fill.

The amount and duration of future settlement under loading from future filling in excess of 0.5 m has not been assessed. Total settlement will be a function of the magnitude / extent of the future loads, the type of subsurface strata and the ability of the substrata to dissipate pore pressure. Settlement of sandy strata is anticipated to be taken up largely during construction; however settlement of clayey material could take months or years.

A fill surcharging and settlement monitoring programme can be designed to match project objectives; however, additional investigation and analysis will be required during the detailed design phase.

The potential for shear failure resulting in lateral spreading or slope failure as a result of the rapid application of fill loads must be considered in the design of filling and or surcharging. A staged filling operation may be required.

5.4 Groundwater

Shallow groundwater was encountered in the northern low-lying portion of the site during previous investigations [4] and around the perimeter adjacent to the shoreline. Shallow groundwater in the northern low-lying portion of the site will have an impact on the proposed development. Shallow groundwater may require management during construction of the proposed marina/hotel facility, the restraint/function centre, the under croft parking at residential blocks A, F, G and H and underground services in the northern portion of the site. Dewatering (Section 5.4.3) may be required during construction, and buoyancy forces will need to be considered for any structural elements located below groundwater level.

The shallow ground water in the northern portion of the site is considered to have connectivity with Lake Macquarie, however is deemed to be relatively more isolated from deeper aquifers by the clayey residual soil underlying the alluvial / lake deposits.

A search of the NSW Natural Resource Atlas (Figure 4) indicates that 5 bores are located on or near the site. No information regarding these bores is available through the website, however their position corresponds with the locations of the boreholes that were undertaken as a part of the previous investigations on site [4]. Groundwater was recorded at approximate RL 0 in bores BH101, BH102, and BH104. Water level was recorded at approximately RL -1.5 in BH 103. Groundwater was not encountered in BH 105, however it was not advanced deeper than approximate RL +1.6. Groundwater was recorded a near RL 0 in the CPT probes undertaken adjacent to the lake.

No extraction bores or groundwater users are located within near the site are recorded in the atlas.

Although the shallow groundwater in the northern portion of the site will affect the development, the proposed development is not anticipated to have a detrimental effect on the local or regional groundwater regime or on groundwater quality. The development may impact future access to the isolated areas where groundwater of marginal quality has been identified (Figure 4). It should be noted that there are no groundwater users currently accessing or extracting from these areas.

Figure 4: Groundwater Availability (1995-2002) from the NSW Natural Resource Atlas (http://www.nratlas.nsw.gov.au/wmc/savedapps/nratlas) accessed 3 January 2015**.** Isolated areas identified with 'marginal' water availability are indicated. The blue dots correspond with the borehole locations undertaken in previous investigations. (Note: groundwater availability areas within the site have been highlighted in red for clarity.)

5.4.1 Groundwater Flow, Gradient and Yield

Detailed groundwater flow analysis has not been undertaken, however the data from the borings conducted as a part of the previous investigation [4] and geomorphology suggest that flow and gradient are toward the lake.

Based on the material descriptions in the logs [4], it is anticipated that the rate of groundwater inflow to temporary excavations required during construction can likely be managed by sump and pump methods. Dewatering may be required for deeper excavations. Yield analysis including permeability and slug testing should be undertaken when the development plans are finalised for specific design elements that will require groundwater management during construction. All water discharged must be treated in accordance with the ASSMP [6] and Hunter Water guidelines.

5.4.2 Groundwater Chemistry

Lake sediment and water chemistry data [7] and groundwater chemistry data [8] has been previously collected for the purpose of establishing a pre-development base line for comparison with future assessments. The results sediment and water chemistry testing data are summarised in the reports attached as Appendix E and Appendix F of this report. The data are considered to be sufficient to establish a base line for comparison with future analysis.

5.4.3 Dewatering

Groundwater management will likely be required during construction to accommodate the subgrade for under croft parking and utility excavations in the low-lying portions of the site.

Sump and pump methods will likely be workable for relatively shallow temporary excavations required during construction, i.e. under croft parking and underground services.

Dewatering wells may be required during construction for excavations for a sewer pump station or for subsurface fuel storage tanks in the vicinity of the marina. A series of temporary dewatering wells (combined with temporary sheet piling) along the excavation perimeter may be a viable to method to temporarily ameliorate groundwater inflow during construction in isolated locations.

The need for ongoing dewatering after the construction period is not anticipated.

All water discharge must comply with the Acid Sulfate Soils Management Plan [6] and Hunter Water regulations if sewer disposal is proposed. A license will be required for any dewatering wells and a licence will be required for any discharge of water generated during construction.

Structures should be designed in consideration of potential buoyancy uplift forces as a result of elevated groundwater and potential tidal/seasonal groundwater level changes. Sub-lab moisture barriers should be incorporated into the design of the under croft slab and stem walls if damp conditions within the structures are not tolerable. The under croft parking may have to be fully tanked to prevent ingress of groundwater.

5.4.4 Groundwater Protection, Monitoring and Reporting

Subsurface fuel storage tanks, if planned, must be installed in accordance with UPSS 2008 [10] guidelines and protocols. If Underground fuel storage tanks are planned, a system for permanent groundwater monitoring wells must be incorporated into the design. Periodic sampling and contamination screening should be undertaken to show compliance with ANZECC 2000 guidelines [11] and USPP 2008 guidelines [10]. Reporting procedures including a mechanism for transfer of information to the NSW DPI Office of Water should be prepared in association with the monitoring programme.

Other than possible underground fuel storage tanks, it is not anticipated that the development will include components likely to produce contamination that could affect groundwater quality.

Any construction or excavation in areas where Acid Sulfate Soils have been identified must be undertaken in accordance with the Acid Sulfate Soils Management Plan [6], including establishing a baseline with respect to Acid Sulfate Soils prior to construction. Remedial measures and contingency plans for management of ASS should be confirmed when the configurations of the specific design elements are finalised.

5.5 Liquefaction

The alluvial soils may be prone to liquefaction under dynamic loading or as a result of a seismic event. The potential for liquefaction has not been assessed.

The potential for liquefaction, if present, could be reduced by densification of the liquefiable zones by surcharging along with reducing pore pressure by means of wick drains, rock chimneys or other means.

5.6 Excavation

Trench excavations in the clay soils and extremely weathered rock in the southern portion of the site could be expected to stand close to vertical in the short-term. Unsupported short-term excavations or trenches may undergo some local slumping into the excavation where sandy layers or zones occur within the extremely weathered rock and residual soil profile.

Excavations in the lower northern portion of the site will likely expose wet sandy material that will not stand without support.

Where personnel are to enter excavations, options for short-term excavations include benching or battering back of the excavations to 1H:1V or the support of excavations within the residual soil and extremely weathered rock profile.

It is recommended that long-term excavations should be either battered at 2H:1V or flatter and protected against erosion or be supported by engineer designed and suitably constructed retaining walls. Excavations may be battered steeper than 2H:1V in rock materials, subject to specific geotechnical assessment

5.7 Earthworks

It is anticipated that material excavated from the excavations within the site will may be used to raise the elevation of portions of the low-lying northern portions of the site, depending on staging.

5.7.1 Site Preparation

Where filling is required, topsoil stripping should be minimised to avoid exposing boggy subsoils. The use of heavy equipment may be problematic during the initial stages of filling. A granular bridging layer and or geogrid / geotextile may be required to create a working platform for future filling. The bridging material should comprise angular granular material with a nominal diameter of less than 150 mm. A geofabric layer may facilitate installation of the bridging layer / first layers of fill. The bridging layer material should contain sufficient fines to minimise voids.

5.7.2 Filling

If substantial filling or surcharging is planned, then a sequencing programme may be required to reduce the potential for shear failure of the subsoils. Additional analysis will be required to provide detailed filling recommendations suitable to the finalised design plans.

In general, all fill placed (with the exception of a fill surcharge) should be placed as a controlled fill as defined in Section 2.5.3 of AS 2870-2011 [12] per the guidelines in AS 3798-2007 [13].

Once a suitable bridging layer has been established, fill should be placed and compacted in accordance with AS 3798-2007, Guidelines on Earthworks for Commercial and Residential Development [13]. Construction of a suitable fill platform would include the following:

- Where a bridging layer is not required, the subgrade should be stripped of topsoils and proof rolled to confirm that there are no loose/soft areas remaining in the area to receive fill. Loose/soft subgrade areas should be excavated and replaced with compacted fill. All uncontrolled fill should be removed to expose a suitable subgrade.
- Spread loose material not in excess of 300 mm thick over a horizontal surface,
- Adjust the moisture content if necessary to between 85% and 115% of standard optimum moisture content;
- Compact each lift to 98% standard relative compaction;
- Where necessary, bench of the exposed subgrade if the subgrade slope is steeper than 8:1 (H:V) or approximately 7°.
- Deep benching may be required where colluvial soils are present on natural slopes particularly where future fill batters daylight on natural ground inclined steeper than 8:1 (H:V). The requirements for benching should be confirmed by the geotechnical consultant during earthworks.
- Any seepage in subgrade in areas that requiring benching shall be collected by a subsoil drain. Subsoil drainage, if required shall be designed by the geotechnical consultant during earthworks.

Care is required to ensure that compaction is achieved over the entire fill area, particularly adjacent any vertical excavated faces. This may require benching to allow compaction equipment to achieve full compaction to the edge. Alternately, the use of hand compaction equipment may be required.

All fill should be supported by properly designed and constructed retaining walls or else battered at a slope of 2H:1V or flatter and protected against erosion by vegetation or similar and the provision of adequate drainage.

Properly compacted fill batters may be constructed up to 6 m high at gradient of 2H:1V or flatter. Specific geotechnical advice is required for higher or steeper batters.

Materials excavated on site with the exception of topsoil and other deleterious materials, are considered suitable for re-use as engineering fill. The materials may require treatment or moisture re-conditioning, subject to further assessment and weather conditions prior to and during construction.

5.8 Pavements

Pavement design outlined in the previous investigation [4] Appendix B is considered reasonable for planning purposes. The proposed parking area and drive will likely be underlain by fill generated from earthworks within the site. CBR and pavement design should be confirmed after the completion of earthworks.

Preliminary pavement design from the previous investigation [4] is reproduced in Table 5-3. The pavement design including the ESA will need to be revised based on actual subgrade conditions.

Table 5-3 Preliminary Pavement Thickness Design

Pavement Layer	Main Driveways ($3x10^5$ ESA) (mm)	Carpark ($8x10^3$ ESA) (mm)
Wearing Course	40[1]	30[2]
Base Course	110	100
Subbase	100	100
Total	**255**	**230**

Notes:
1 - AC14 or equivalent
2 – AC10 or equivalent
Where asphalt is used as a wearing course, a 7 mm prime seal should be applied on the base.

Material quality and compaction requirements from the previous report [4] are summarised in Table 5-4.

Table 5-4 Material Quality and Compaction Requirements

Pavement Layer	Material Quality	Compaction
Basecourse	CBR > 80%, PI = 6%, Grading in accordance with RTA Form 3051	Compact to at least 98% dry density ratio Modified (AS 1289.5.2.1)
Subbase	CBR > 30%, PI = 12%, Grading in accordance with RTA Form 3051	Compact to at least 95% dry density ratio Modified (AS 1289.5.2.1)
Select Subgrade	CBR =15%	Compact to at least 100% dry density ratio Standard (AS 1289.5.1.1)
Natural subgrade	CBR =5%	Compact to at least 80% density index (AS 1289.6.2.1) or 100% Dry Density Modified (AS 1289.5.2.1)

5.9 Mine Subsidence

The site lies within a mine subsidence district, and the development will require approval of the mine subsidence board. The MSB has indicated that there are no previous workings beneath the site, however the mining may occur beneath the site in the future. As indicated in correspondence from the MSB dated 9 December 2014, approval would be subject to the project components being designed in accordance with the following:

Area A: Development on land below RL2.0AHD

> Maximum vertical subsidence = 50 mm
> Maximum horizontal ground strains = ± 1 mm/m
> Maximum tilt = 1 mm/m.
> Maximum Radius of Curvature = 10 km.

Area B: Development of land above RL2.0AHD

> Maximum vertical subsidence = 150 mm
> Maximum horizontal ground strains = ± 2 mm/m
> Maximum tilt = 2 mm/m.
> Maximum Radius of Curvature = 5 km.

Area C: Development of land over the water including the Marina

- Maximum vertical subsidence = 400 mm
- Maximum horizontal ground strains = ± 4 mm/m
- Maximum tilt = 7 mm/m.
- Maximum Radius of Curvature = 2.5 km.

5.10 Slope Stability

The near vertical cliffs at Bluff Point at the south of the site are up to 8 m high and in places are undercut by wave activity at the toe. The upper portion exposes loose material including soils and blocks up to about 0.5 mm least dimension. Numerous blocks of sandstone along the shore line indicate the erosion is affecting the cliffs. Establishing a cliff top retreat rate is beyond the scope of this investigation.

No development is planned in the immediate vicinity of the seacliffs, however as a guideline any structures in the vicinity of the cliffs should be set back from the cliff top twice the height of the cliff. The cliff top is defined as the point at which the ground surface exceeds an angle 25$^{o.}$

5.11 Acid Sulfate Soils

Potential and actual Acid Sulfate Soils were detected in the previous investigations [5]. The study is considered to be applicable to the current development concept.

All excavation and dewatering (if necessary) should be undertaken in accordance with the guidelines outlined in the Acid Sulfate Soils Management Plan [6] and in Section 5.4.3 above.

Note: Although the ASSMP was prepared for an earlier development concept, the current development concept is similar in scope and extent and is not likely to result in a substantially greater impact to potential or actual Acid Sulfate Soils. The ASSMP [6] remains applicable to the current development concept. Regardless of building footprint size, the management of Acid Sulfate Soils would be the same for the current and for previously approved development concepts.

6 Limitations

Cardno Geotech Solutions (CGS) has performed investigation and consulting services for this project in general accordance with current professional and industry standards. No subsurface investigation was undertaken in preparation of this repot; we have relied on information from previous investigations. The extent of testing for the previous investigations was limited to discrete test locations and variations in ground conditions can occur between test locations that cannot be inferred or predicted.

A geotechnical consultant or qualified engineer shall provide inspections during construction to confirm assumed conditions in this assessment. If subsurface conditions encountered during construction differ from those given in this report, further advice shall be sought without delay.

Cardno Geotech Solutions, or any other reputable consultant, cannot provide unqualified warranties nor does it assume any liability for the site conditions not observed or accessible during the investigations. Site conditions may also change subsequent to the investigations and assessment due to ongoing use.

This report and associated documentation was undertaken for the specific purpose described in the report and shall not be relied on for other purposes. This report was prepared solely for the use by Johnson Property Group Pty Ltd C/- Squillace Architects and any reliance assumed by other parties on this report shall be at such parties own risk.

7 References

[1] Squillace Architects, *Trinity Point Marina and Mixed Use Development, Morisset PArk Rd, Morisset Park - Concept Proposal,* 2014.

[2] Newcastle Coalfield Regional 1:100 000 Geology Map, “Geological Series Sheet 9231, and part of 9131, 9132 and 9232 (Edition 1),” Geological Survey of NSW, Department of Mineral Resources, 1995.

[3] LMCC, “Lake Macquarie City Council Property Enquiry,” LMCC, 2014. [Online]. Available: http://apptracking.lakemac.com.au/modules/PropertyMaster/default.aspx.

[4] Douglas Partners, “Report on Geotechncial Investigtion, Proposed Trinity Point Marina and Tourist Development, 49 Lakeview Road, Morisset Park, Project 89823,” 2007 December.

[5] Douglas Partners, “Acid Sulphate Soil Assessment, Proposed Trinity Point Marina and Tourist Development, 49 Lakeview Road, Morisset - Job No 89823A,” 2007 December.

[6] Douglas Partners, “Acid Sulphate Soil Management Plan, Proposed Trinity Point Marina and Tourist Development, 49 Lakeview Road, Morisset Park - Job no. 39823A,” 2007 December.

[7] Douglas Partneres , “Report on Geochemical Assessment, Proposed Trinity Park Marina, Morisset Park, Lake Macquarie - Job No. 39823B,” 2007 December.

[8] Douglas Partners, “Additional Groundwater Sampling and Testing, Trinity Point MArina, Morisset Park 89823.04,” May 2008.

[9] NSW Maritime, “Engineering standards and guidelines for design of maritime structures,” NSW Maritime, 2005.

[10] NSW, *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008,* NSW, 2008.

[11] ANZECC National Water Quality Management Strategy, Paper No. 4: Australian and New Zealand Guidelines for Fresh and Marin Water Quality, Australian and New Zealand Environment and Conservation Council, October 2000.

[12] Australian Standard AS2870-2011, “Residential Slabs and Footings,” Standards Australia, 2011.

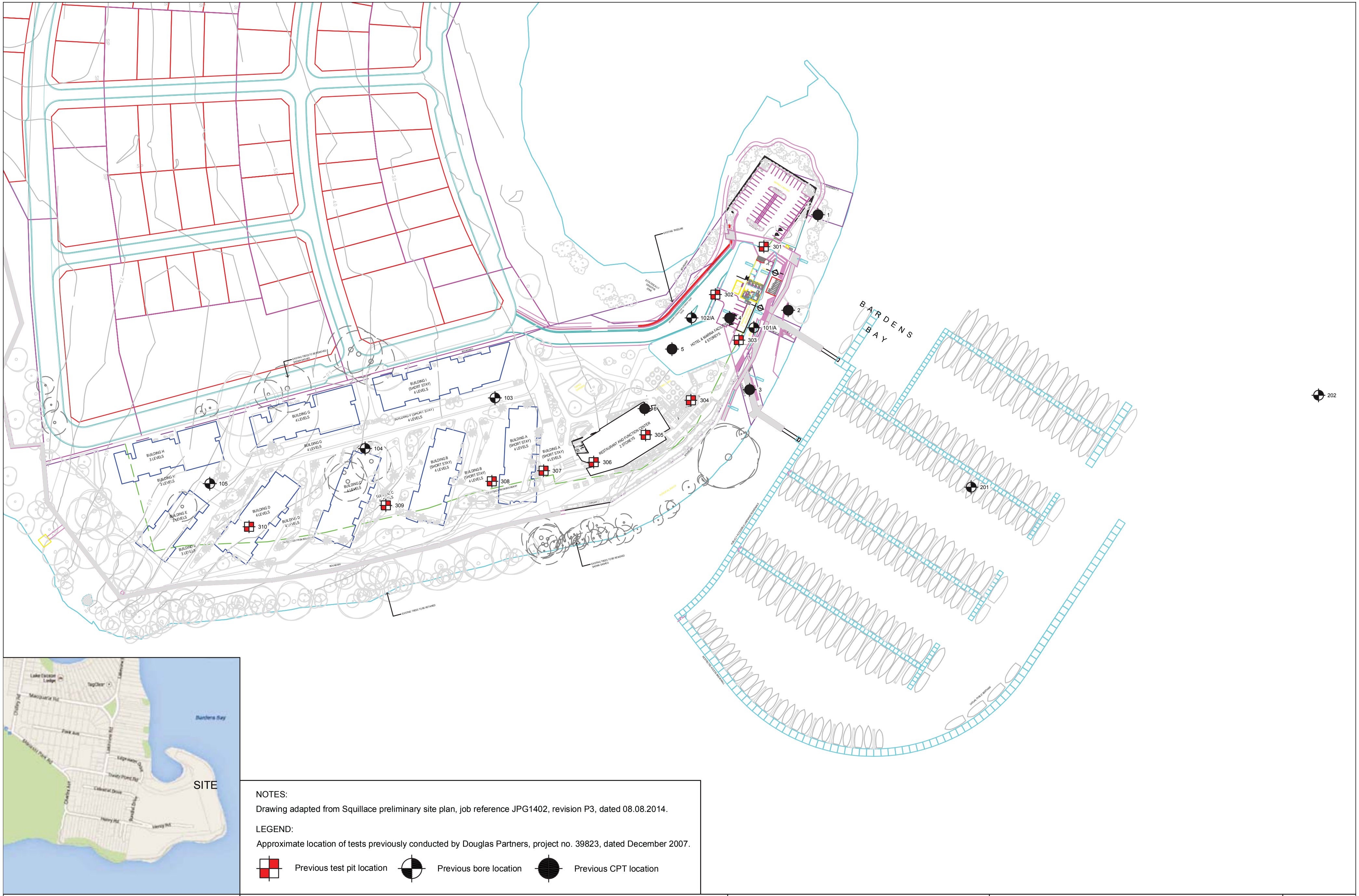
[13] Australian Standard AS3798-2007, “Guidelines on Earthworks for Commercial and Residential Structures,” Standards Australia, 2007.

APPENDIX A

DRAWINGS

Cardno® Geotech Solutions

Shaping the Future



NOTES:

Drawing adapted from Squillace preliminary site plan, job reference JPG1402, revision P3, dated 08.08.2014.

LEGEND:

Approximate location of tests previously conducted by Douglas Partners, project no. 39823, dated December 2007.

🟥	Previous test pit location
◐	Previous bore location
●	Previous CPT location

Cardno Geotech Solutions
Shaping the Future

DRAWING TITLE: PREVIOUS TEST LOCATION PLAN
PROJECT NAME: PROPOSED TRINITY POINT DEVELOPMENT
SITE LOCATION: MORISSET PARK

CLIENT: Johnson Property Group
PROJECT NO: CGS2221
DRAWING NO: 1
FILE REF: 2221-002-d1

DRAWN BY: DGB
CHECKED BY: JD
OFFICE: 4/5 Arunga Drive, Beresfield NSW 2322
DATE: 19 August 2014

NORTH

APPENDIX B

REPORT ON GEOTECHNICAL INVESTIGATION

Cardno®
Geotech Solutions
Shaping the Future

Douglas Partners
Geotechnics • Environment • Groundwater

Integrated Practical Solutions

REPORT
on
GEOTECHNICAL INVESTIGATION

PROPOSED TRINITY POINT MARINA AND TOURIST DEVELOPMENT
49 LAKEVIEW ROAD
MORISSET PARK

Prepared for
JOHNSON PROPERTY GROUP PTY LTD

Project 39823
DECEMBER 2007

Douglas Partners
Geotechnics • Environment • Groundwater

REPORT
on
GEOTECHNICAL INVESTIGATION

PROPOSED TRINITY POINT MARINA AND TOURIST DEVELOPMENT
49 LAKEVIEW ROAD
MORISSET PARK

Prepared for
JOHNSON PROPERTY GROUP PTY LTD

Project 39823
DECEMBER 2007

Douglas Partners Pty Ltd
ABN 75 053 980 117

Box 324
Hunter Region Mail Centre
NSW 2310 Australia

15 Callistemon Close
Warabrook, NEWCASTLE

Phone: 02 4960 9600
Fax: 02 4960 9601
newcastle@douglaspartners.com.au

TABLE OF CONTENTS

Page

ATTACHMENTS

CSIRO BTF 18
Notes Relating to this Report
CPT Test Results (CPT 1 to 6)
Borehole Logs – Bores 101 to 105 and 201 to 203
Core Photo Plates
Test Pit Logs – Pits 301 to 310
Laboratory Test Results
Pile Capacity Charts
Copy of Mine Subsidence Board Correspondence
Drawing 1 – Locality Plan
Drawing 2 – Test Location Plan

JAW:kd
Project No: 39823
P:\39823\Docs\39823.doc
4 December 2007

REPORT ON
GEOTECHNICAL INVESTIGATION
PROPOSED TRINITY POINT MARINA AND TOURIST DEVELOPMENT
49 LAKEVIEW ROAD, MORISSET PARK

---

1. INTRODUCTION

This report presents the results of a geotechnical investigation at the site of the proposed Trinity Point Marina and Tourist Development, located at 49 Lakeview Drive, Morisset Park (Lot 31, Part Lot 32 and Part Lot 33, DP 1117408). The work was carried out for Johnson Property Group Pty Ltd.

The purpose of the investigation was to provide the following:

- subsurface conditions at the site;
- site classification with regard to foundation soil reactivity (shrink-swell), in accordance with AS 2870-1996 (Ref 1);
- comments on suitable footing types and soil parameters for footing design of the proposed on-land structures and the proposed marina;
- background groundwater quality data;
- comments on site preparation and earthworks;
- flexible pavement thickness design;
- material quality and compaction requirements for the proposed driveways and parking areas;

For the purpose of the investigation, the client supplied concept plans of the proposed development, along with site survey plans. The concept plans used in the preparation of this report are the Site Plans by HBO + EMTB Architects Pty Ltd (Ref No 202669, SK000, Issue I dated 29 October 2007 and SK000 Option 01, Revision J, dated 2 November 2007). The site survey plan was prepared by SurDevel Pty Ltd, (Ref 1320, dated 30 November 2006). A hydrographic survey of the proposed marina area had been undertaken by another consultant, however the contours were provided to DP on a plan by Patterson Britton & Partners (Ref 6759.10-GA, dated 17 September 2007).

The project is subject to other reports recently prepared by Douglas Partners Pty Ltd (DP) which includes an acid sulphate soil assessment (Ref 1), a geochemical analysis within the proposed marina (Ref 2), and a waste classification report for the northern part of the site (Ref 3).

2. PROPOSED DEVELOPMENT

2.1 General

The Trinity Point Marina and Tourist Resort comprises a number of components including the Marina, Marina Village and clusters of multi-storey accommodation buildings (Blocks A to G).

The Marina and Marina Village development will include an approximately 300 berth marina, along with an associated breakwater, boat maintenance facilities (travel lift, hardstand and workshop), and other related commercial infrastructure such as café, restaurant and function facilities.

Immediately south of the Marina Village is a cluster of multi storey buildings, up to six stories in height for short to medium term tourist accommodation. These areas are shown as Blocks A, B, C and D on the attached Drawing 2. These buildings will include under-croft car parking.

Another three clusters of multi-storey accommodation buildings are located further to the south (shown as Blocks E, F and G on attached Drawing 2). These three clusters comprise apartment style accommodation, in two to five storey buildings, associated car parking (underground parking), access roadways, footpaths, boardwalks, jetties and landscaping.

2.2 Proposed Marina Village Centre and Floating Marina Berths

The proposed marina and village centre will include a 308 berth marina consisting of up to four arms of floating pontoons, a floating helipad pontoon, marina administration offices, a breakwater, a travel lift with associated hardstand area for boat repairs and maintenance, and a workshop. It is understood that the marina has been configured to avoid any dredging.

The marina will comprise a system of floating walkways, and associated berths. The floating walkways would be located between vertical piles driven into the lake bed. It is understood that the preferred pile type is tubular steel piles.

The marina will incorporate a breakwater around the southern and eastern boundaries. The proposed breakwater will consist of two rows of parallel tubular steel piles driven in to the lake bed, with timber slats supported on the outer side of each row of piles. The breakwater will also have a timber walkway, allowing access around the perimeter of the marina, and for access to the helipad.

The helipad will be an approximately 25 m by 25 m floating steel pontoon anchored to the lake bed, with an access gangway directly from the breakwater walkway. The current preference is that the anchors would be steel piles driven into the lake bed similar to piles for the breakwater and pontoons, however the piles would be cut off at the lake bed level.

In addition to the marina, there will be an associated on-shore village centre incorporating a café, restaurant, function centres, chandlery, general store and commercial offices.

2.3 Proposed Tourist/Accommodation Development

The southern portion of the site will incorporate apartment style accommodation (serviced tourist and permanent residential) with two to five storey buildings arranged in a series of three building clusters (Blocks E, F and G).

2.4 Pavements

Proposed pavement areas for the site include access roads and parking areas. It is understood that the majority of parking for Blocks A to D will be offered via under-croft parking beneath the proposed multi-storey buildings. It is understood that the under-croft parking in this area of the site will be at about RL 1.2 (AHD).

Blocks E to G will include basement car parking with preliminary basement floor levels ranging from 0.35 m to 4.85 m AHD.

2.5 Cut/Fill

Preliminary levels for under-croft car parking and basement car parking floor levels suggest approximate cut and fill depths could be in the order of the following:

Building Cluster	Approximate Ground Surface Level (AHD)	Preliminary Under-croft/Basement Floor Level (AHD)	Preliminary Approx Fill Depth (m)	Preliminary Approx Excavation Depth (m)
A	0.8	1.2	0.4	-
B	0.9	1.2	0.3	-
C	0.9	1.2	0.3	-
D	0.9 – 1.9	1.2	0.3	0.7
E	1.6 – 3.4	0.35	-	1.25 – 3.05
F	2.6 – 6.8	1.65 to 3.53	-	0.95 – 3.29
G	4.0 – 8.5	4.85	0.85	3.65

It is anticipated that excavations could also be required for installation of utilities, and also for swimming pool construction, although the final locations of these features are unknown at this time.

3. SITE DESCRIPTION AND REGIONAL GEOLOGY

The site is located to the north of, and on, Bluff Point on the Morisset Peninsula of the western shores of Lake Macquarie. The site is described as 49 Lakeview Road (Lot 31, Part Lot 32 and Part Lot 33, DP 1117408), Morisset Park. A plan showing the approximate location of the site is shown on Drawing 1, attached.

It is understood that the site used to contain several buildings, however these have been demolished. At the time of the investigation, the site was grassed with several stands of mature trees, particularly along the shoreline. Several stockpiles of building rubble and vegetation were located towards the southern part of the site.

Site elevations range from water level in the northern and eastern parts of the site up to about 8.5 m (AHD) at the southern end, which is known as Bluff Point. The site is relatively level in the northern part, where the marina is to be constructed, and slopes up to the high point at about 2º to 6º.

The following photographs show the general site area at the time of the investigation.

Photo 1 – set up on Bore 101, in the area of the proposed marina

Photo 2 – view of site from the Lake

Photo 3 – looking south towards the crest of Bluff Point, in the area of the proposed tourist village

Photo 4 – drill rig set up on modular barge, in proposed marina area

Reference to the 1:100,000 Newcastle Coalfield Geological series sheet indicates that the site is underlain the Narabeen Group of rocks. The Narabeen Group includes both the Terrigal Formation and the Clifton Subgroup. The Terrigal Formation typically includes sandstone and siltstone, while the Clifton Subgroup typically includes conglomerate, sandstone, siltstone and claystone.

4. FIELD WORK METHODS

The field work was undertaken in the period 25 September to 16 October 2007 and included the following:

- six cone penetration tests within the proposed marina area (CPT 1 to 6);
- four on-land bores within the proposed marina village area (Bores 101/A and 102/A);
- three on-land bores within the proposed tourist development (Bores 103 to 105);
- three over water bores within the proposed marina area (Bores 201 to 203); and
- ten test pits across the site (Pits 301 to 310).

The CPTs were taken to refusal, which ranged from 9.6 m depth (CPT 3) to 13.1 m depth (CPT 4). The tests comprised hydraulically pushing a 35 mm diameter instrumented cone and friction sleeve assembly into the ground from a ballasted truck.

Bores 101 to 105 were drilled using a truck mounted drilling rig, equipped for geotechnical sampling. In situ testing included standard penetration tests (SPTs) at regular depth intervals. A pocket penetrometer was also used to assess the strength of samples recovered from the SPTs. The target depth for Bores 101 and 102 was 6 m of rock core, while the target depth for Bores 103 to 105 was 5 m or refusal. Groundwater monitoring wells were installed in each of these bores on completion.

Bores 101A and 102A were drilled by a 4WD mounted drilling rig equipped with hollow flight augers for the purpose of installing a second, shallower groundwater monitoring well adjacent to each of Bores 101 and 102, respectively.

The over-water bores were also drilled using a truck mounted drilling rig, set up on a modular barge (refer Photo 4). The target depth for the over-water bores was 3 m into rock, however this was not able to be achieved at all locations. Bore 201 had to be abandoned early due to strong winds and unsafe working conditions.

The test pits were excavated using a backhoe to depths of between 2 m and 3 m.

The locations of the CPTs, Bores and Pits are indicated on attached Drawing 2.

The tests were set out by a geotechnical or geo-environmental engineer from DP who also logged the subsurface profile in each pit and bore and took regular samples for laboratory testing and identification purposes. Pocket penetrometer and dynamic cone penetrometer tests were performed at selected depths and locations.

All test locations were selected based on the proposed concept layout available at the time of the investigation. The locations were positioned approximately, with some measured from existing site features, and some positioned using a hand-held GPS unit. The on-land test locations were staked on completion and were subsequently surveyed for location and elevation by project surveyors, SurDevel Pty Ltd. The over-water bores were surveyed by the project surveyors while the rig was set up at the bore location.

5. FIELD WORK RESULTS

5.1 General

The subsurface conditions encountered are presented in detail in the attached CPT reports, borehole logs and test pit logs. These should be read in conjunction with the general notes preceding them, which explain the descriptive terms and classification methods used in the reports. The following is a summary of these subsurface conditions.

Marina Area (off-shore Portion)

In general, the lake bed sediments comprised a mixture of sand, silt and clay in varying proportions. The over-water bores (Bores 201 to 203) encountered soft lake sediment which ranged in thickness from about 1.7 m to 3.0 m. The underlying soils generally comprised clay, gravelly clay and clayey sand, which was in turn underlain by bedrock at depths which ranged from 5.8 m to 7.9 m below the lake bed.

Marina Village and Blocks A to D

Bores 101 and 102, and Pits 301 to 306 generally encountered sandy soils with variable proportions of clay, silt and gravel to depths of about 5 m. In the bores, the sandy soils were underlain by clay, sandy clay and gravelly clay. Rock was encountered in the bores at depths of 12.8 m and 11.4 m respectively.

The profile in CPT 1 indicates the presence of very soft to soft clay between about 1.8 m and 3.1 m depth, in the vicinity of the boat ramp and workshop.

Blocks E, F and G

Bores 103 to 105, and Pits 307 to 310 generally encountered filling (with the exception of Pit 309) to depths of up to 1.15 m over generally sandy and clayey soils. The clay in Pit 309 graded to clayey sand/extremely weathered sandstone below about 1.0 m, and backhoe refusal was encountered at 1.8 m depth. Rock was also encountered in Bores 104 and 105, with pebbly sandstone encountered below 4.2 m in Bore 104, and residual clay grading to an extremely low strength conglomerate below 4 m in Bore 105.

5.2 Bedrock

The following table summarises the depth to the top of bedrock and/or refusal in each of the tests.

Table 5.1 – Summary of Rock Depths

Project Component	Test	Approximate Surface RL (m)	Depth to Top of Rock (m)	Depth to Refusal (m)
Marina	201	-5.86	5.8	-
	202	-5.15	6.9	-
	203	-5.35	7.9	-
Marina Village	1	0.67	-	11.4
	2	0.81	-	12.6
	3	0.92	-	9.6
	4	0.99	-	13.1
	101	1.27	12.8	-
	102	0.89	11.4	-
Blocks A to D	5	0.78	-	10.6
	6	1.05	-	10.6
Blocks E to G	103	2.49	NE to 5.95	-
	104	3.82	4.2	-
	105	6.62	4.0*	-

Notes to Table 5.1:

NE – Not encountered
* Approximate depth at which soil started transitioning/grading to rock

5.3 Groundwater

Groundwater was observed in each of the remnant CPT holes. Groundwater monitoring wells were installed in each of the on-land bores (ie. Bores 101 to 105, 101A and 102A) to facilitate measurement of groundwater levels on different occasions and also sampling for groundwater chemistry analysis. Groundwater seepage was observed during excavation of the test pits, however the pits were only open for a relatively short period of time, and hence it is likely that these observations do not necessarily represent the static water level. The following tables summarise the groundwater observations made during field work, and also within the wells on the subsequent site visits.

Table 5.2 – Summary of Groundwater Observations in Remnant CPT Holes

Project Component	CPT	Approximate Surface Level (AHD)	Approximate Depth to Water in Remnant CPT Hole (m)	Approximate Groundwater Level in Remnant CPT Hole (AHD)
Marina Village	1	0.67	0.5	0.2
	2	0.81	0.5	0.3
	3	0.92	0.9	0.0
	4	0.99	0.8	0.2
Blocks A to D	5	0.78	0.4	0.4
	6	1.05	0.7	0.4

Table 5.3 – Summary of Groundwater Seepage Observations in the Test Pits

Project Component	Location	Approximate Surface Level (AHD)	Depth of Groundwater Seepage Observed During Field Work (m)
Marina Village	301	0.96	1.5
	302	0.97	1.3
	303	1.21	1.4
Blocks A to D	304	1.16	1.0
	305	1.15	1.0
	306	1.12	1.1
Blocks E to G	307	1.78	1.5
	308	2.6	Not encountered
	309	3.0	Not encountered
	310	4.4	Not encountered

Table 5.4 – Summary of Groundwater Measurements in Bores

Project Component	Bore	Approximate Surface Level (AHD)	Depth to Groundwater Below Ground Surface (m) and date				Range of Groundwater Levels Observed (AHD)
			5/10/07	9&10/10/07	16/10/07	24/10/07	
Marina Village	101	1.27	1.2	1.2	1.2	NM	0.1
	101A	1.27	NM	NM	1.15	1.22	0.0 to 0.1
	102	0.89	NM	0.61	0.88	NM	0.0 to 0.3
	102A	0.89	NM	NM	0.83	0.94	-0.1 to 0.1
Blocks E to G	103	2.47	1.51	1.57	1.63	NM	0.8 to 1.0
	104	3.82	2.83	2.85	2.93	NM	0.9 to 1.0
	105	6.62	Dry	Dry	Dry	Dry	-

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

Groundwater pH, Electrical Conductivity, Dissolved Oxygen and Turbidity were also measured in the wells following installation, with the results summarised in Table 5.5, below:

Table 5.5 – Summary of Groundwater Properties in Bores

Bore No	Range of pH values	Range of EC values	DO(%)	Turbidity (NTU)
101	7.1 to 7.3	1.7 to 3.8	31 to 49	1450 to 2618
101A	7.2 to 7.7	0.6 to 0.8	47	2541
102	6.8 to 7.3	8.7 to 2.1	42 to 95	1277 to 1324
102A	7.4 to 7.7	1.2 to 2.1	77	2452
103	5.0	0.6	43	2262
104	4.1 to 4.2	5.6 to 6.8	51	2619
105	dry	dry	Dry	Dry

Notes to Table 5.5:

EC – Electrical Conductivity
DO – Dissolved Oxygen

6. LABORATORY TESTING

Geotechnical laboratory testing comprised the following:

- ten particle size distribution tests;
- nine plasticity index tests;
- two linear shrinkage tests;
- two soil aggressivity tests (pH, chlorides and sulphates);
- 32 point load index tests on recovered rock core to assess rock strength.

In addition, groundwater samples were collected from each of the wells to obtain background water quality data, and also groundwater aggressivity data. The well in Bore 105 was dry, and hence no sample was collected. One sample (D1) was submitted for QA/QC purposes. Groundwater was tested for the following:

- Metals: Arsenic (As); Antimony (Sb); Barium (Ba); Beryllium (Be); Boron (B); Cadmium (Cd); Chromium (Cr); Copper (Cu); Cobalt (Co); Lead (Pb); Manganese (Mn); Molybdenum (Mo); Nickel (Ni); Selenium (Se); Zinc (Zn); and Mercury (Hg);
- Nitrite, Nitrate, Chloride, Sulphate;
- Total Phosphorous; Total Nitrogen;
- Total Iron.

Limited soil geochemical and acid sulphate soil testing was undertaken concurrent with the geotechnical investigation. The results are reported separately and have not been included in this report (Refs 1 to 3).

The results of the point load index testing are shown on the attached borehole logs. The detailed results of other laboratory testing are presented in the attached laboratory report sheets, and are summarised in the following tables.

Table 6.1 – Summary of Geotechnical Laboratory Testing

Project Component	Bore	Depth (m)	Description	% Sand and Gravel	% Fines (Passing 75 micron sieve)	W_L	W_P	PI	LS (%)
Marina Village	101	1.0 – 1.45	Gravelly sand	89	11	-	-	-	-
	102	1.0 – 1.45	Sand	88	12	-	-	N/P	-
		1.0 – 4.45	Silty sand	75	25	-	-	N/P	-
Marina	201	0.0 – 0.45	Silty sand/sandy silt	55	45	-	-	-	-
		2.4 – 2.75	Silty clay	2	98	41	15	26	-
	202	0.0 – 0.45	Sandy silty clay	69	31	-	-	-	-
		4.0 – 4.45	Clayey sand	64	36	34	18	16	-
	203	2.5 – 2.95	Sandy silty clay	42	58	34	15	19	-
		5.0 – 5.45	Clay	85	15	58	15	43	-
Blocks E to G	103	1.0 – 1.45	Silty gravelly sand	63	37	17	15	2	-
	104	2.5 – 2.95	Silty clay	-	-	46	25	21	11.0
	105	1.0 – 1.45	Silty sandy clay	-	-	35	18	17	10.5

Notes to Table 6.1:

W_P – Plastic Limit
W_L – Liquid Limit
PI - Plasticity Index
LS – Linear Shrinkage
N/P – Non-plastic

Table 6.2 – Summary of Soil Aggressivity Results

Project Component	Bore	Depth (m)	Description	pH	Chloride, Cl (mg/kg)	Sulphate, SO_4 (mg/kg)
Marina village	101	2.5 – 2.95	Gravelly clayey sand	8.0	14	26
	102	5.5 – 5.95	Silty clay	7.5	820	170

Table 6.3 – Summary of Laboratory Results for Groundwater Chemistry - Metals

Project Component	Location	Analyte (µg/L)																Analyte (mg/L)						
		Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Copper	Cobalt	Lead	Manganese	Molybdenum	Nickel	Selenium	Zinc	Tin	Total Iron	Nitrate as N	Chloride, Cl	Sulphate, SO4	Total Phosphorus as	Total Nitrogen	Mercury
Marina village	101	<PQL	<PQL	33	<PQL	470	<PQL	1.2	<PQL	<PQL	<PQL	260	2.5	<PQL	<PQL	12	<PQL	2.4	<PQL	850	110	0.40	4.6	<PQL
	102	<PQL	6.4	190	<PQL	1500	<PQL	6.3	1.3	22	<PQL	130(	2.6	11	23	12(	0.03	250	<1	8400	1300	<0.5	3.3	<PQL
locks E t G	103	<PQL	<PQL	40	<PQL	53	<PQL	<PQL	1.1	2.1	5.4	77	<PQL	3.4	<PQL	33	<PQL	).25	<PQL	190	44	0.13	<PQL	<PQL
	104	<PQL	<PQL	140	3.6	120	0.64	15	3.9	16	40	300	<PQL	13	<PQL	11(	<PQL	15	<0.1	2600	180	<PQL	1.0	<PQL
A Sampl	D1	<PQL	<PQL	34	<PQL	480	<PQL	<PQL	<PQL	<PQL	<PQL	250	2.5	<PQL	<PQL	14	<PQL	NT	NT	NT	NT	NT	NT	<PQL
Laboratory PQL		1	1	1	1	1	0.1	1	1	1	1	1	1	1	2	1	0.03	0.01	0.05	1	1	0.1	1	5E-04

Notes to Table 6.3:

Sample D1 is a duplicate of Sample 101
PQL – Practical quantification limit
NT – Not tested

7. COMMENTS

7.1 General

The comments presented herein primarily relate to the portion of the site which includes the Marina, Marina Village and Blocks A to D. Comments related to other areas of the site (ie Blocks E to G) are preliminary in nature.

All of the comments assume that detailed, targeted investigation will be undertaken during the detailed design stage of the project, once the building layout and proposed earthworks details are confirmed.

In general, the lower lying portions of the site are underlain by weak alluvial soils, with groundwater present at depths of about 0.5 m to 1.0 m. Zones of very loose sandy soils, and very soft to soft clayey and silty soils were encountered to depths of up to about 5.5 m, with conditions below this depth improving, but still including zones of loose sandy soils and/or firm clays to depths of generally about 6 m to 8 m, but up to about 11.5 m (Bore 101 and CPT 2).

These soils present limitations for the support of the proposed structures (low-rise, high-rise and pavements) because they will settle under loads from buildings, filling and their own self weight. These soils may also be at risk of liquefaction if subjected to a seismic event, however additional analysis would be required to assess this further.

The geotechnical conditions will likely result in the need to consider deep foundations (piles) for the majority of the structures proposed within the Marina area, Marina Village and Blocks A to D.

Conditions improve gradually as site elevations rise to the south, however, it is expected that most multi-storey buildings constructed on the site will likely require the use of footings founded in bedrock due to relatively high structural loads. It may be possible to found some of the smaller structures located in the southern portion of the site on shallow foundations, however this will require specific targeted investigation during the design stage of the project, once structural loads are known.

The presence of shallow groundwater combined with the poor ground conditions in the lower lying areas of the site also present potential access issues on the site, and hence it is likely that bridging layers will be required to form working platforms on which construction equipment can operate, and to support at-grade features such as pavements, slabs etc.

Comments regarding these and other geotechnical aspects of the proposed development are presented in the following sections of this report.

7.2 Groundwater

7.2.1 General

Groundwater chemistry data is presented in Section 6 of this report. This data has not been compared to any guidelines at this point in time, and was collected to provide background water quality data for future reference.

Groundwater was encountered at depths as shallow as 0.4 m below ground surface during the investigation. It is possible that there may be some tidal influence in the groundwater levels in the low-lying area of the site, however this has not been assessed in detail. Groundwater levels may therefore fluctuate depending on the water level in Lake Macquarie, as well as prevailing weather conditions.

Anecdotal evidence indicates that the water level in Lake Macquarie rose by about 1 m above average levels during the recent June long weekend storms, with much of the Lake's low-lying foreshore areas inundated. It is not known whether the Trinity Point project area was inundated or not during this time. However this recent weather event illustrates the potential for low lying areas to become inundated, and hence groundwater levels to potentially rise to the ground surface during extreme weather events.

The relatively shallow groundwater, combined with potential fluctuations, means that a number of structural elements, such as slabs, shallow footings etc, may need to be designed to accommodate potential buoyancy or uplift forces, depending on site grades.

7.2.2 Dewatering

Excavations within the lower-lying Marina, Marina Village and Blocks A to D components are likely to encounter groundwater, and may require dewatering. At the time of the investigation, groundwater was encountered at depths as shallow as 0.4 m, however the groundwater response to rainfall events and/or tidal fluctuation has not been assessed at this time.

It is considered that if dewatering is required within the lower lying areas of the site, then additional testing and analysis may be required once excavation levels are confirmed to assess soil permeability and appropriate dewatering methods.

Within the southern part of the site (Blocks E to G) it is possible that sump and pump arrangements may become suitable, as the soils increase in clay content and the depth to groundwater increases.

If excavations requiring dewatering are likely, it is recommended that additional investigation include in situ testing to assess soil permeability, and also monitoring of groundwater level response to weather events and tidal fluctuations.

Dewatering at the site will need to consider acid sulphate soils (Ref 1).

7.3 Site Classification

7.3.1 General

Site classification to AS 2870 (Ref 4) is not strictly applicable to this site due to it being a commercial and high-rise development rather than a traditional low-rise residential development. However, the principles of footing design and site maintenance presented therein should be taken into account for the buildings proposed for the site.

Site classification of foundation soil reactivity provides an indication of the propensity of the ground surface to move with seasonal variation in moisture and is based on procedures presented in AS 2870-1996 (Ref 4), the typical soil profiles revealed in the tests, and the results of laboratory testing. The process of cutting and filling will affect the site classification, and hence the classifications should be revised once details of site cutting and/or filling are known, as required by AS 2870-1996 (Ref 4).

The site classifications for the Marina Village and Blocks A to D are presented in the following sections, and are based on the information obtained from test pits and bores and on the results of laboratory testing. The classifications have involved some interpolation between data points, and in the event that the conditions encountered during construction are different to those presented in this report, it is recommended that advice be sought from this office.

Articulation joints should be provided within masonry walls in accordance with TN61 (Ref 5) in order to reduce the effects of differential movement.

It should be noted that the classifications are dependent on proper site maintenance.

7.3.2 Marina Village

The marina village is designated Class P due to the poor ground conditions. Footings should be designed therefore in accordance with engineering principles as required by AS 2870-1996 (Ref 1). Site maintenance should be carried out in accordance with the attached CSIRO BTF 18 and Appendix B of AS 2870-1996 for a Class S site.

7.3.3 Blocks A to D

Blocks A, B and C are each greater than three storeys in height, and hence will require design by engineering principles. Site classification to AS 2870-1996 will not apply.

Block D contains buildings between two and five storeys in height. This area of the site is also designated Class P due to the poor ground conditions, and will therefore require design by engineering principles.

7.4 Shallow Footings

The loose sandy soils encountered within the upper profile of the CPTs, bores and pits in the low lying area of the site (ie Marina Village and Blocks A to D) are not suitable to support shallow footings. It is considered likely that deep footings (piles) will be required to support most structural loads within this area of the site.

Shallow footings may become an option for lightly loaded structures as development progresses uphill to the south, as ground conditions improve, or in areas where more than 0.5 m of engineered filling is present below footings. This will need to be delineated and further analysed during future geotechnical investigation for the southern portion of the site.

Raft slabs constructed on a layer of engineered filling may be suitable to spread loads and avoid the use of piles in some areas. Slabs should be configured to transfer a maximum pressure of 10 kPa to the underlying soils.

A minimum of 0.5 m of engineered filling should be present beneath the slab to allow bridging over the underlying weak soils. Recommendations for the preparation of the bridging layer are presented in Section 7.9 of this report. Addition of 0.5 m of filling will result in settlements which are estimated to be in the order of about 25 mm. Due to the generally sandy nature of the soils, the majority of settlement is estimated to occur during construction. Very soft to soft clay was encountered in CPT 1. Consolidation of soft clay will not occur as quickly as settlement of sandy soils. Therefore, additional testing and analysis may be required in the area of the proposed boat ramp and workshop to assess the rate and magnitude of settlement in this part of the site.

For raft slabs proportioned for the maximum allowable bearing pressure of 10 kPa, settlement, additional to that caused by the filling, is estimated to be in the order of about 25 mm (ie. total of about 50 mm). If slabs are proportioned for an allowable bearing pressure of 5 kPa, then the additional settlement is estimated to be in the order of 15 mm (ie. total of about 40 mm). The majority of settlement attributable to the structural loads is similarly estimated to occur during construction for the sandy profiles. Consolidation of soft clay, such as that found in CPT 1 is expected to occur over a longer period of time. Differential settlements between similarly sized and loaded footings are expected to be approximately one-half to two-thirds of the total settlement.

Opportunities to reduce post-construction settlement include:

- undertake settlement monitoring of the engineered filling and commence construction once settlement has slowed to an acceptable rate;
- surcharge the area by placing a pre-determined additional depth of granular filling (also called a pre-load), to accelerate settlement, then remove the surcharge after an appropriate proportion of the settlement has occurred. A bridging layer will still likely need to remain in place;
- construct a piled raft.

The above options will require additional assessment if they are to be considered further.

Excavations for footings will need to consider the presence of acid sulphate soils (Ref 1).

If the settlements cannot be tolerated, or if the site cannot accommodate the inclusion of a bridging layer, then slabs will need to be fully suspended and supported on piles.

7.5 Deep Footings

7.5.1 General

Deep footings (piles) will be required to support the proposed marina walkways and breakwater.

Most structural loads within the Marina Village, and Blocks A to D will also need to be carried on piles. Most piles will need to be supported on, or in, the underlying bedrock, which was encountered at depths ranging from about 9.6 m to 13.1 m in this part of the site.

It is understood that driven tubular steel piles are the preferred pile type for the marina structures, and bored concrete piles are the preferred pile type for the on-land buildings in the Marina Village and Blocks A to D.

Due to the presence of saturated sand within the on-shore profiles, unsupported bored pile holes will likely collapse and hence are not considered suitable. Suitable pile types, along with their potential benefits and limitations are follows:

- ***Bored Concrete Piles***: installation of bored piles will require the use of temporary or permanent liners to support the water charged sandy soils. Alternatively the piles could be formed under bentonite, with the concrete placed by tremie method, provided the design pressures are reduced by 20% to allow for reduction in shaft adhesion and the absence of inspection/checking of the pile base. It is likely that casing will need to be driven ahead of the pile boring, particularly in the upper 5 m.

- ***Concrete Screw-cast Piles***: a concrete screw-cast pile is screwed into the ground its natural pitch so that the soil is displaced rather than removed. After reaching its intended depth, the reinforcement cage is placed down the centre stem of the auger and the mandrel is filled with concrete as the auger is backed out, again at natural pitch. Piling contractors provide concrete screw-cast piles as proprietary products, eg. Frankipile’s Atlas piles;

- ***Driven Piles***: Select driven pile types would generally drive with relative ease through the soils, although some of the gravelly bands may prove problematic in some areas (eg. Bore 102). The geotechnical capacity of piles driven to refusal on rock approaches the structural capacity of the pile, which is dependent on the pile type and the area of the section used.

7.5.2 Marina Village and Blocks A to D

Estimates of geotechnical pile capacity have been made using the CPT results for a range of diameters for bored concrete piles and concrete screw-cast piles. Once structural loads are known, other pile types and/or diameters can be analysed for suitability. The estimated capacities for various single piles are shown on the attached pile capacity charts. The charts do not include the 20% reduction, as discussed above, and this will need to be taken into account by the designer.

R_{ug} is the ultimate geotechnical strength, which was calculated using static theory, and therefore represents an estimate only. The geotechnical strength reduction factor, ϕ_g, depends on a number of factors including the extent of investigation, type of analysis and testing regime during construction. For the estimates presented above, a ϕ_g = 0.55 was adopted. Higher values of ϕ_g may be justifiable if sufficient load testing is conducted as per AS2159-1995 (Ref 6). The traditional 'allowable' capacity is related to 'working' load and is generally lower than R^*_g, depending on the structural factors applied to determine S*. Allowable (working) capacities may be estimated as approximately 75% of R^*_g.

If the structural loads require socketing into bedrock, then the following parameters maybe used:

Table 7.2 – Indicative Rock Strength Parameters for Pile Design

Project Component	Rock Strength	Approximate Range of Depths to Top of Rock Layer as Encountered in Bores (m)	Allowable Shaft Adhesion (kPa)	Allowable End Bearing Pressure (kPa)
Marina Village	Extremely low strength	11.4 – 12.8	40	550
	Low strength	13.6 – 15.2	120	1200
	Medium strength	16.0 – 19.0	280	2800

The above rock strength parameters include a 20% reduction of typical values, based on the assumption that inspection/checking of the pile base will be difficult.

At the time of the field investigation, the location of on-land structures had not been confirmed, and as such the cored bores (Bores 101 and 102) no longer fall within the footprint of the tallest buildings. It is recommended that the depth to, and presence of, the above listed rock strength layers are confirmed by targeted geotechnical investigation during the detailed design stage of the project.

For some of the smaller buildings, and depending on the structural loads, timber piles driven to refusal on the underlying bedrock could be used to support the proposed loads. It should be noted however, that splicing of the piles may be required if they are not available in lengths which would allow a single pile to be driven to the expected rock depths.

Piles driven to refusal on rock will approach the structural capacity of the pile. The following table shows an extract from a Koppers handbook regarding the structural capacity for softwood and hardwood timber piles of various diameters.

Table 7.3 – Maximum Safe Loads for Treated Softwood Piles (kN)

Pile Type		Pile Toe Diameter (mm)			
		125	150	175	200
De-barked Piles	**F11**	82	126	182	250
	F14	100	153	220	304
Peeled Piles	**F11**	74	113	163	225
	F14	90	138	198	274

Table 7.4 – Maximum Safe Loads for Treated Hardwood Piles (kN)

Pile Type	Pile Toe Diameter (mm)			
	150	210	250	300
F27 Stress Grade	362	710	1007	1450
F17 Stress Grade	230	450	638	919

It should be noted that vibrations associated with pile driving can lead to settlement of soil profiles, especially in very loose and/or saturated soils. Accordingly there is a risk of damage to adjacent structures during pile driving, depending on the construction sequence.

The capacity of driven piles should be proven by the installation method and the opportunity to apply dynamic testing, such as wave equation analysis.

7.5.3 Marina

The estimated loads for the marina and boardwalk structures were not known at this time.

The proposed driven tubular piles are expected to be appropriate for the proposed marina and boardwalk structures, provided that an appropriately sized section can be selected for the structural loads. It is not known at this stage whether penetration into rock will be required to carry the structural loads.

Piles driven to virtual refusal will approach the structural capacity of the piles. Prospective piling contractors should confirm the expected rock penetration and pile capacities achievable with their equipment. The actual load carrying capacity of driven piles should be checked from the results of pile driving sets during construction based on a suitable dynamic method.

Bedrock was encountered at depths of between 5.8 m and 7.9 m below the lake bed in Bores 201 to 203, and refusal was encountered at depths of between 9.6 m and 12.6 m in each of CPTs 1 to 3, which were undertaken near the lake edge.

The following indicative parameters may be used for marina pile design if socketing is required.

Table 7.5 – Indicative Rock Strength Parameters for Pile Design

Project Component	Rock Strength	Approximate Range of Depths to Top of Rock Layer as Encountered in Bores (m)	Allowable Shaft Adhesion (kPa)	Allowable End Bearing Pressure (kPa)
Marina	Extremely low strength	5.8 – 7.9	40	550
	Very low strength	6.4 – 11.0	120	1200

7.5.4 Settlement

Pile settlement will depend on the applied working load, but is expected to be less than about 1% to 2% of the pile diameter for the loads in the above tables.

7.6 Soil Aggressivity

With reference to Tables 6.1 and 6.3 in AS 2159 (Ref 6), piles in water would be classified as follows:

Table 7.6 – Exposure Classification Piles in Seawater

Pile Type	Exposure Condition	Exposure Classification
Steel Piles	Seawater – submerged	Severe
	Seawater – tidal/splash zone	Very severe
Concrete Piles	Seawater – submerged	Moderate
	Seawater – tidal/splash zone	Severe

For piles in soil, the results of laboratory testing suggest the following exposure classifications:

- steel piles in soil – non-aggressive to mild;
- concrete piles in soil – mild to moderate.

It is noted however that the groundwater within the low-lying areas may be impacted by the adjacent tidal marine water, and hence buried concrete and steel structures should be protected accordingly.

Corrosion protection of the structural elements should be designed by an appropriately qualified engineer.

7.7 Mine Subsidence

The site lies within the West Lake Mine Subsidence District, and as such, the proposed development will require the approval of the Mine Subsidence Board. The Mine Subsidence Board (MSB) has indicated that although the current proposal exceeds surface development guidelines, they would consider development of structures up to seven storeys in height (including basement) (refer attached correspondence from MSB).

Discussions between the client and the Mine Subsidence Board indicates that there are no previous workings located beneath the site. Approval would, however, be subject to the structural design accommodating the following parameters, to minimise potential damage if mining were to extend below the site in the future:

(a)	maximum vertical subsidence	150 mm;
(b)	maximum ground strains	±2 mm/m;
(c)	maximum tilt	2 mm/m.

The MSB will require submission of final structural design drawings prior to construction, and also a structural engineer's work-as-executed certification on completion.

Additional details are contained within correspondence from the MSB, copy attached.

7.8 Excavations

It is understood that bulk excavations area are not proposed within the low-lying Marina Village and Blocks A to D. Excavations are possible for installation of buried services, construction of footings and swimming pools, at locations yet to be finalised.

Excavations within this area of the site will likely encountered wet or saturated soils and groundwater, and will need to consider the presence of acid sulphate soils (Ref 1).

Excavations of up to about 3 m are shown for Blocks E to G. It is possible that as the project progresses uphill, rock will become more shallow, and has the potential to be encountered during excavation.

Excavations will need to be supported, and may encounter groundwater. Methods of support for excavations should be further assessed during the design stage of the project.

7.9 Site Preparation

Due to the poor ground conditions, it is anticipated that initial site preparation in the low-lying Marina, Marina Village and Blocks A to D could prove problematic, depending on the size of equipment used, and the prevailing weather conditions at the time of construction.

The field work for this investigation followed a period of relatively fine weather, however the CPT rig, drill rig and a crane used to lift the barge into the water, each came very close to becoming bogged in the low lying areas of the site, and each left ruts in the ground after being positioned in one location for a period of time.

It is considered that the upper topsoil forms a partial crust over the underlying loose and wet sandy soils, and hence should not be completely removed.

Therefore, care will be required when stripping topsoil prior to construction, to avoid over-stripping of the surface crust. It may also be prudent to consider smaller earthworks equipment for these initial stages of construction.

In any event, given the likely need for larger construction equipment to traverse the site during construction, it is recommended that bridging layers be constructed to create a working platform for construction equipment.

Excavation and replacement of the poor soils is not recommended due to the presence of shallow groundwater, and likelihood that conditions will not improve significantly in the upper 1 m or so of the ground surface. In addition, bulk excavation and replacement will need to consider the presence of acid sulphate soils (Ref 1).

Therefore, it is recommended that a granular bridging layer be placed by carefully stripping the existing vegetation and then placing, spreading and compacting an appropriate granular material, such as recycled crushed concrete or similar, to form the bridging layer. It is possible that the bridging layer may need to be about 0.5 m thick. The incorporation of a geogrid may assist in minimising the thickness of the bridging layer. Construction of a trial pad may assist in determining an appropriate bridging layer thickness for the development of the low-lying areas of the site.

The bridging layer should comprise a granular material with a nominal diameter of less than 150 mm. The selected maximum particle size should consider the need for future excavation through the material for features such as buried services. The bridging layer material should be placed with sufficient fines to avoid the occurrence of voids, and should have a California bearing ratio (CBR) of 15% or greater.

The bridging layer should be compacted to achieve at least 100% dry density ratio (Standard) for the upper 0.3 m. It should be placed under geotechnical inspection and tested in accordance with AS 3798 (Ref 7).

7.10 Engineered Filling

Where raising of site levels is required, filling should be placed as engineered filling if it is to support structural elements, such as footings, slabs, pavements, etc.

The following procedure is recommended for placement of engineered filling:

- remove any topsoil, uncontrolled filling or deleterious materials;
- prepare the site surface as outlined in Section 7.9 above;
- suitable filling should be placed in horizontal layers not exceeding 300 mm loose thickness and compacted to a dry density ratio of at least 100% Standard for clayey soils and 80% density index for sandy soils. Moisture content should be in the range -3% OMC (dry) to OMC, where OMC is the optimum moisture content at standard compaction.

Geotechnical inspections and testing should be performed during construction.

7.11 Pavements

7.11.1 Preliminary Pavement Thickness Design

The following preliminary pavement thickness design is in accordance with Austroads (Ref 8) and AP-T36/06 (Ref 9).

The field testing indicates that natural subgrade soils are likely to comprise sandy soils. Based on the poor ground conditions, it has been recommended that at a bridging layer of at least

0.5 m thickness be placed over the natural site soils to improve accessibility. Therefore, the bridging layer will act as a 'select subgrade' layer in proposed pavement areas.

For the purpose of the preliminary pavement thickness design, a subgrade CBR of 5% has been adopted for the natural sandy soils, based on previous experience. A CBR of 15% has been adopted for the select subgrade, based on the recommendations presented in Section 7.9, above. This will result in an effective subgrade CBR of about 8%, which will be used for the preliminary pavement thickness design.

Indicative traffic loadings have been adopted from AP-T36/06 (Ref 9) based on the following:

Street Type (as defined in Ref 9)	**Possible Application**	**Indicative Design Traffic (ESA)**
"Minor with two lane traffic"	Carpark and driveway areas subject only to light vehicle traffic (ie. cars up to 3 tonnes)	8×10^3
"Local access in industrial area"	Driveways which include delivery vehicles	3×10^5

ESA – equivalent standard axles

It is important that the pavement areas are carefully considered and separated into those areas likely to see truck traffic and those that are unlikely to see truck traffic. If trucks are allowed to traffic pavement areas which have been designated for car traffic, there is a risk of reduced design life and pavement damage. The above loadings are not applicable for traffic such as forklifts, loaders, etc. Heavy duty pavement areas will require specific pavement design once vehicle types and loads are known.

The above traffic loadings should be reviewed as more detailed information on traffic loading becomes available. In particular, the likely number and types of trucks should be confirmed to assess the suitability of the suggested pavement thickness.

The recommended pavement thickness design is as presented in Table 7.7, below.

Table 7.7 – Preliminary Indicative Pavement Thickness

Pavement Layer	Indicative Thickness (mm)	
	Effective Subgrade (CBR ≥8%)	
	Main Driveways (3 x 10^5 ESA)	Carpark (8 x 10^3 ESA)
Wearing course	40[1]	30[2]
Basecourse	115	100
Subbase	100	100
Total	**225**	**200**

Notes to Table 7.7:

* Where asphalt is to be used as a wearing course, a 7 mm prime seal should first be laid
1 – AC 14 or equivalent
2 – AC 10 or equivalent

The pavement thicknesses presented above are dependant on the provision and maintenance of adequate surface and subsurface drainage. Depending on finished levels, subsoil drainage may be required beneath pavement areas.

7.11.2 Material Quality and Compaction Requirements

Recommended pavement material quality and compaction requirements are presented in Table 7.8, below.

Table 7.8 – Material Quality and Compaction Requirements

Pavement Layer	Material Quality	Compaction
Basecourse	CBR > 80%, PI ≤ 6%, Grading in accordance with RTA Form 3051 or Ref 9	Compact to at least 98% dry density ratio Modified (AS 1289.5.2.1)
Subbase	CBR > 30%, PI ≤ 12%, Grading in accordance with RTA Form 3051 or Ref 10	Compact to at least 95% dry density ratio Modified (AS 1289.5.2.1)
Select subgrade (bridging layer)	CBR ≥15%	Compact to at least 100% dry density ratio Standard (AS 1289.5.1.1)
Natural sandy subgrade	CBR ≥5%	Compact to at least 80% density index (AS 1289.6.2.1)

7.11.3 Subgrade Preparation

The subgrade should be prepared in accordance with the site preparation measures presented in Section 7.9 above, so that a minimum of 0.5 m of select subgrade is present beneath the top of subgrade level.

Geotechnical inspections and testing should be performed during construction, in accordance with AS 3798 (Ref 7).

8. LIMITATIONS

Conditions on site different to those identified during this assessment may exist. Therefore Douglas Partners Pty Ltd (DP) cannot provide unqualified warranties nor does DP assume any liability for site conditions not recorded in the data available for this assessment.

This report and associated documentation and the information herein have been prepared solely for the use of Johnson Property Group Pty Ltd. Any reliance on this report assumed by other parties shall be at such party's own risk. Any ensuing liability resulting from use of the report by other parties cannot be transferred to DP.

DOUGLAS PARTNERS PTY LTD

Reviewed by:

Julie Wharton
Associate

John Harvey
Principal

REFERENCES

1. Douglas Partners Pty Ltd Report "Acid Sulphate Soil Assessment, Proposed Trinity Point Marina and Tourist Development, 49 Lakeview Road, Morisset Park", Project 39823A, December 2007.

2. Douglas Partners Pty Ltd Report "Geochemical Assessment, Proposed Trinity Point Marina, Morisset Park, Lake Macquarie", Project 39823B, December 2007.

3. Douglas Partners Pty Ltd Draft Report "Waste Classification, Proposed Trinity Point Marina and Marina Village, 49 Lakeview Road, Morisset Park", Project 39823C, November 2007.

4. Australian Standard AS 2870-1996 "Residential Slabs and Footings – Construction", Standard Association of Australia.

5. Cement & Concrete Association of Australia, TN61 "Articulated Walling".

6. Australian Standard AS 2159-1995 "Piling – Design and Installation", Standards Australia.

7. Australian Standard AS 3798 2007: Guidelines on Earthworks for Commercial & Residential Development.

8. "Pavement Design: A Guide to the Structural Design of Road Pavements", AUSTROADS 2004.

9. AP/T-36 "Pavement Design for Light Traffic: A supplement to AUSTROADS Pavement Design Guide" AUSTROADS 2006.

10. ARRB Special Report 41 "A Structural Design Guide for Flexible Residential Street Pavements", Australian Road Research Board, April 1989.

Foundation Maintenance and Footing Performance:

A Homeowner's Guide

BTF 18 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

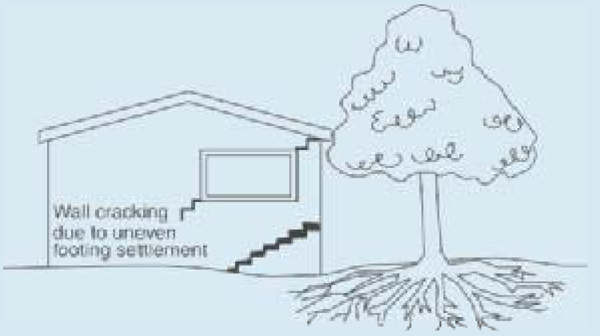
Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage



As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

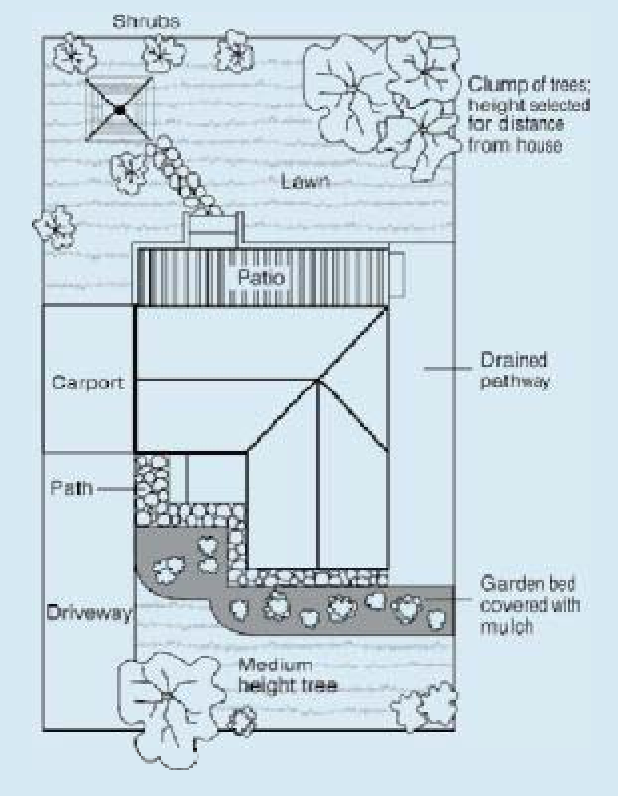
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

Distributed by
CSIRO PUBLISHING PO Box 1139, Collingwood 3066, Australia
Freecall 1800 645 051 Tel (03) 9662 7666 Fax (03) 9662 7555 www.publish.csiro.au
Email: publishing.sales@csiro.au

NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring 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.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling 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 with 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.

Details of the type and method of sampling are given in the report.

Drilling Methods.

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

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of 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 sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole 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 in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water 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 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength 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 short of full penetration, 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 tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6) \text{ N (blows per 300 mm)}$$

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

$$q_c = (12 \text{ to } 18)\ c_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. 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 relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is 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.

Bore Logs

The bore logs presented herein 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. 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 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, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it 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.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations 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.

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 (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). 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 condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

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

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, the Company requests that it immediately be notified. Most problems are much 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.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical 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.

AN ENGINEERING CLASSIFICATION OF SEDIMENTARY ROCKS IN THE SYDNEY AREA

This classification system provides a standardized terminology for the engineering description of the sandstone and shales in the Sydney area, but the terms and definitions may be used elsewhere when applicable.

Under this system rocks are classified by Rock Type, Degree of Weathering, Strength, Stratification Spacing, and Degree of Fracturing. These terms do not cover the full range of engineering properties. Descriptions of rock may also need to refer to other properties (e.g. durability, abrasiveness, etc.) where these are relevant.

ROCK TYPE DEFINITIONS

Rock Type	Definition
Conglomerate:	More than 50% of the rock consists of gravel sized (greater than 2mm) fragments
Sandstone:	More than 50% of the rock consists of sand sized (.06 to 2mm) fragments
Siltstone:	More than 50% of the rock consists of silt-sized (less than 0.06mm) granular particles and the rock is not laminated
Claystone:	More than 50% of the rock consists of clay or sericitic material and the rock is not laminated
Shale:	More than 50% of the rock consists of silt or clay sized particles and the rock is laminated

Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, e.g. clayey sandstone, sandy shale.

DEGREE OF WEATHERING

Term	Symbol	Definition
Extremely Weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly Weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately Weathered	MW	Rock substance affected by weathering to the extent that staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is no longer recognisable.
Slightly Weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	Fs	Rock substance unaffected by weathering, limonite staining along joints.
Fresh	Fr	Rock substance unaffected by weathering.

STRATIFICATION SPACING

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

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics (Reference).

Strength Term	Is(50) MPa	Field Guide	Approx. qu MPa*
Extremely Low:	0.03	Easily remoulded by hand to a material with soil properties	0.7
Very Low:	0.1	May be crumbled in the hand. Sandstone is “sugary” and friable.	2.4
Low:	0.3	A piece of core 150 mm long x 50 mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	7
Medium:	1	A piece of core 150 mm long x 50 mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.	24
High:	3	A piece of core 150 mm long x 50 mm dia. cannot be broken by unaided hands, can be slightly scratched or scored with knife.	70
Very High:	10	A piece of core 150 mm long x 50 mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.	240
Extremely High:		A piece of core 150 mm long x 50 mm dia. is difficult to break with hand held hammer. Rings when struck with a hammer.	

* The approximate unconfined compressive strength (qu) shownin the table is based on an assumed ratio to the point load index of 24:1. This ratio may vary widely.

DEGREE OF FRACTURING

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude known artificial fractures such as drilling breaks

Term	Description
Fragmented:	The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than the core diameter.
Highly Fractured:	Core lengths are generally less than 20 mm - 40 mm with occasional fragments.
Fractured:	Core lengths are mainly 30 mm - 100 mm with occasional shorter and longer sections.
Slightly Fractured:	Core lengths are generally 300 mm - 1000 mm with occasional longer sections and occasional sections of 100 mm - 300 mm.
Unbroken:	The core does not contain any fracture.

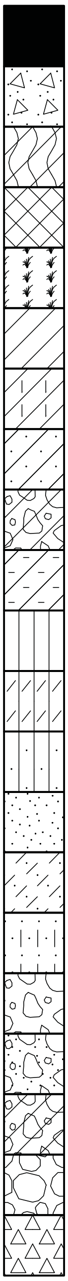
REFERENCE

International Society of Rock Mechanics, Commission on Standardisation of Laboratory and Field Tests, Suggested Methods for Determining the Uniaxial Compressive Strength of Rock Materials and the Point Load Strength Index, Committee on Laboratory Tests Document No. 1 Final Draft October 1972

Log!GRAPHIC-SYMBOLS 24/11/2003 4:38:57 PM

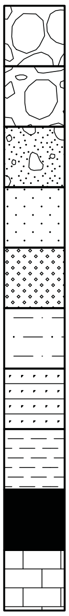
GRAPHIC SYMBOLS FOR SOIL & ROCK

SOIL



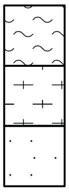
- BITUMINOUS CONCRETE
- CONCRETE
- TOPSOIL
- FILLING
- PEAT
- CLAY
- SILTY CLAY
- SANDY CLAY
- GRAVELLY CLAY
- SHALY CLAY
- SILT
- CLAYEY SILT
- SANDY SILT
- SAND
- CLAYEY SAND
- SILTY SAND
- GRAVEL
- SANDY GRAVEL
- CLAYEY GRAVEL
- COBBLES/BOULDERS
- TALUS

SEDIMENTARY ROCK



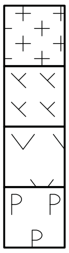
- BOULDER CONGLOMERATE
- CONGLOMERATE
- CONGLOMERATIC SANDSTONE
- SANDSTONE FINE GRAINED
- SANDSTONE COARSE GRAINED
- SILTSTONE
- LAMINITE
- MUDSTONE, CLAYSTONE, SHALE
- COAL
- LIMESTONE

METAMORPHIC ROCK



- SLATE, PHYLITTE, SCHIST
- GNEISS
- QUARTZITE

IGNEOUS ROCK



- GRANITE
- DOLERITE, BASALT
- TUFF
- PORPHYRY

Douglas Partners
Geotechnics · Environment · Groundwater

ABBREVIATIONS USED IN DISCONTINUITIES COLUMN OF TEST BORE LOGS

Abbreviation	Meaning
DB	Drill Break
P	Parting
J	Joint
Fr	Fracture
F	Fault
un	Undulating
ro	Rough
H	Healed
pl	Planar
fg	Fragmented
cs lam	Carbonaceous lamination
sm	Smooth
ti	Tight
di	Probably drilling induced
st	Stepped
sl	Slickensided
Fe	Ironstained
hor	Horizontal
V	Vertical
sh	Subhorizontal
sv	Subvertical
cy	clay
ca	calcite

Examples:

1. At 62.04 m, P, 30°, un, st, ro, cs lam
   At 62.04 m Parting, 30°, undulating, stepped, rough, on carbonaceous siltstone lamination

2. At 65.08 m, Fr, 70°, pl, ro, st, fr
   At 65.08 m, fracture, planar, rough, stepped, fragmented.

Ref: M:\Reference\Discontinuities Abbreviations.doc

CONE PENETRATION TEST

CLIENT: JOHNSON PROPERTY GROUP

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

LOCATION: OFF HENRY ROAD, MORISSET PARK

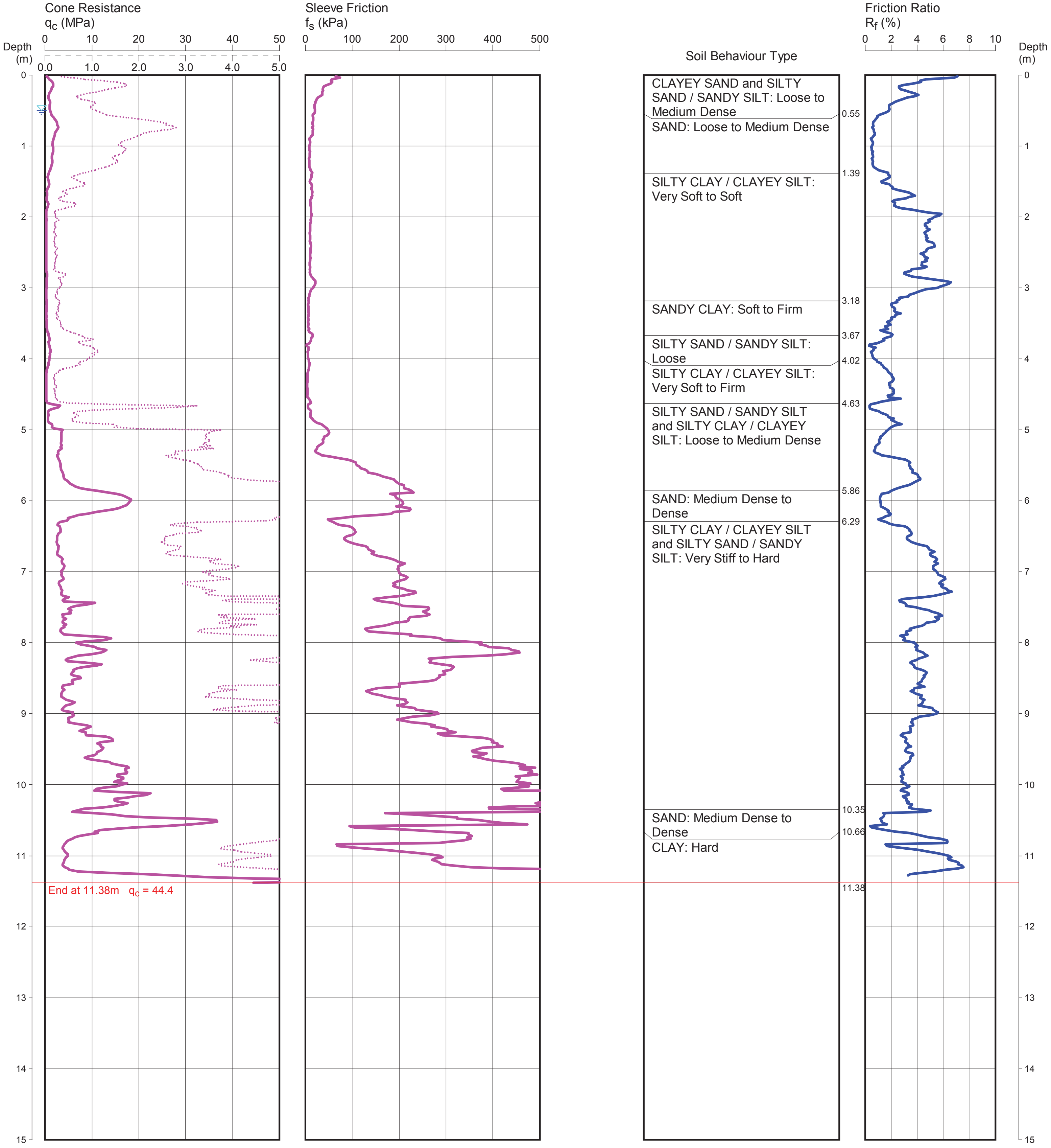
PROJECT No: 39823

CPT 1

Page 1 of 1

DATE 25/09/2007

SURFACE RL: 0.665



	CLAYEY SAND and SILTY SAND / SANDY SILT: Loose to Medium Dense
0.55	SAND: Loose to Medium Dense
1.39	SILTY CLAY / CLAYEY SILT: Very Soft to Soft
3.18	SANDY CLAY: Soft to Firm
3.67	SILTY SAND / SANDY SILT: Loose
4.02	SILTY CLAY / CLAYEY SILT: Very Soft to Firm
4.63	SILTY SAND / SANDY SILT and SILTY CLAY / CLAYEY SILT: Loose to Medium Dense
5.86	SAND: Medium Dense to Dense
6.29	SILTY CLAY / CLAYEY SILT and SILTY SAND / SANDY SILT: Very Stiff to Hard
10.35	SAND: Medium Dense to Dense
10.66	CLAY: Hard
11.38	

REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 0.5 m
MGA Coordinates: E363772.903, N 6334208.428

Date
Plotted
Checked

File: P:\39823\Field\39823-01.CP5
Cone ID: 413 **Type:** 2 Standard

ConePlot Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

CONE PENETRATION TEST

CLIENT: JOHNSON PROPERTY GROUP

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

LOCATION: OFF HENRY ROAD, MORISSET PARK

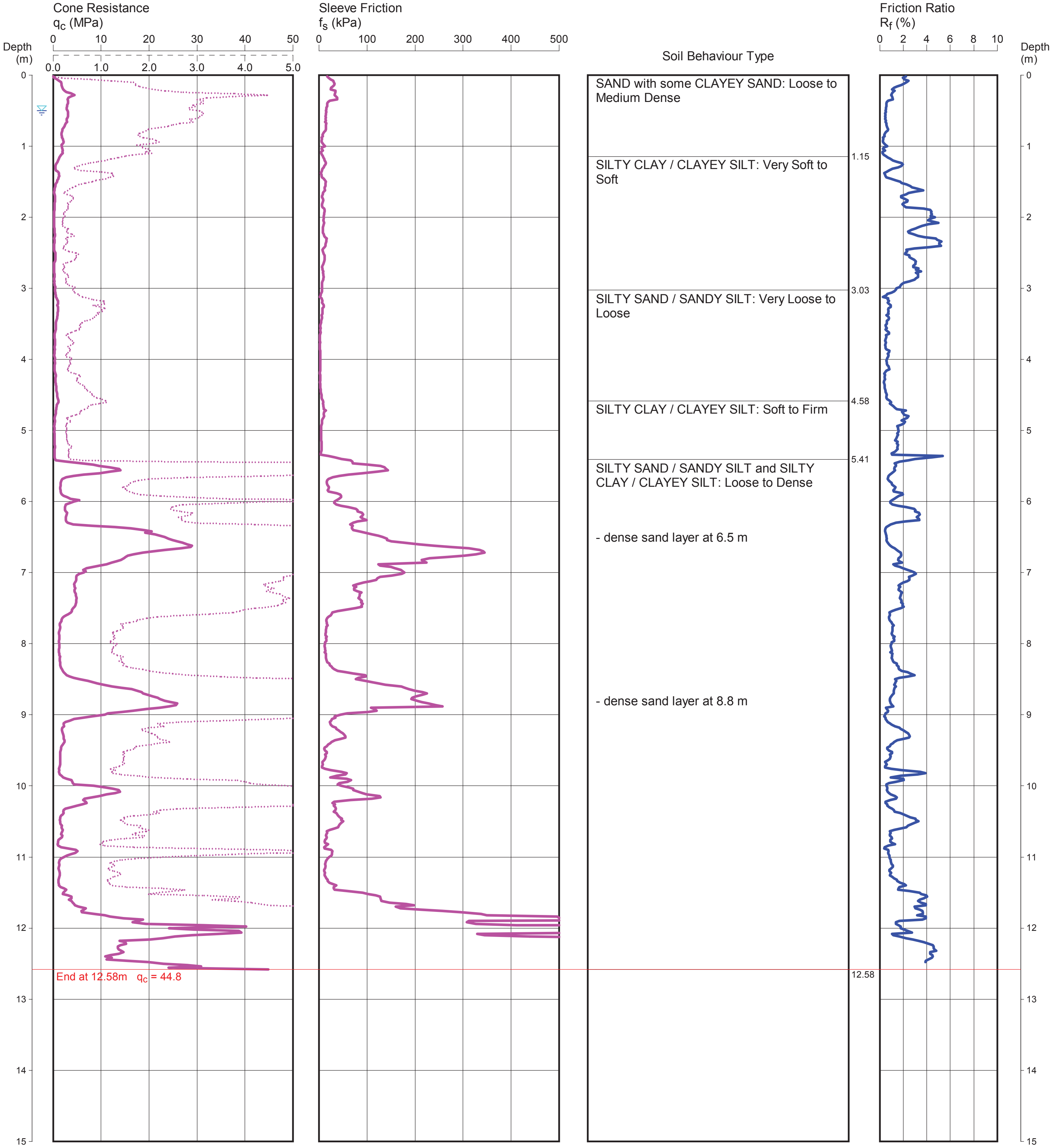
PROJECT No: 39823

CPT 2

Page 1 of 1

DATE 25/09/2007

SURFACE RL: 0.81



SAND with some CLAYEY SAND: Loose to Medium Dense

SILTY CLAY / CLAYEY SILT: Very Soft to Soft

SILTY SAND / SANDY SILT: Very Loose to Loose

SILTY CLAY / CLAYEY SILT: Soft to Firm

SILTY SAND / SANDY SILT and SILTY CLAY / CLAYEY SILT: Loose to Dense

- dense sand layer at 6.5 m

- dense sand layer at 8.8 m

REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 0.5m
MGA Coordinates: E363824.4, N6334193.0

Date
Plotted
Checked

File: P:\39823\Field\39823-02.CP5
Cone ID: 413 **Type:** 2 Standard

ConePlot Version 5.8.1

CONE PENETRATION TEST

CLIENT: JOHNSON PROPERTY GROUP

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

LOCATION: OFF HENRY ROAD, MORISSET PARK

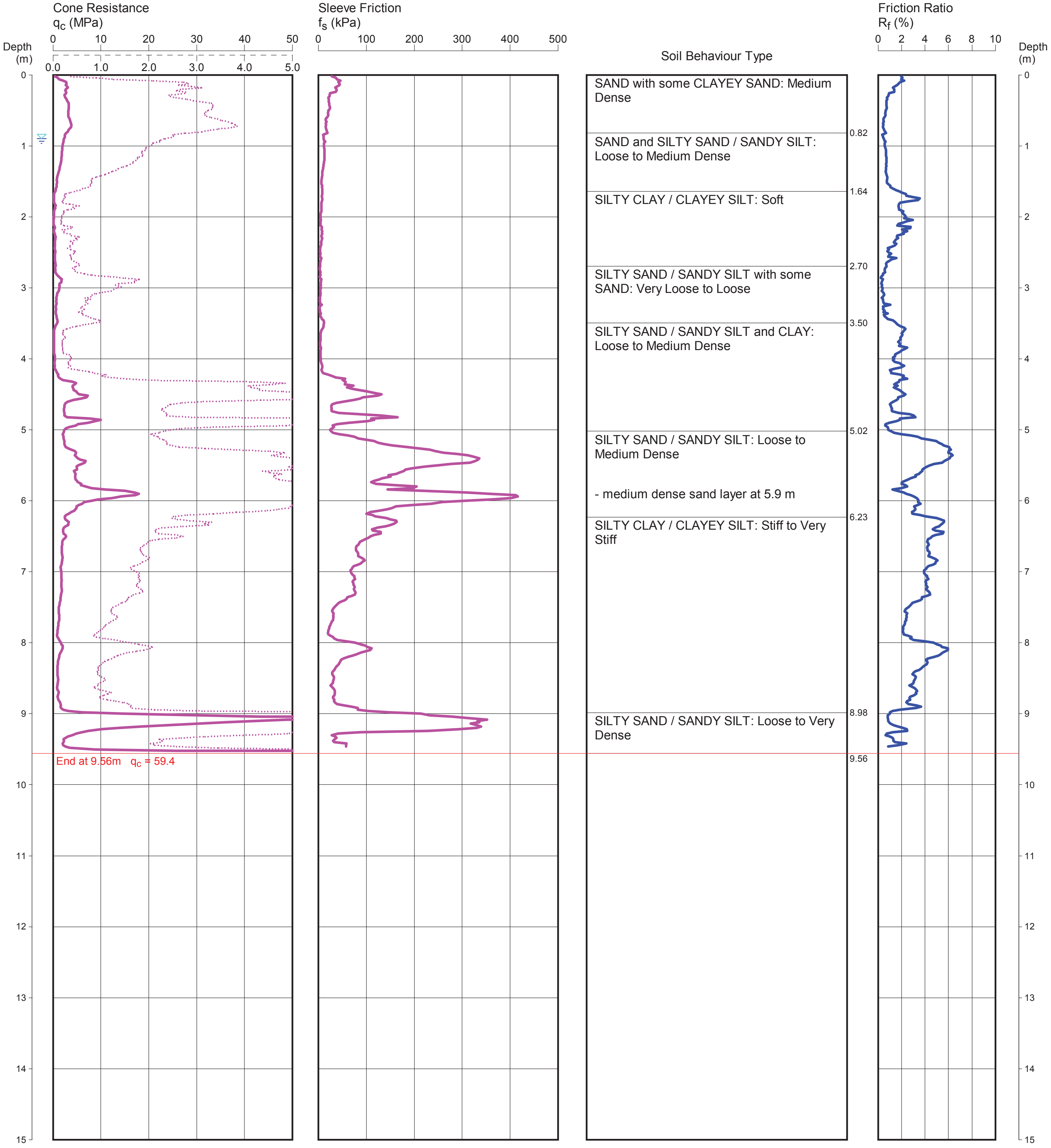
PROJECT No: 39823

CPT 3

Page 1 of 1

DATE 25/09/2007

SURFACE RL: 0.92



Soil Behaviour Type

SAND with some CLAYEY SAND: Medium Dense

0.82

SAND and SILTY SAND / SANDY SILT: Loose to Medium Dense

1.64

SILTY CLAY / CLAYEY SILT: Soft

2.70

SILTY SAND / SANDY SILT with some SAND: Very Loose to Loose

3.50

SILTY SAND / SANDY SILT and CLAY: Loose to Medium Dense

5.02

SILTY SAND / SANDY SILT: Loose to Medium Dense

- medium dense sand layer at 5.9 m

6.23

SILTY CLAY / CLAYEY SILT: Stiff to Very Stiff

8.98

SILTY SAND / SANDY SILT: Loose to Very Dense

9.56

REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 0.9 m
MGA Coordinates: E363867.4, 6334172.0

Date
Plotted
Checked

File: P:\39823\Field\39823-03.CP5
Cone ID: 413 **Type:** 2 Standard

ConePlot Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

CONE PENETRATION TEST

CLIENT: JOHNSON PROPERTY GROUP

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

LOCATION: OFF HENRY ROAD, MORISSET PARK

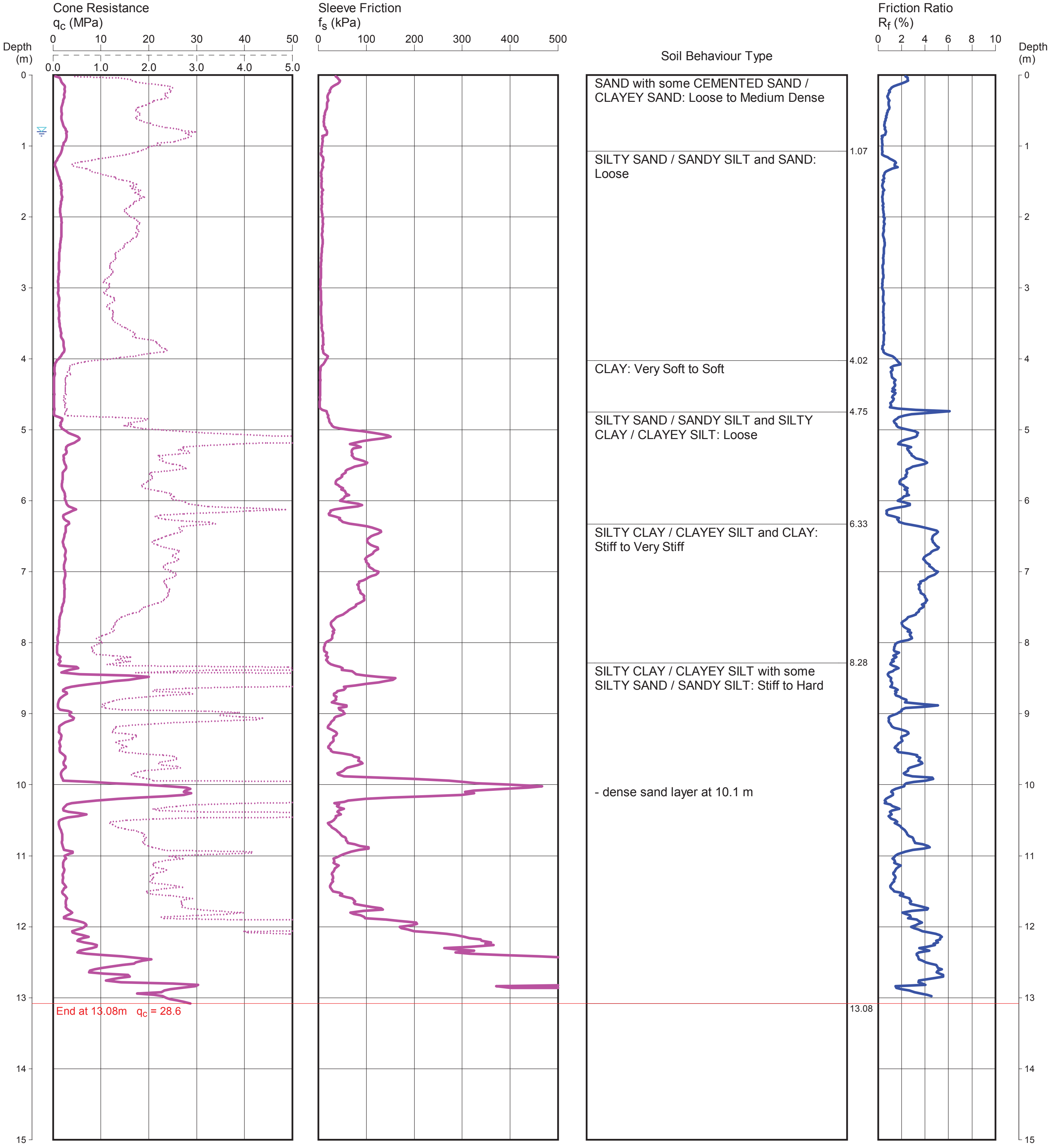
PROJECT No: 39823

CPT 4

Page 1 of 1

DATE 25/09/2007

SURFACE RL: 0.99



SAND with some CEMENTED SAND / CLAYEY SAND: Loose to Medium Dense

SILTY SAND / SANDY SILT and SAND: Loose

CLAY: Very Soft to Soft

SILTY SAND / SANDY SILT and SILTY CLAY / CLAYEY SILT: Loose

SILTY CLAY / CLAYEY SILT and CLAY: Stiff to Very Stiff

SILTY CLAY / CLAYEY SILT with some SILTY SAND / SANDY SILT: Stiff to Hard

- dense sand layer at 10.1 m

REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 0.8 m
MGA Coordinates: E363828.683, N6334161.2

Date
Plotted
Checked

File: P:\39823\Field\39823-04.CP5
Cone ID: 413 **Type:** 2 Standard

ConePlot Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

CONE PENETRATION TEST

CLIENT: JOHNSON PROPERTY GROUP

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

LOCATION: OFF HENRY ROAD, MORISSET PARK

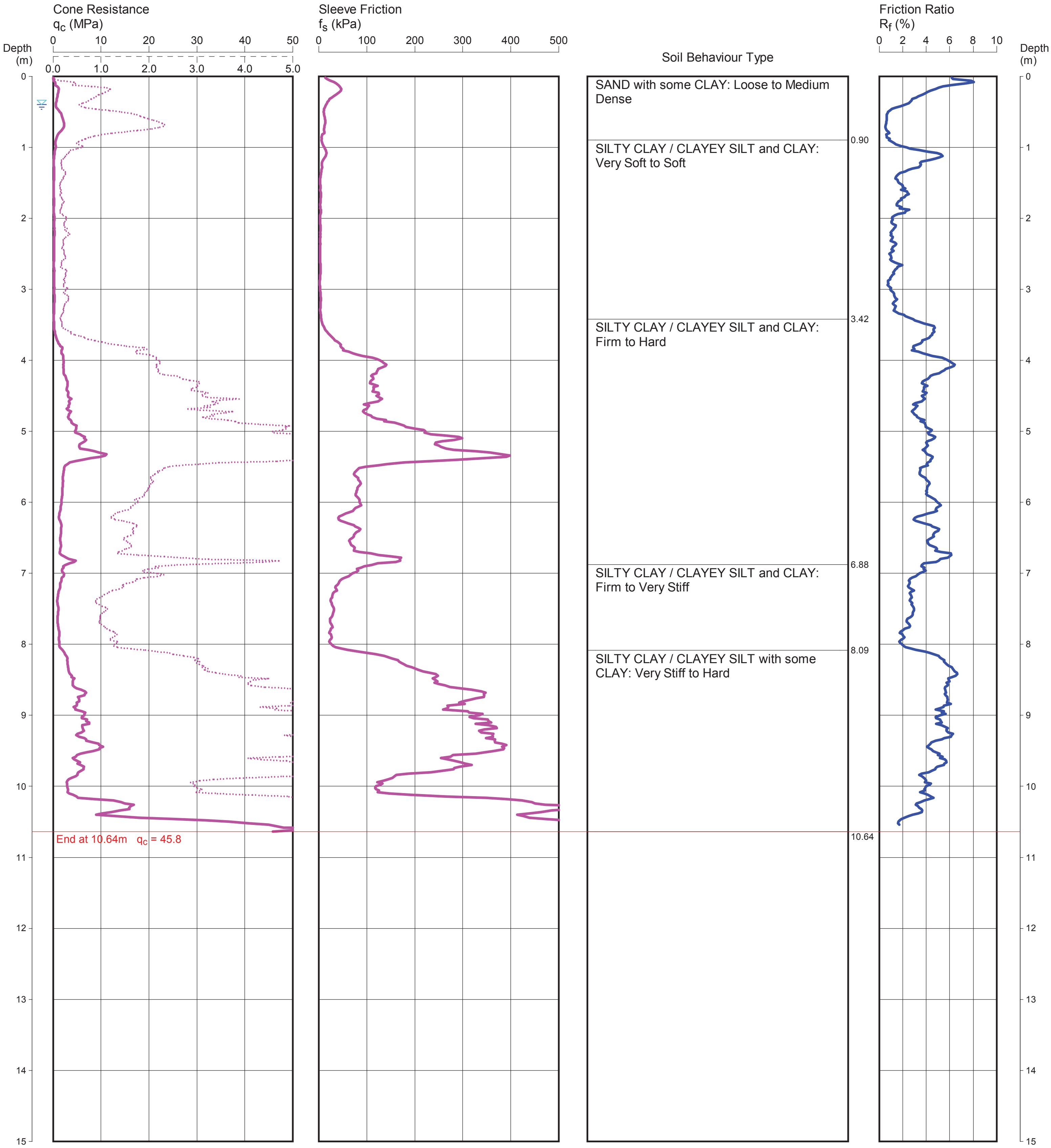
PROJECT No: 39823

CPT 5

Page 1 of 1

DATE 25/09/2007

SURFACE RL: 0.78



REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 0.4 m
MGA Coordinates: E363845.3, N6334130.1

Date
Plotted
Checked

File: P:\39823\Field\39823-05.CP5
Cone ID: 413 **Type:** 2 Standard

ConePlot Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

CONE PENETRATION TEST

CLIENT: JOHNSON PROPERTY GROUP

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

LOCATION: OFF HENRY ROAD, MORISSET PARK

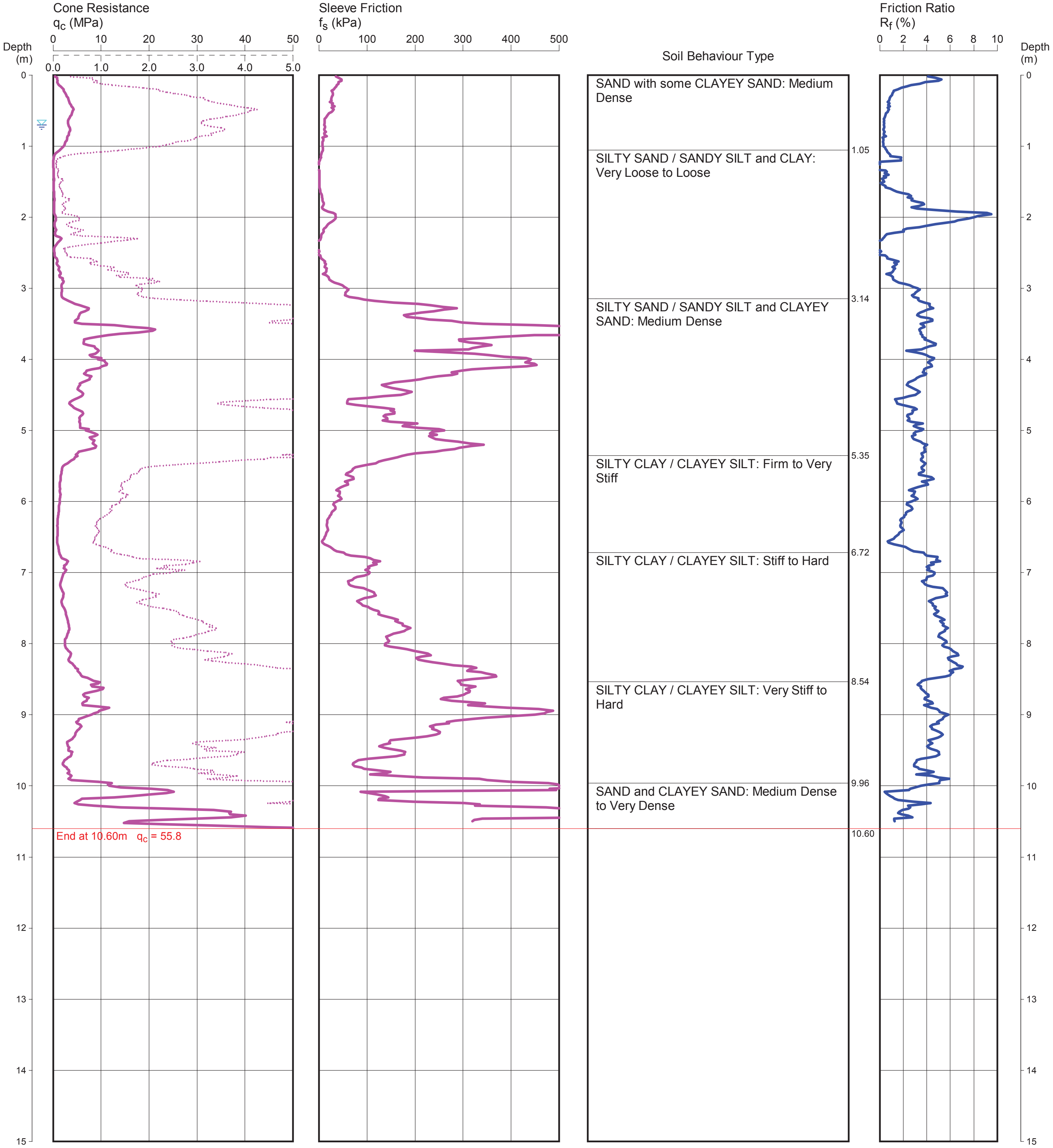
PROJECT No: 39823

CPT 6

Page 1 of 1

DATE 25/09/2007

SURFACE RL: 1.05



Depth to (m)	Soil Behaviour Type
1.05	SAND with some CLAYEY SAND: Medium Dense
3.14	SILTY SAND / SANDY SILT and CLAY: Very Loose to Loose
5.35	SILTY SAND / SANDY SILT and CLAYEY SAND: Medium Dense
6.72	SILTY CLAY / CLAYEY SILT: Firm to Very Stiff
8.54	SILTY CLAY / CLAYEY SILT: Stiff to Hard
9.96	SILTY CLAY / CLAYEY SILT: Very Stiff to Hard
10.60	SAND and CLAYEY SAND: Medium Dense to Very Dense

REMARKS: DEPTH TO WATER AT COMPLETION OF TEST : 0.7 m
MGA Coordinates: E363877.37, N6334115.6

Date
Plotted
Checked

File: P:\39823\Field\39823-06.CP5
Cone ID: 413 **Type:** 2 Standard

ConePlot Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: 1.27 AHD
EASTING: 363834
NORTHING: 6334174
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 39823
DATE: 26/9/07
SHEET 1 OF 2

Depth (m)	Description of Strata	Water	Type	Test Results & Comments
	FILLING: Generally comprising brown fine to coarse grained gravelly silty sand, humid			
0.35	GRAVELLY SAND: Very loose to loose grey-brown fine to coarse grained gravelly sand, with trace silt and clay, damp From 0.6m, moist to wet From 1.0m, saturated	▼	A A S	 1,0,1 N = 1
1.7	GRAVELLY CLAYEY SAND: Very loose to loose grey-brown fine to coarse grained gravelly sand, with some silt, shell fragments, saturated		S	1,0,0 N = 0
3.0	GRAVEL: Loose grey and brown fine to medium sized gravel, with some sand and shells and trace silt, saturated			
4.05	GRAVELLY SAND: Loose grey fine to medium grained silty gravelly sand, with some shells, saturated		S	5,2,2 N = 4
5.5	GRAVELLY CLAY: Very stiff to hard grey-brown and brown gravelly clay, with some sand, M~Wp		S	5,14,16 N = 30
6.3	GRAVELLY SANDY CLAY: Very stiff light grey-brown gravelly sandy clay, M~Wp			
7.0	SILTY CLAY: Very stiff grey-brown and red-brown silty clay, M~Wp		S	3,7,12 N = 19
7.8	SANDY SILTY CLAY: Firm to stiff grey-brown sandy silty clay, with some gravel, M~Wp From 8.55m to 8.8m, soft to firm		pp pp S pp	30-50 kPa 30-50 kPa 1,0,4 N = 4 80-100 kPa

RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 5.5m

TYPE OF BORING: Solid flight auger (tc-bit) to 2.5m, then wash boring to 5.5m; then rotary with mud to 13.25m; then NMLC coring to 19.9m

WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling

REMARKS: Coordinates are MGA. 50mm diameter Class 18 PVC piezometer installed to 4m; screened from 1.0m to 4.0m; 5mm gravel filter from 0.4m to 4.0m; bentonite plug from surface to 0.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

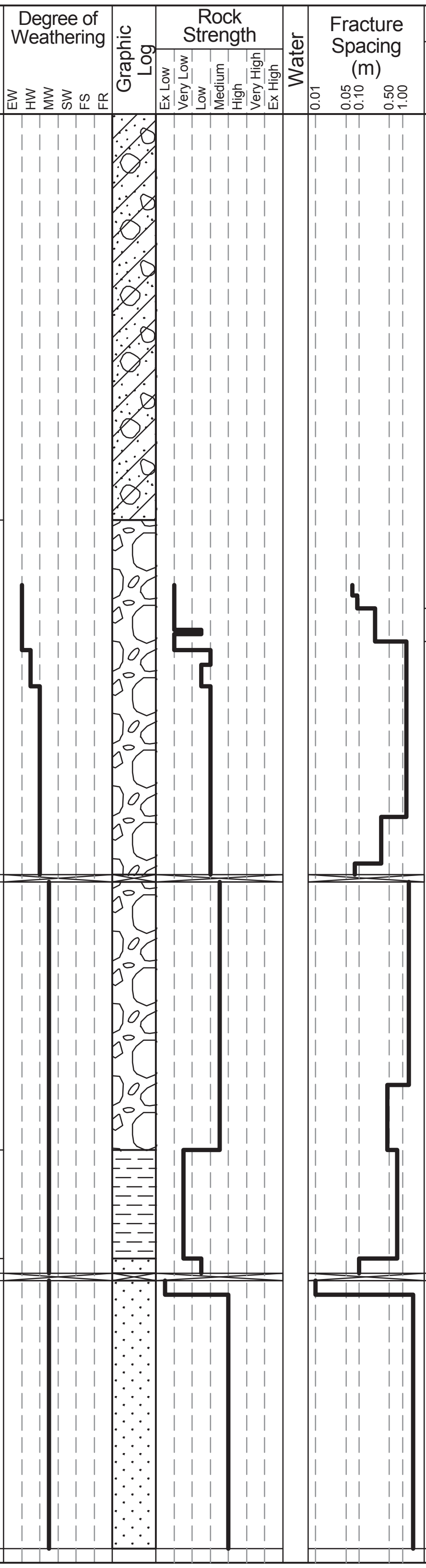
Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: 1.27 AHD
EASTING: 363834
NORTHING: 6334174
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 39823
DATE: 26/9/07
SHEET 2 OF 2



Discontinuities: B - Bedding, J - Joint, S - Shear, D - Drill Break

Depth (m)	Description of Strata	Discontinuities	Type	Core Rec. %	RQD %	Test Results & Comments
10.0	GRAVELLY SANDY CLAY: Stiff grey-brown gravelly sandy clay, M~Wp		S pp			120-140 kPa 5,4,6 N = 10
			S			7,4,11 N = 15
	From 11.9m, stiff to very stiff					
12.8	CONGLOMERATE: Extremely low strength, extremely weathered orange-brown and light grey conglomerate		S			23,25/80mm
	From 13.25m, extremely low to very low strength, extremely to highly weathered From 13.56m to 13.59, low strength	13.32m: P, 5º, ro, un 13.41m: P, 5º, ro, un 13.64m: J, 10º, ro, un	C	100	73	PL(A) = 0.67MPa PL(D) = 0.26MPa
	From 13.7m, low to medium strength, highly to moderately weathered	14.85m: J, 45º, ro, un	C	100	94	
15.25	CORE LOSS:	15.25m: CORE LOSS: 50mm				
15.3	CONGLOMERATE: Medium strength, moderately weathered brown conglomerate	15.77m: J, 10º, sm, pl 16.7m: P, 5º, sm, pl, Fe	C	98	98	PL(A) = 0.7MPa PL(D) = 0.35MPa
17.15	CLAYSTONE: Very low strength, moderately weathered brown conglomerate	17.15m: P, 10º, ro, pl, Fe				PL(A) = 0.07MPa PL(D) = 0.05MPa
17.9	PEBBLY SANDSTONE: Low strength, moderately weathered light grey fine to coarse grained pebbly sandstone	17.9m: P, 5º, ro, pl	C	97	90	
18.0	CORE LOSS:	18m: CORE LOSS: 50mm				
18.05	PEBBLY SANDSTONE: Extremely low strength, moderately weathered light grey fine to coarse grained pebbly sandstone	From 18.05m to18.15m, highly Fg (1mm to 10mm)				
	From 18.45m, medium to high strength		C	100	100	PL(A) = 1.57MPa PL(D) = 1.06MPa
19.9	Bore discontinued at 19.9m, limit of investigation					

RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 5.5m

TYPE OF BORING: Solid flight auger (tc-bit) to 2.5m, then wash boring to 5.5m; then rotary with mud to 13.25m; then NMLC coring to 19.9m

WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling

REMARKS: Coordinates are MGA. 50mm diameter Class 18 PVC piezometer installed to 4m; screened from 1.0m to 4.0m; 5mm gravel filter from 0.4m to 4.0m; bentonite plug from surface to 0.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

Bore 101 – 13.25 m to 19.9 m

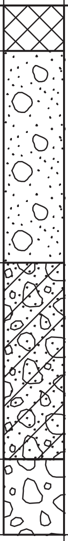
BOREHOLE LOG

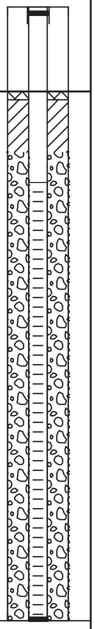
CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 1.27
EASTING: 363834
NORTHING: 6334174
DIP/AZIMUTH: 90°/--

BORE No: 101A
PROJECT No: 39823
DATE: 16 Oct 07
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	FILLING: Generally comprising brown fine to medium grained gravelly silty sand, humid						From 0.05m to 0.4m, bentonite
0.3	GRAVELLY SAND: Very loose to loose grey-brown fine to coarse grained sand, some silt and clay, damp From 0.65m, wet to saturated					▼	
1.7	GRAVELLY CLAYEY SAND: Very loose to loose grey-brown fine to coarse grained gravelly sand, with some silt, saturated						From 0.4m to 3.5m, 5mm gravel filter From 0.6m to 3.5m, screen
3.0	GRAVEL: Loose grey-brown fine to coarse gravel, with some sand and trace silt, saturated						
3.5	Bore discontinued at 3.5m, limit of investigation						





RIG: Truck mounted rig **DRILLER:** Atkins **LOGGED:** Karpiel **CASING:** -
TYPE OF BORING: 150mm hollow flight auger
WATER OBSERVATIONS: Free groundwater observed at 1.15m below ground level during drilling
REMARKS: Endcap dislodged during removal of casing, screen backfilled inside well to 1.84m below ground level

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: 0.89 AHD
EASTING: 363828.6
NORTHING: 6334140.7
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 39823
DATE: 08 Oct 07
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Water	Sampling Type	Test Results & Comments
		TOPSOIL: Generally comprising dark brown-black clayey sandy silt, with trace rootlets to 0.2m, damp			
	0.4	SILTY SAND: Dark brown fine to medium grained silty sand, damp		A	
0	0.7	SAND: Very loose brown fine to medium grained sand, with trace silt, clay and shell fragments, moist		A S	 1,0,0 N = 0
-1 -2 -3	1.3	SILTY SAND: Very loose grey fine to medium grained silty sand, with trace clay and shell fragments, saturated	▼	S	0,0,0 N = 0 (weight of hammer)
	4.2	CLAYEY SAND/SANDY CLAY: Very soft grey-brown medium grained clayey sand/sandy clay, saturated		S	3,1,2 N = 3
-4	4.7	SILTY SANDY CLAY: Firm to stiff light brown sandy clay, with fine grained gravel, M>Wp			
-5 -6	5.3	SILTY CLAY: Firm to very stiff light brown silty clay, with some sand, M<Wp		pp pp S pp	80 kPa 150 kPa 3,3,6 N = 9 320 kPa
-7	7.15	GRAVELLY SANDY CLAY: Very stiff to hard light brown gravelly sandy clay, M~Wp		S	3,8,25/130mm
-8 -9	8.0	SILTY CLAY: Stiff light brown silty clay, with some fine grained sand, M>Wp From 9.5m, very stiff to hard, slightly sandy		S pp	3,4,5 N = 9 170 kPa

Other form columns: Degree of Weathering (EW, HW, MW, SW, FS, FR); Graphic Log; Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High); Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00); Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break); Core Rec. %; RQD %

RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 7.2m, HQ to 11.65m

TYPE OF BORING: 100mm diameter solid flight auger (tc-bit to 4.5m), then rotary wash boring to 11.65m, then NMLC coring to 17.75m

WATER OBSERVATIONS: Free groundwater observed at 1.3m during drilling

REMARKS: Coordinates are MGA. 50mm diameter Class 18 PVC piezometer installed to 4.0m depth on completion

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

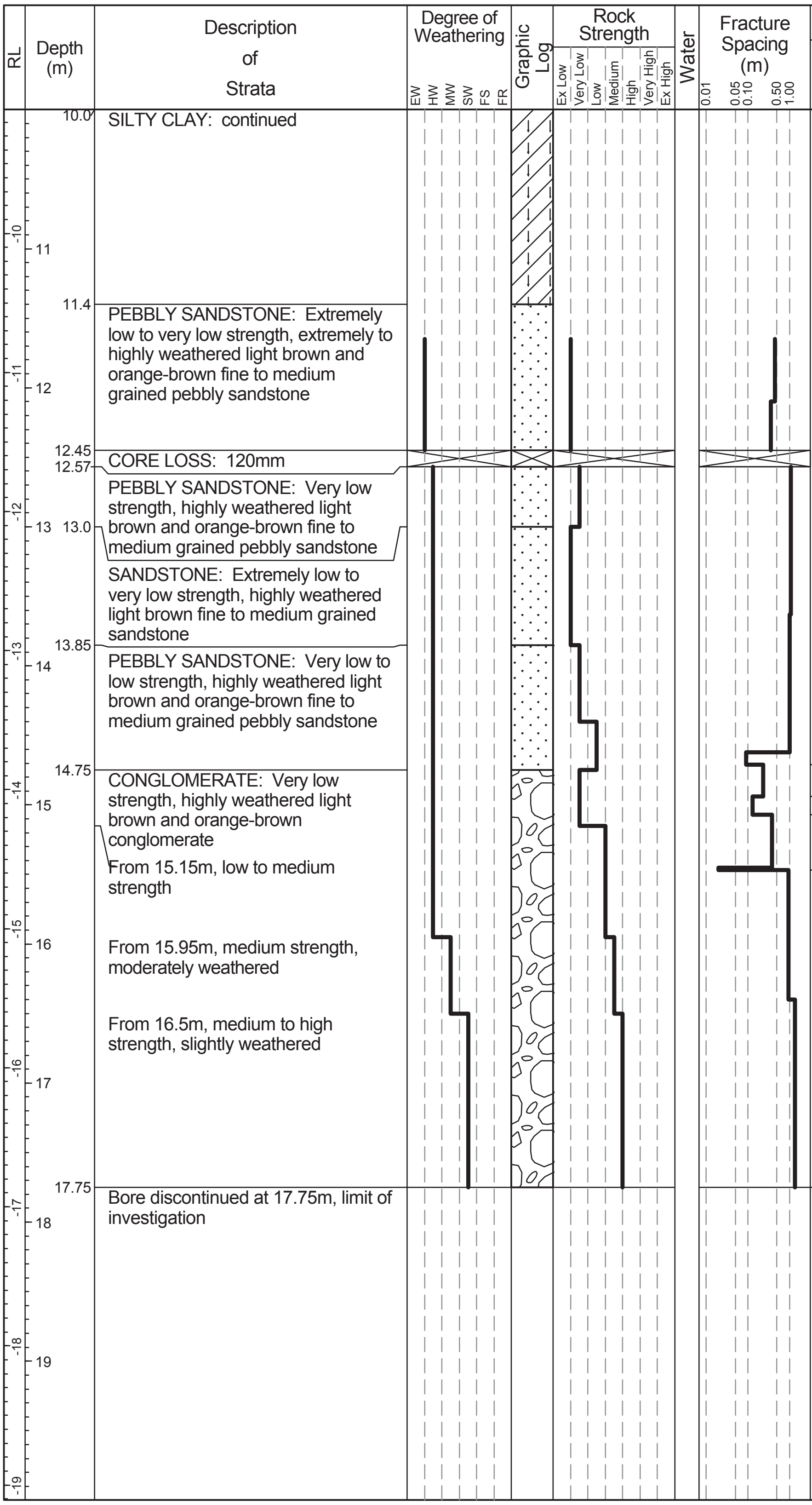
CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: 0.89 AHD
EASTING: 363828.6
NORTHING: 6334140.7
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 39823
DATE: 08 Oct 07
SHEET 2 OF 2

Depth (m)	Description of Strata	Discontinuities	Type	Core Rec. %	RQD %	Test Results & Comments
10.0	SILTY CLAY: continued		S pp pp			340 kPa 5,9,13 N = 22 380-440 kPa
11.4	PEBBLY SANDSTONE: Extremely low to very low strength, extremely to highly weathered light brown and orange-brown fine to medium grained pebbly sandstone	12.1m: J, 70º, ro, un	S C	 100	 100	25/120mm PL(A) = 0.04MPa PL(D) = 0.05MPa
12.45	CORE LOSS: 120mm	12.45m: CORE LOSS: 120mm				
12.57	PEBBLY SANDSTONE: Very low strength, highly weathered light brown and orange-brown fine to medium grained pebbly sandstone		C	92	92	
13.0	SANDSTONE: Extremely low to very low strength, highly weathered light brown fine to medium grained sandstone	13.63m: J, 10º, ro, pl				PL(A) = 0.01MPa PL(D) = 0MPa
13.85	PEBBLY SANDSTONE: Very low to low strength, highly weathered light brown and orange-brown fine to medium grained pebbly sandstone	14.62m: P, 5º, ro, un	C	100	94	
14.75	CONGLOMERATE: Very low strength, highly weathered light brown and orange-brown conglomerate From 15.15m, low to medium strength From 15.95m, medium strength, moderately weathered From 16.5m, medium to high strength, slightly weathered	14.71m: P, 5º, ro, un 14.94m: P, 5º, ro, pl 15.07m: J, 40º, ro, pl 15.45m: P, 5º, ro, pl 15.47m: J, 20º, ro, un 16.4m: J, 30º, ro, un	C	100	99	PL(A) = 0.31MPa PL(D) = 0.22MPa PL(A) = 0.57MPa PL(D) = 0.5MPa
17.75	Bore discontinued at 17.75m, limit of investigation					

Discontinuities: B - Bedding J - Joint S - Shear D - Drill Break



RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 7.2m, HQ to 11.65m

TYPE OF BORING: 100mm diameter solid flight auger (tc-bit to 4.5m), then rotary wash boring to 11.65m, then NMLC coring to 17.75m

WATER OBSERVATIONS: Free groundwater observed at 1.3m during drilling

REMARKS: Coordinates are MGA. 50mm diameter Class 18 PVC piezometer installed to 4.0m depth on completion

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners
Geotechnics · Environment · Groundwater

PROJECT: TRINITY POINT

PROJECT NUMBER: 39823

DATE: OCT 2007

BORE: 102

FROM 11·65 m TO 17·75 m

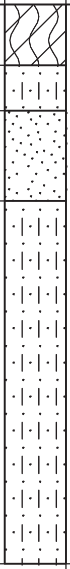
Bore 102 – 11.65 m to 17.75 m

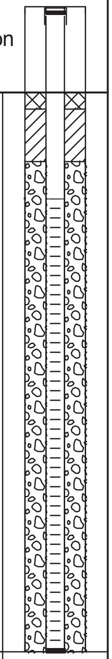
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 0.89
EASTING: 363829
NORTHING: 6334141
DIP/AZIMUTH: 90°/--

BORE No: 102A
PROJECT No: 39823
DATE: 16 Oct 07
SHEET 1 OF 1





RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL: Generally comprising black clayey sandy silt, with trace rootlets to 0.2m						End cap Stick up ~0.57m From 0.1m to 0.45m, bentonite
	0.4	SILTY SAND: Dark brown silty sand medium grained, damp						
0	0.7 1	SAND: (Very loose) fine to medium grained sand with trace silt, clay and shell, wet					▼	
-1 -2	1.3 2 3	SILTY SAND: (Very loose) grey fine to medium grained silty sand, with trace clay, saturated						From 0.45m to 3.7m, 5mm gravel filter From 0.7m to 3.7m, screen
-3 -4 -5 -6 -7 -8 -9	3.7 4 5 6 7 8 9	Bore discontinued at 3.7m, limit of investigation						

RIG: Truck mounted rig **DRILLER:** Atkins **LOGGED:** Karpiel **CASING:** -

TYPE OF BORING: 150mm hollow flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.83m below ground level during drilling

REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

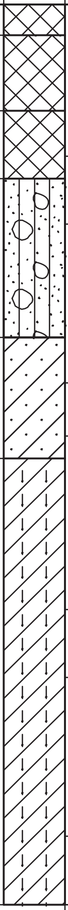
Douglas Partners
Geotechnics · Environment · Groundwater

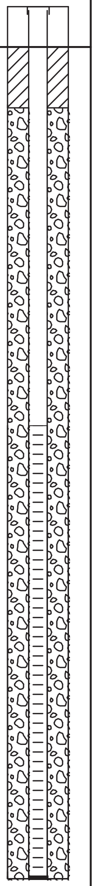
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 2.487
EASTING: 363872
NORTHING: 6334034
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 39823
DATE: 28 Sep 07
SHEET 1 OF 1





RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - Generally comprising dark brown sandy silt with some organics, (bark, wood chips, rootlets), dry to moist						From surface to 0.4m, bentonite plug
	0.2	FILLING - Generally comprising dark brown-black fine to medium grained silty sand with trace sand, damp	A	0.5				
	0.7	FILLING - Generally comprising light brown and dark brown gravelly sandy clay with some silt, M>Wp						
	1.15	SILTY GRAVELLY SAND - Medium dense to dense, red and orange-brown silty gravelly sand, M~Wp	pp A,S	1.0 1.2 1.45		150-300 kPa 8,18,13 N = 31		
	2.2	SANDY CLAY - Very stiff, light grey-brown sandy clay, M~Wp	U_{50} pp	2.5 2.85		350-390 kPa		
	3.0	SILTY CLAY - Very stiff, light grey-brown and red-brown silty clay with some gravel, M>Wp						From 0.4m to 5.5m, 5mm gravel filter
			S,pp	4.0 4.45		4,7,12 N = 19 300 kPa	▼	From 2.5m to 5.5m, 50mm diameter Class 18 PVC screen
			S	5.5 5.95		7,13,16 N = 29		
	5.95	Bore discontinued at 5.95m, limit of investigation						

RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:**
TYPE OF BORING: 100mm diameter solid flight auger (tc-bit)
WATER OBSERVATIONS: Free groundwater observed at 4.0m during drilling
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep
		▼	Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 3.82
EASTING: 363899
NORTHING: 6333964
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 39823
DATE: 28 Sep 07
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	FILLING -						From surface to 0.4m, bentonite plug
0.2	FILLING - Generally comprising brown sandy silt, dry to humid from 0.6m, some gravel	A	0.5				
1.05	SANDY SILTY CLAY - Very stiff, grey-brown, orange and red-brown sandy silty clay, M<Wp	A,S,pp	1.0 1.45		5,8,9 N = 17 400 kPa		
1.8	SILTY CLAY - Very stiff, light grey-brown silty clay with some gravel, M<Wp	S,pp	2.5 2.95		3,8,8 N = 16 320-360 kPa		From 0.4m to 5.0m, 5mm gravel filter
	from 3.6m, (stiff) to very stiff					▼	From 2.0m to 5.0m, 50mm diameter Class 18 PVC screen
4.2	PEBBLY SANDSTONE - Extremely low to very low strength, extremely to highly weathered, orange-brown fine to medium grained pebbly sandstone	S,pp	4.0 4.45		7,13,19 N = 32 150-250 kPa		
5.0	Bore discontinued at 5.0m, limit of investigation						

RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:**

TYPE OF BORING: 100mm diameter solid flight auger (tc-bit)

WATER OBSERVATIONS: Free groundwater observed at 3.6m during drilling

REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

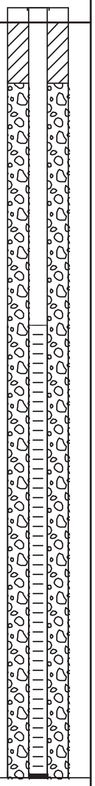
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 6.62
EASTING: 363918
NORTHING: 6333881
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 39823
DATE: 28 Sep 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING -							
	0.2	FILLING - Generally comprising dark brown fine to medium grained silty sand with some fine grained sand, humid		A	0.5				From surface to 0.4m, bentonite plug
	1.05	SILTY SANDY CLAY - Very stiff to hard, orange and red-brown silty sandy clay with some fine grained gravel		A,S,pp pp	1.0 1.4 1.45		4,5,10 N = 15 >450 kPa >450 kPa		
		from 2.1m, slightly gravelly		S,pp	2.5 2.95		6,10,13 N = 23 350->450 kPa		From 0.4m to 5.0m, 5mm gravel filter From 2.0m to 5.0m, 50mm diameter Class 18 PVC screen
		from 4m, hard, grading to extremely low strength conglomerate		S	4.0 4.45		4,14,18 N = 32		
	5.0	Bore discontinued at 5.0m, limit of investigation							



RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:**
TYPE OF BORING: 100mm diameter solid flight auger (tc-bit)
WATER OBSERVATIONS: No free groundwater observed during drilling
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

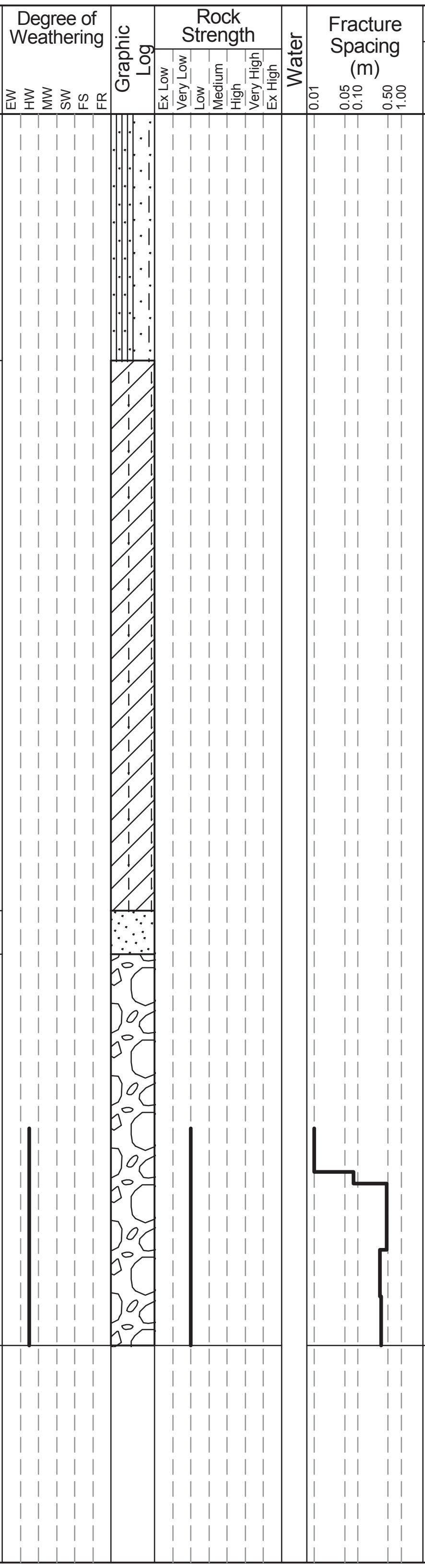
Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.86 AHD
EASTING: 363920.9
NORTHING: 6334291.7
DIP/AZIMUTH: 90°/--

BORE No: 201
PROJECT No: 39823B
DATE: 03 Oct 07
SHEET 1 OF 1



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear D - Drill Break	Type	Core Rec. %	RQD %	Test Results & Comments
-6		SANDY SILT/SILTY SAND: Very loose/very soft grey-brown silty sand/sandy silt, with some shells, M>Wp		S			0,0,0 N = 0 (weight of rods)
-7	1			S			0,0,0 N = 0 (weight of rods)
	1.7	SILTY CLAY: Stiff to very stiff light grey-brown and grey-brown silty clay, M>Wp					
-8	2			pp S			350-390 kPa 3,5,8 N = 13
-9	3						
-10	4	From 4.25m, soft to firm		pp S pp			140-220 kPa 3,5,4 N = 9 20-60 kPa
-11	5	From 5.3m, some sand and coal fragments					
	5.5	SAND: Very loose to loose fine to coarse grained sand, with some silt and coal fragments, saturated		S			1,1,12 N = 13
-12	5.8 6	CONGLOMERATE: Extremely low to very low strength, extremely to highly weathered light grey-brown conglomerate From 6.4m, (very low to low strength) higher resistance to drilling, brown					
-13	7	From 7.45m, very low to low strength	From 7.0m to 7.3m, highly Fr 7.38m: J, 60º, ro, un 7.84m: J, 45º, ro, un 8.16m: J, 10º, ro, pl	C	100	100	PL(A) = 0.06MPa PL(D) = 0.05MPa PL(A) = 0.04MPa PL(D) = 0.04MPa
-14	8 8.5	Bore discontinued at 8.5m, bore abandoned due to strong winds					
-15	9						

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 2.2m

TYPE OF BORING: 100mm diameter rotary wash boring to 7.0m, then NMLC coring to 8.5m

WATER OBSERVATIONS: Depth of water 4.95m at start of bore

REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

Bore 201 – 7.0 m to 8.5 m

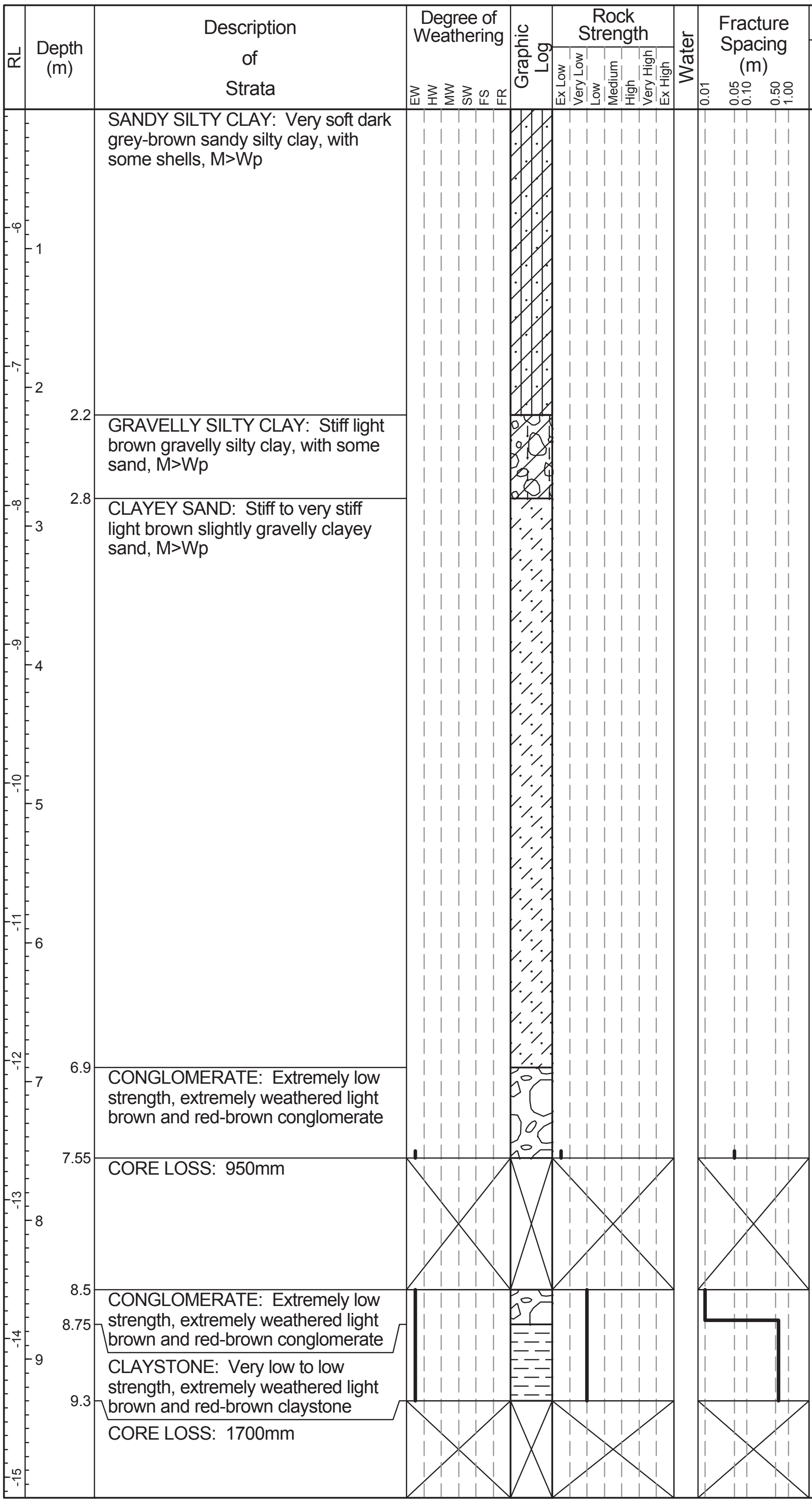
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.15 AHD
EASTING: 363870.5
NORTHING: 6334479.2
DIP/AZIMUTH: 90°/--

BORE No: 202
PROJECT No: 39823B
DATE: 04 Oct 07
SHEET 1 OF 2

Depth (m)	Description of Strata	Discontinuities
0.0	SANDY SILTY CLAY: Very soft dark grey-brown sandy silty clay, with some shells, M>Wp	
2.2	GRAVELLY SILTY CLAY: Stiff light brown gravelly silty clay, with some sand, M>Wp	
2.8	CLAYEY SAND: Stiff to very stiff light brown slightly gravelly clayey sand, M>Wp	
6.9	CONGLOMERATE: Extremely low strength, extremely weathered light brown and red-brown conglomerate	
7.55	CORE LOSS: 950mm	7.55m: CORE LOSS: 950mm
8.5	CONGLOMERATE: Extremely low strength, extremely weathered light brown and red-brown conglomerate	From 8.5m to 8.72m, highly Fr
8.75	CLAYSTONE: Very low to low strength, extremely weathered light brown and red-brown claystone	
9.3	CORE LOSS: 1700mm	9.3m: CORE LOSS: 700mm



Discontinuities: B - Bedding J - Joint S - Shear D - Drill Break

Sampling & In Situ Testing

Type	Core Rec. %	RQD %	Test Results & Comments
S			0,0,0 N = 0 (weight of rods)
S			0,0,0 N = 0 (weight of rods)
pp S pp			160 kPa 3,5,7 N = 12 160 kPa
pp S pp			100-150 kPa 4,8,12 N = 20 >450 kPa
S pp			4,8,12 N = 20 300-360 kPa
S			5,12,18 N = 30
C	46	31	PL(A) = 0.1MPa PL(D) = 0.12MPa
C	33	33	

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 3.0m
TYPE OF BORING: 100mm diameter rotary wash boring to 7.5m, then NMLC coring to 14.55m
WATER OBSERVATIONS: Depth of water 5.25m at start of bore
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▽ Water level

CHECKED
Initials:
Date:

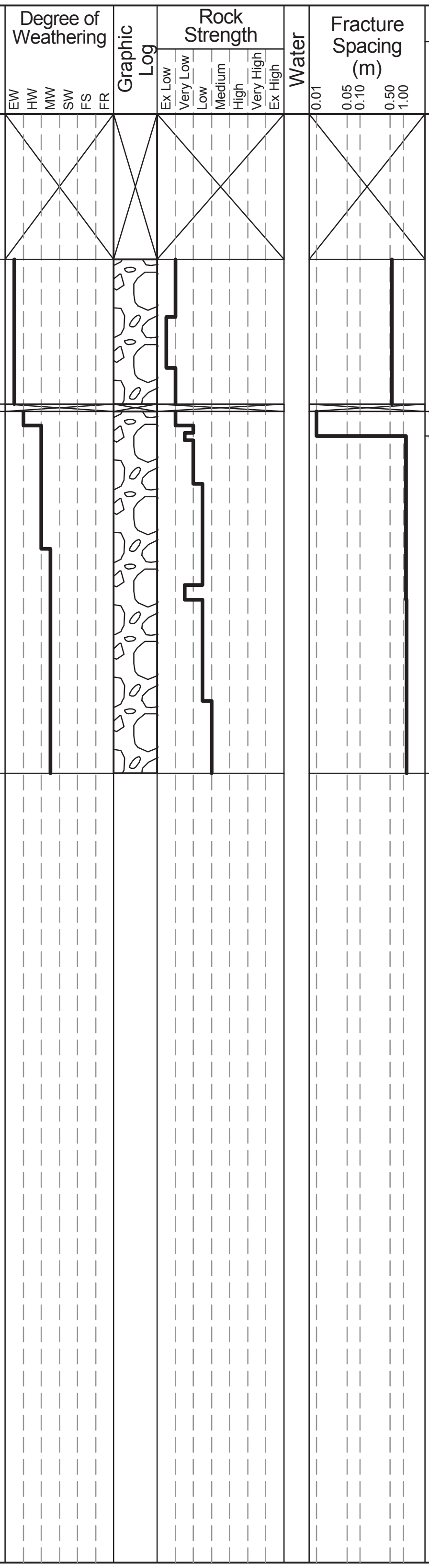
Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.15 AHD
EASTING: 363870.5
NORTHING: 6334479.2
DIP/AZIMUTH: 90°/--

BORE No: 202
PROJECT No: 39823B
DATE: 04 Oct 07
SHEET 2 OF 2



RL	Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Type	Core Rec. %	RQD %	Test Results & Comments
	10.0	CORE LOSS: continued	10m: CORE LOSS: 1000mm				
-16	11 11.0	CONGLOMERATE: Extremely low to very low strength, extremely weathered light orange-brown conglomerate	11.55m: P, sh, ro, un, cy filled (20mm)	C	33	33	PL(A) = 0.03MPa PL(D) = 0.04MPa
-17	12 12.0	CORE LOSS: 50mm	12m: CORE LOSS: 50mm				
	12.05	CONGLOMERATE: Extremely low to very low strength, extremely to highly weathered orange-brown conglomerate From 12.15m, very low to low strength, highly to moderately weathered	From 12.05m to 12.55m, high Fr 12.22m: P, sh, ro, un, cy filled (15mm)	C	95	78	PL(A) = 0.04MPa PL(D) = 0.02MPa
-18	13	From 13.0m, moderately weathered light brown	13.35m: P, sh, ro, un	C	100	100	
-19	14	From 14.05m, low to medium strength					PL(A) = 0.11MPa PL(D) = 0.06MPa
	14.55	Bore discontinued at 14.55m, limit of investigation					
-20	15						
-21	16						
-22	17						
-23	18						
-24	19						
-25							

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 3.0m

TYPE OF BORING: 100mm diameter rotary wash boring to 7.5m, then NMLC coring to 14.55m

WATER OBSERVATIONS: Depth of water 5.25m at start of bore

REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

Bore 202 – 7.5 m to 14.55 m

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.35 AHD
EASTING: 364077.3
NORTHING: 633437.6
DIP/AZIMUTH: 90°/--

BORE No: 203
PROJECT No: 39823B
DATE: 05 Oct 07
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering EW HW MW SW FS FR	Graphic Log	Rock Strength Ex Low Very Low Low Medium High Very High Ex High	Water	Fracture Spacing (m) 0.01 0.05 0.10 0.50 1.00	Discontinuities B - Bedding J - Joint S - Shear D - Drill Break	Type	Core Rec. %	RQD %	Test Results & Comments
		SANDY SILTY CLAY: Very soft dark grey-brown sandy silty clay, with some shell fragments, M>>Wp							S			0,0,0 N = 0 (weight of rods)
-6												
	1								S			0,0,0 N = 0 (weight of rods)
-7												
	2											
-8									S			0,0,0 N = 0 (weight of rods)
	3 3.0	CLAY: Stiff light brown and brown clay, with some sand, and silt, M>Wp										
-9												
	4								pp S pp			180 kPa 2,4,7 N = 11 190-200 kPa
-10												
	5								pp S pp			140 kPa 3,5,7 N = 12 160-180 kPa
-11												
	6											
	6.5	GRAVELLY CLAY: Very stiff light brown gravelly clay, with some sandy gravelly clay bands, M>Wp							pp S pp			200-220 kPa 7,9,11 N = 20 300-400 kPa
-12												
	7											
-13												
	7.9	CONGLOMERATE: Extremely low strength, extremely weathered light brown and red-brown conglomerate, with soil like properties										
	8								S			5,8,10 N = 18
-14												
	9											
-15		From 9.5m, extremely low to very low strength, extremely to highly weathered							S			13,27,25/90mm

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 4.0m
TYPE OF BORING: 100mm diameter rotary wash boring to 11.0m, then NMLC coring to 13.45m
WATER OBSERVATIONS: Depth of water 5.5m at start of bore
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.35 AHD
EASTING: 364077.3
NORTHING: 633437.6
DIP/AZIMUTH: 90°/--

BORE No: 203
PROJECT No: 39823B
DATE: 05 Oct 07
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01 0.05 0.10 0.50 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Type	Core Rec. %	RQD %	Test Results & Comments
	10.0	CONGLOMERATE: continued										
	11	From 11.0m, extremely low to very low strength, highly weathered red-brown and orange-brown						11.91m: J, 30º, sm, un 12.36m: P, 10º, sm, pl 12.53m: J, 15º, ro, pl 12.76m: J, 15º, sm ,un 12.93m: J, 15º, sm, un 13.24m: J, 10º, sm, pl	C	100	100	PL(A) = 0.03MPa PL(D) = 0.03MPa PL(A) = 0.01MPa PL(D) = 0.02MPa
	13.45	Bore discontinued at 13.45m, limit of investigation										

RL scale: -16, -17, -18, -19, -20, -21, -22, -23, -24, -25
Depth scale: 11, 12, 13, 14, 15, 16, 17, 18, 19

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 4.0m
TYPE OF BORING: 100mm diameter rotary wash boring to 11.0m, then NMLC coring to 13.45m
WATER OBSERVATIONS: Depth of water 5.5m at start of bore
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

Bore 203 – 11.0 m to 13.45 m

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 0.96 m AHD
EASTING: 363790.057
NORTHING: 6334179.819
DIP/AZIMUTH: 90°/--

PIT No: 301
PROJECT No: 39823A
DATE: 03 Oct 07
SHEET 1 OF 1

Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
	SILTY SAND: Brown fine to medium grained silty sand with rootlets and gravels, humid	D	0.1			
0.3	SAND: Light brown medium grained sand, moist - wet below 0.6m - layer of shells at 0.85m	D	0.5			
0.9	CLAYEY SAND: Yellow brown and grey medium to coarse grained clayey sand with trace shells, wet	D D D	1.0 1.5 2.0			
2.1	GRAVELLY SAND: Light grey medium to coarse grained gravelly sand with trace silt, wet	D	2.5			
2.6	Pit discontinued at 2.6m. Pit collapse					

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

RL: 0 -1 -2 -3

RIG: 4 tonne Excavator with 450mm bucket

LOGGED: Kerry

WATER OBSERVATIONS: Groundwater Seepage at ~1.5m

REMARKS: Coordinates are MGA

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 0.965 m AHD
EASTING: 363815.964
NORTHING: 6334153.651
DIP/AZIMUTH: 90°/--

PIT No: 302
PROJECT No: 39823A
DATE: 03 Oct 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Sampling & In Situ Testing: Depth	Sampling & In Situ Testing: Sample	Sampling & In Situ Testing: Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		SILTY SAND: Brown fine to medium grained silty sand with rootlets and gravels, humid		D	0.1				
	0.3	SAND: Light brown to dark brown medium grained sand with some gravel, moist		D	0.5				
		- layer of shells at 0.75m							
	0.8	CLAYEY SAND: Yellow brown and grey medium to coarse grained clayey sand with trace shells, wet							
0	1			D	1.0				1
				D	1.5				
-1	2			D	2.0				2
		- trace of gravel from 2.1m							
	2.5	Pit discontinued at 2.5m. Pit collapse		D	2.5				
-2	3								3
-3									

RIG: 4 tonne Excavator with 450mm bucket

LOGGED: Kerry

WATER OBSERVATIONS: Groundwater Seepage at ~1.3m

REMARKS: Coordinates are MGA

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 1.205 m AHD
EASTING: 363841.3
NORTHING: 6334166.143
DIP/AZIMUTH: 90°/--

PIT No: 303
PROJECT No: 39823A
DATE: 03 Oct 07
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
1		SILTY SAND: Brown fine to medium grained silty sand with rootlets and gravels, humid		D	0.1				
	0.35	SAND: Light brown medium grained sand, moist		D	0.5				
	0.85	CLAYEY SAND: Yellow brown and grey medium to coarse grained clayey sand with trace shells, wet - layer of shells at 1.15m		D	1.0				
0	1.2	SANDY GRAVEL: Light brown grey medium sandy gravel, wet							
	1.35	CLAYEY SAND: Grey medium grained clayey sand, wet		D	1.5				
-1	1.7	GRAVELLY SAND: Light grey medium to coarse grained gravelly sand with trace silt, wet		D D	2.0 2.5				
-2	2.8	Pit discontinued at 2.8m. Pit collapse							

RIG: 4 tonne Excavator with 450mm bucket

LOGGED: Kerry

WATER OBSERVATIONS: Groundwater Seepage at ~1.4m

REMARKS: Coordinates are MGA

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

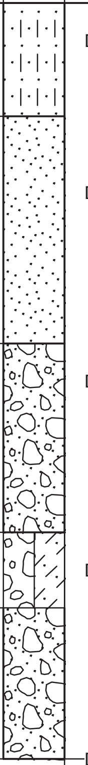
Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 1.16 m AHD
EASTING: 363872.673
NORTHING: 6334140.639
DIP/AZIMUTH: 90°/--

PIT No: 304
PROJECT No: 39823A
DATE: 03 Oct 07
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
		SILTY SAND: Brown fine to medium grained silty sand with rootlets and gravels, humid		D	0.1				
	0.3	SAND: Brown and grey medium grained sand, moist		D	0.5				
	0.9	SANDY GRAVEL: Light orange brwon grey medium grained sandy gravel with trace silt, wet		D	1.0				
	1.4	GRAVELLY CLAYEY SAND: Grey medium grained gravelly clayey sand, wet		D	1.5				
	1.6	SANDY GRAVEL: Light grey medium grained sandy gravel, wet		D	2.0				
	2.0	Pit discontinued at 2.0m. Pit collapse							

RIG: 4 tonne Excavator with 450mm bucket

LOGGED: Kerry

WATER OBSERVATIONS: Groundwater Seepage at ~1.0m

REMARKS: Coordinates are MGA

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 1.145 m AHD
EASTING: 363892.75
NORTHING: 6334115.794
DIP/AZIMUTH: 90°/--

PIT No: 305
PROJECT No: 39823A
DATE: 03 Oct 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
1		SILTY SAND: Brown fine to medium grained silty sand with rootlets and gravels, humid		D	0.1				
	0.2	GRAVELLY SAND: Brown fine to medium grained gravelly sand, moist		D	0.5				
	1			D	1.0				1
0				D	1.5				
	1.6	SAND: Grey medium grained sand with some clay and gravel, wet							
	2 2.0	Pit discontinued at 2.0m. Pit collapse		D	2.0				2
-1									
	3								3
-2									

RIG: 4 tonne Excavator with 450mm bucket

LOGGED: Kerry

WATER OBSERVATIONS: Groundwater Seepage at ~1.0m

REMARKS: Coordinates are MGA. Some H_2S "Egg gas" odours

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 1.115 m AHD
EASTING: 363905.646
NORTHING: 6334088.408
DIP/AZIMUTH: 90°/--

PIT No: 306
PROJECT No: 39823A
DATE: 03 Oct 07
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
		SILTY SAND: Brown fine to medium grained silty sand with rootlets and gravels, humid		D	0.1				
	0.3	GRAVELLY SAND: Light brown grey medium grained gravelly sand, moist		D	0.5				
	0.9	GRAVELLY SAND: Orange grey medium grained gravelly sand with some clay, moist to wet		D	1.0				
		- grey at 1.5m		D	1.5				
	2.0	Pit discontinued at 2.0m. Pit collapse		D	2.0				

RIG: 4 tonne Excavator with 450mm bucket

LOGGED: Kerry

WATER OBSERVATIONS: Groundwater Seepage at ~1.1m

REMARKS: Coordinates are MGA. Some H_2S "Egg gas" odours

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 1.775 m AHD
EASTING: 363911.911
NORTHING: 4334061.065
DIP/AZIMUTH: 90°/--

PIT No: 307
PROJECT No: 39823A
DATE: 03 Oct 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
		FILLING: Brown sandy silt with rootlets mixed red brown grey silty clay, M<Wp with gravels and inclusions of bricks coal chitter and clay pipe , M<Wp		D	0.1				
				D	0.5				
	0.7	CLAYEY GRAVELLY SAND: Light grey and brown medium to coarse grained sand, wet							
1									
	1			D	1.0				1
		- grading to light grey mottled orange brown sandy gravelly clay, M<Wp		D	1.5				
	1.7	CLAYEY SAND: Grey mottled red brown medium grained clayey sand with trace of small gravel, moist							
0									
	2			D	2.0				2
	2.2	SILTY CLAY: Very stiff light grey medium plasticity silty clay, M>Wp							
				D, pp	2.5		350-400kPa		
-1									
		- some sand at 3.0m							
	3 3.0	Pit discontinued at 3.0m. Limit of investigation		D	3.0				3
-2									

RIG: 4 tonne Excavator with 450mm bucket

LOGGED: Kerry

WATER OBSERVATIONS: Minor seepage at 1.5m

REMARKS: Coordinates are MGA

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 2.60 m AHD
EASTING: 363917.353
NORTHING: 6334032.813
DIP/AZIMUTH: 90°/--

PIT No: 308
PROJECT No: 39823A
DATE: 03 Oct 07
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
		FILLING: Brown fine grained silty clayey sand with some gravels and trace of roots		D	0.1				
2	0.4	SILTY SAND: Dark brown fine to medium grained silty sand with trace of rootlets, moist		D	0.5				
	0.95	SAND: Light grey medium grained sand with trace of silt and clay, moist		D	1.0				
1	1.3	SANDY CLAY: Stiff to very stiff grey mottled orange brown low to medium plasticity sandy clay with some small gravel, M~Wp		D	1.5				
				D	2.0				
0				D, pp	2.5		220-250kPa		
	2.7	SILTY CLAY: Very stiff light grey medium plasticity silty clay, M~Wp							
-1	3.0	Pit discontinued at 3.0m. Limit of investigation		D, pp	3.0		350-380kPa		

RIG: 4 tonne Excavator with 450mm bucket

LOGGED: Kerry

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: Coordinates are MGA

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 3.00 m AHD
EASTING: 363930.136
NORTHING: 6333975.397
DIP/AZIMUTH: 90°/--

PIT No: 309
PROJECT No: 39823A
DATE: 03 Oct 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing Type	Sampling & In Situ Testing Depth	Sampling & In Situ Testing Sample	Sampling & In Situ Testing Results & Comments	Water	Dynamic Penetrometer Test (blows per mm) 5 10 15 20
3		SILTY SAND: Brown medium grained silty sand with rootlets and gravels, humid		D	0.1				
				D	0.5				
	0.65	SILTY SAND CLAY: Grey mottled red brown low to medium plasticity silty sandy clay, M<Wp							
2	1	- grading to clayey sand/extremely weathered sandstone at 1.0m		D	1.0				1
				D	1.5				
	1.8	Pit discontinued at 1.8m. Refusal							
1	2								2
0	3								3

RIG: 4 tonne Excavator with 450mm bucket
LOGGED: Kerry
WATER OBSERVATIONS: No Free Groundwater Observed
REMARKS: Coordinates are MGA

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⊻ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

TEST PIT LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Resort
LOCATION: Morisset Park

SURFACE LEVEL: 4.00 m AHD
EASTING: 363741.902
NORTHING: 6333901.569
DIP/AZIMUTH: 90°/--

PIT No: 310
PROJECT No: 39823A
DATE: 03 Oct 07
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
4		FILLING: Light orange brown sandy clay filling mixed with bricks, tiles and concrete and trace of metal and plastic sheeting, humid		D	0.1				
				D	0.5				
	0.8	SANDY CLAY: Stiff, light grey mottled orange brown medium plasticity sandy clay with trace gravels, M~Wp							
3	1			D	1.0				1
				D, pp	1.5		170-220kPa		
2	2	- grading to clayey sand/sandy clay at 2.0m, moist		D	2.0				2
	2.5	Pit discontinued at 2.5m. Limit of investigation		D	2.5				
1	3								3

RIG: 4 tonne Excavator with 450mm bucket

LOGGED: Kerry

WATER OBSERVATIONS: No Free Groundwater Observed

REMARKS: Coordinates are MGA

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

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⊻ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

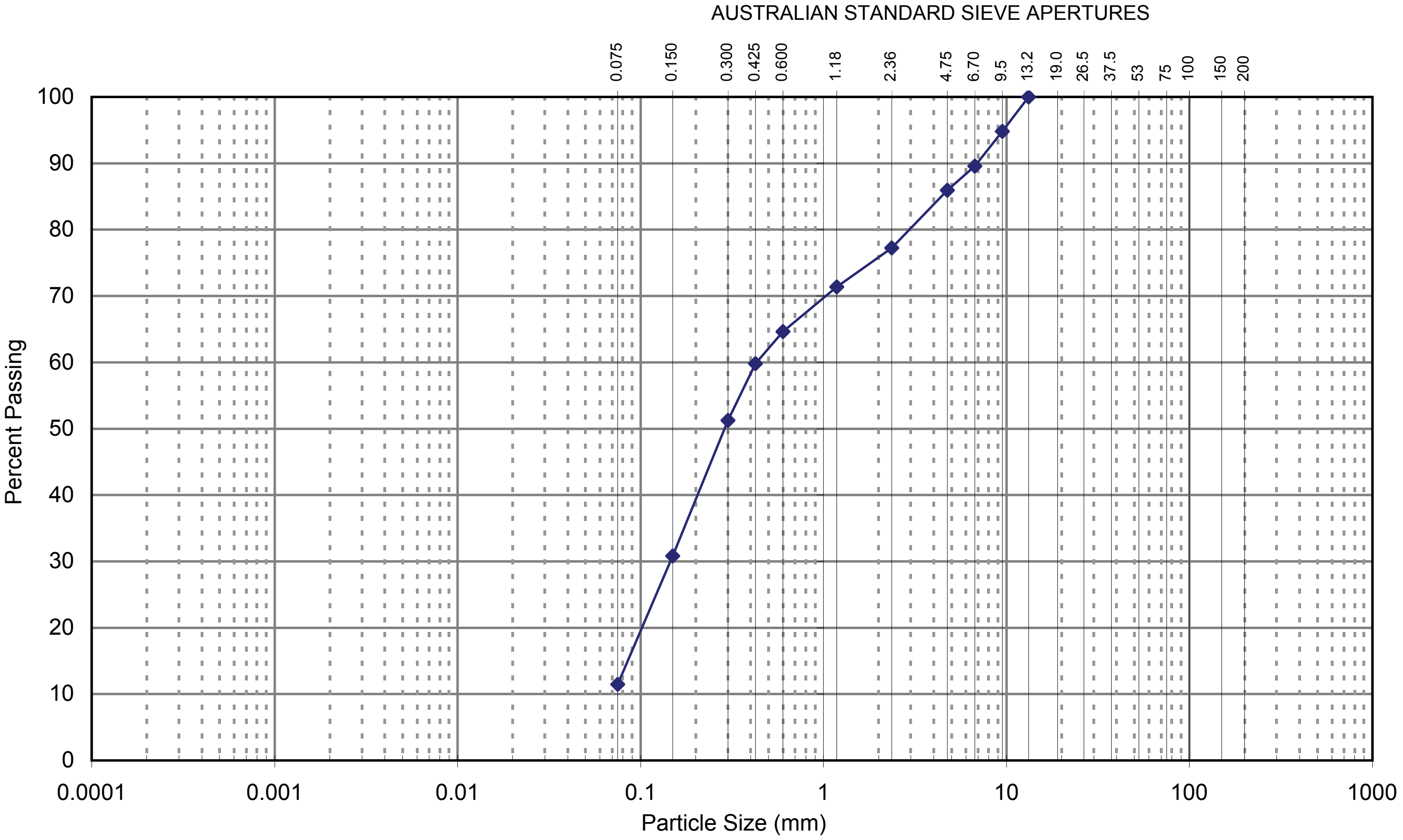
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone (02) 4960 9600
Fax: (02) 4960 9601
newcasstle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	Johnson Property Group Pty Ltd	**Project No. :**	39823
		Report No. :	N07-204
Project :	Trinity Point Marina & Mixed Use Resort	**Report Date :**	29/10/2007
Location :	Morisset	**Date Sampled:**	-
Test Location :	101	**Date of Test:**	19/10/2007
Depth / Layer :	1.00-1.45m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

0.002 0.006 0.02 0.06 0.2 0.6 2.0 6.0 20 60

Description: Gravelly SAND - Grey brown

Test Method(s): AS 1289.3.6.1-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

NATA
ACCREDITED FOR TECHNICAL

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

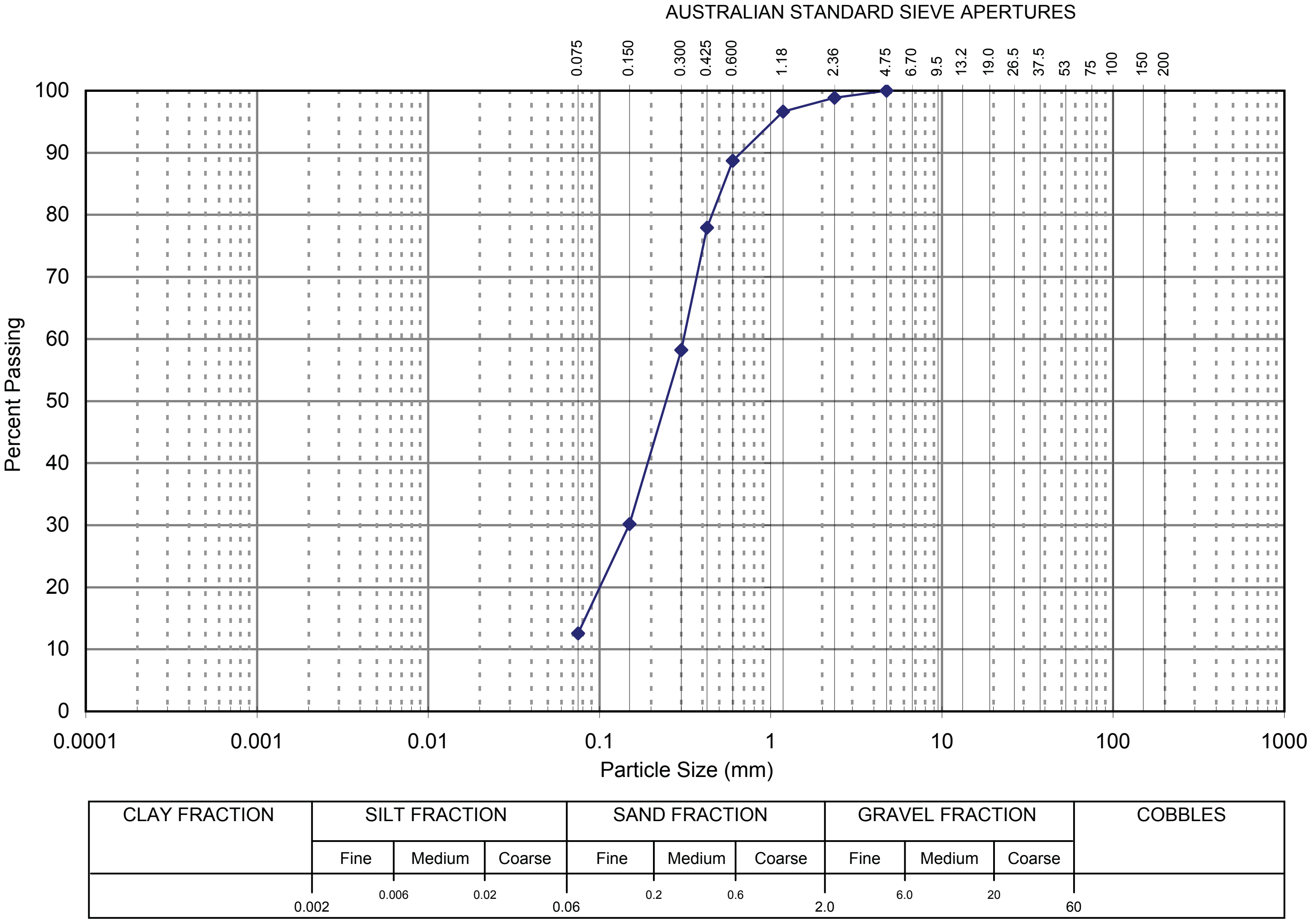
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone (02) 4960 9600
Fax: (02) 4960 9601
newcasstle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	Johnson Property Group Pty Ltd	**Project No. :**	39823
		Report No. :	N07-204a
Project :	Trinity Point Marina & Mixed Use Resort	**Report Date :**	29/10/2007
Location :	Morisset	**Date Sampled:**	-
Test Location :	102	**Date of Test:**	19/10/2007
Depth / Layer :	1.00-1.45m	**Page:**	1 of 1



Description: SAND - Dark grey/brown

Test Method(s): AS 1289.3.6.1-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

NATA
ACCREDITED FOR TECHNICAL

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

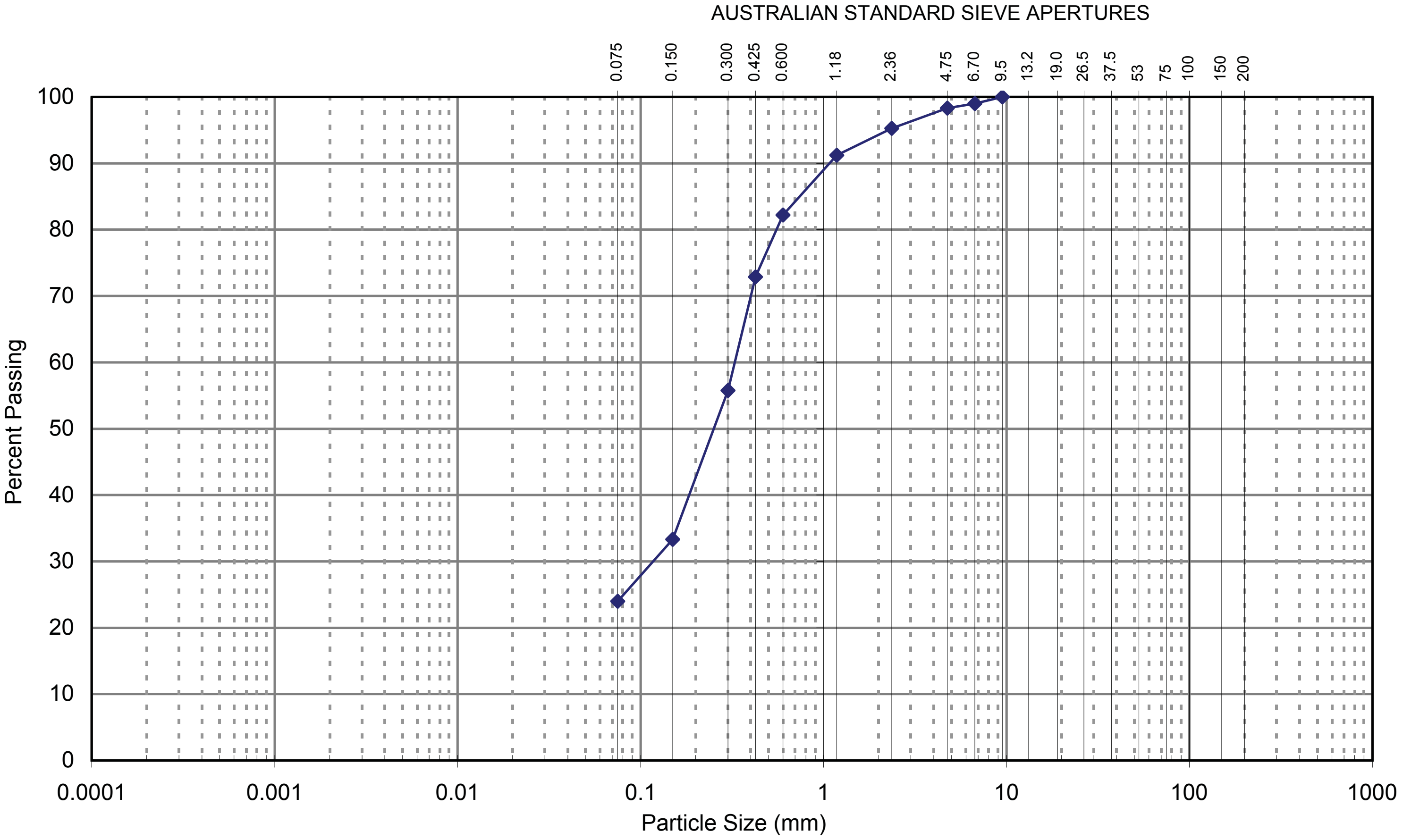
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone (02) 4960 9600
Fax: (02) 4960 9601
newcasstle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	Johnson Property Group Pty Ltd	**Project No. :**	39823
		Report No. :	N07-204b
Project :	Trinity Point Marina & Mixed Use Resort	**Report Date :**	29/10/2007
Location :	Morisset	**Date Sampled:**	-
Test Location :	102	**Date of Test:**	19/10/2007
Depth / Layer :	4.00-4.45m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description: Silty SAND - Grey/brown

Test Method(s): AS 1289.3.6.1-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

Box 324
Hunter Region Mail Centre NSW 2310
Australia

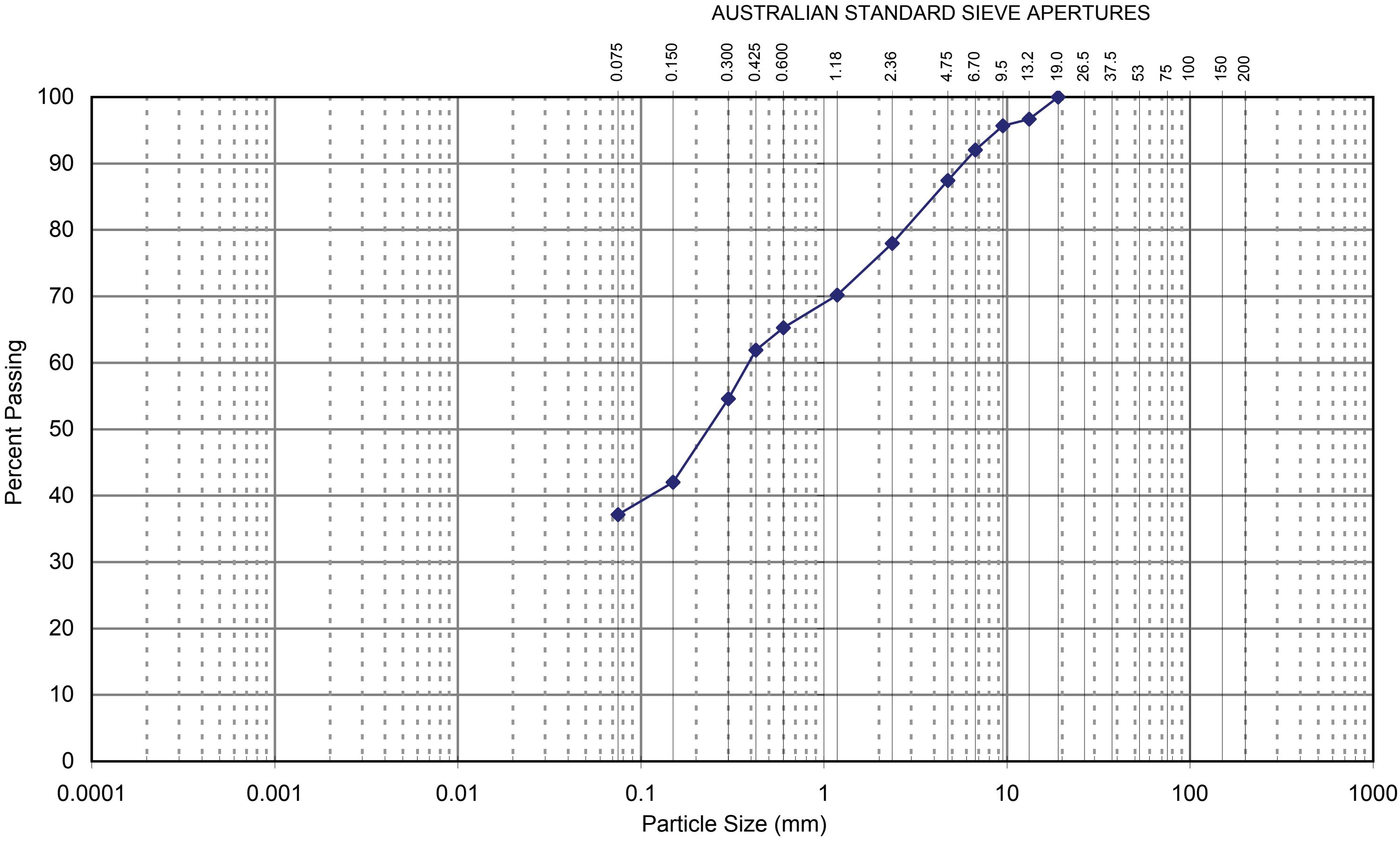
15 Callistemon Close
Warabrook NSW 2304

Phone** **(02) 4960 9600
Fax: (02) 4960 9601
newcasstle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client : Johnson Property Group Pty Ltd
Project No. : 39823
Report No. : N07-204c
Project : Trinity Point Marina & Mixed Use Resort
Report Date : 29/10/2007

Location : Morisset
Date Sampled: -
Test Location : 103
Date of Test: 19/10/2007
Depth / Layer : 1.00-1.45m
Page: 1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description: Silty Gravelly SAND

Test Method(s): AS 1289.3.6.1-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

Form R004 Rev5 July 2006

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone (02) 4960 9600
Fax: (02) 4960 9601
newcastle@douglaspartners.com.au

RESULTS OF MOISTURE CONTENT, PLASTICITY AND LINEAR SHRINKAGE TESTS

Client: **Johnson Property Group Pty Ltd**

Project: Trinity Point Marina & Mixed Use Resort

Location: Morisset

Project No: 39823
Report No: N07-204d
Report Date: 29/10/2007

Date Sampled: -
Date of Test: 25/10/2007
Page: 1 of 1

TEST LOCATION	DEPTH (m)	DESCRIPTION	CODE	W_F %	W_L %	W_P %	PI %	*LS %
102	1.00-1.45	SAND - Dark grey/brown	2,5	34.5	-	-	N/P	-
102	4.00-4.45	Silty SAND - Grey/brown	2,5	19.4	-	-	N/P	-
103	1.00-1.45	Silty Gravelly SAND	2,5	11.8	17	15	2	-
104	2.50-2.95	Silty CLAY	2,5	18.3	46	25	21	11.0
105	1.00-1.45	Silty Sandy CLAY	2,5	15.7	35	18	17	10.5

Legend:

W_F	Field Moisture Content
W_L	Liquid limit
W_P	Plastic limit
PI	Plasticity index
LS	Linear shrinkage from liquid limit condition (Mould length 250mm)

Test Methods:

Moisture Content:	AS 1289 2.1.1 - 2005
Liquid Limit:	AS 1289 3.1.2 - 1995
Plastic Limit:	AS 1289 3.2.1 - 1995
Plasticity Index:	AS 1289 3.3.1 – 1995
Linear Shrinkage	AS 1289.3.4.1 - 1995

Code
Sample history for plasticity tests
1. Air dried
2. Low temperature (<50ºC) oven dried
3. Oven (105ºC) dried
4. Unknown

Method of preparation for plasticity tests
5. Dry sieved
6. Wet sieved
7. Natural

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Remarks:

Approved Signatory:

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

NATA Accredited Laboratory Number: 828

This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Tested: LB/DR
Checked: DM

D Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

Box 324
Hunter Region Mail Centre NSW 2310
Australia

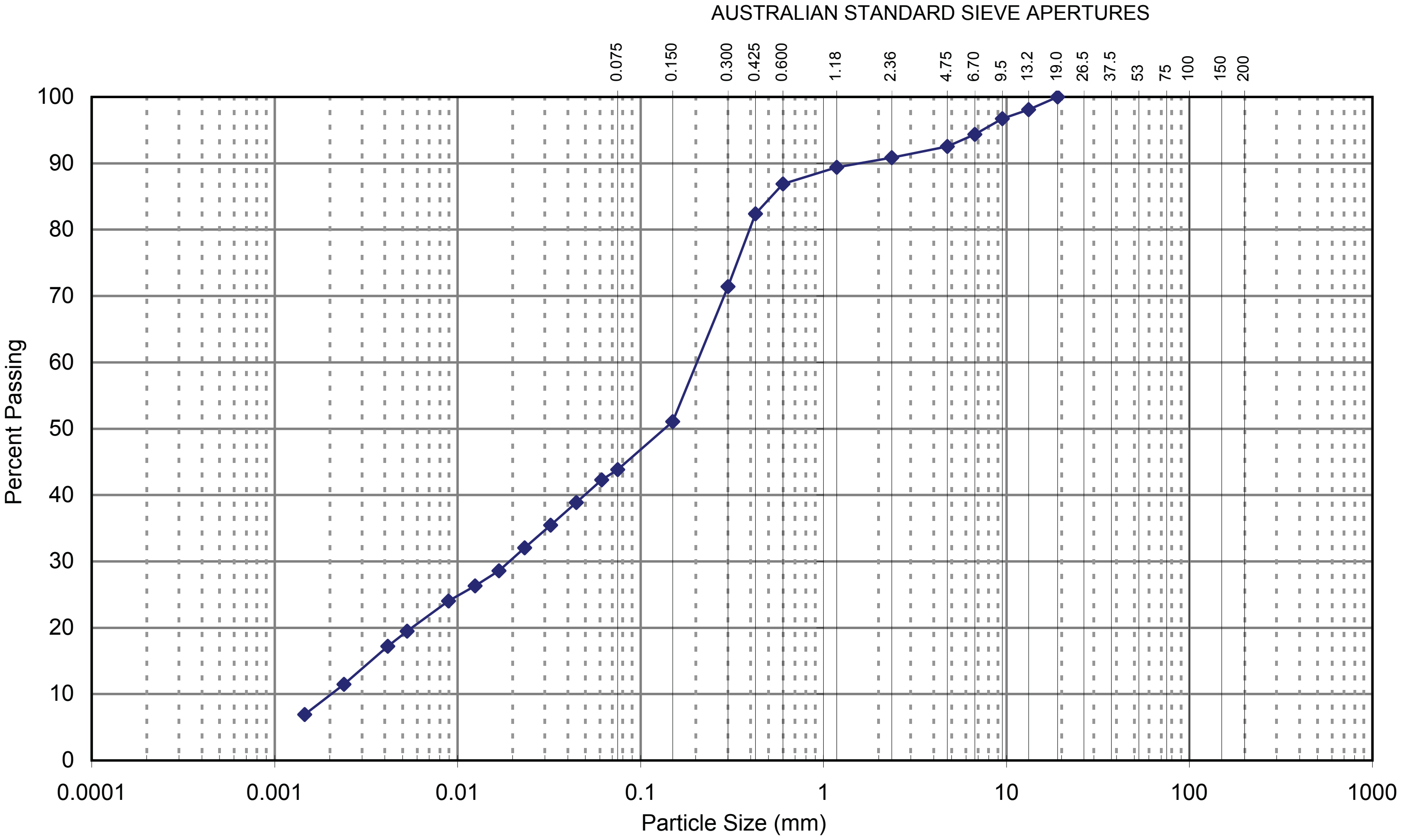
15 Callistemon Close
Warabrook NSW 2304

Phone (02) 4960 9600
Fax: (02) 4960 9601
newcastle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client : Johnson Property Group Pty Ltd
Project No. : 39823B
Report No. : N07-207
Project : Trinity Point Marina & Mixed Use Resort
Report Date : 1/11/2007

Location : off Henry Street, Morisset
Test Location : 201
Depth / Layer : 0.0-0.45m
Date Sampled: -
Date of Test: 26/10/2007
Page: 1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description: Silty SAND/Sandy SILT

Test Method(s): AS 1289.3.6.3-1995
Loss in pretreatment: N/A

Sampling Method(s): AS 1289.1.2.1 (6.2) - 1998, AS 1289.1.1 - 2002
Type of Hydrometer: g/l

Method of Dispersion: Sodium Hexametaphosphate

Remarks:

NATA
ACCREDITED FOR
TECHNICAL

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

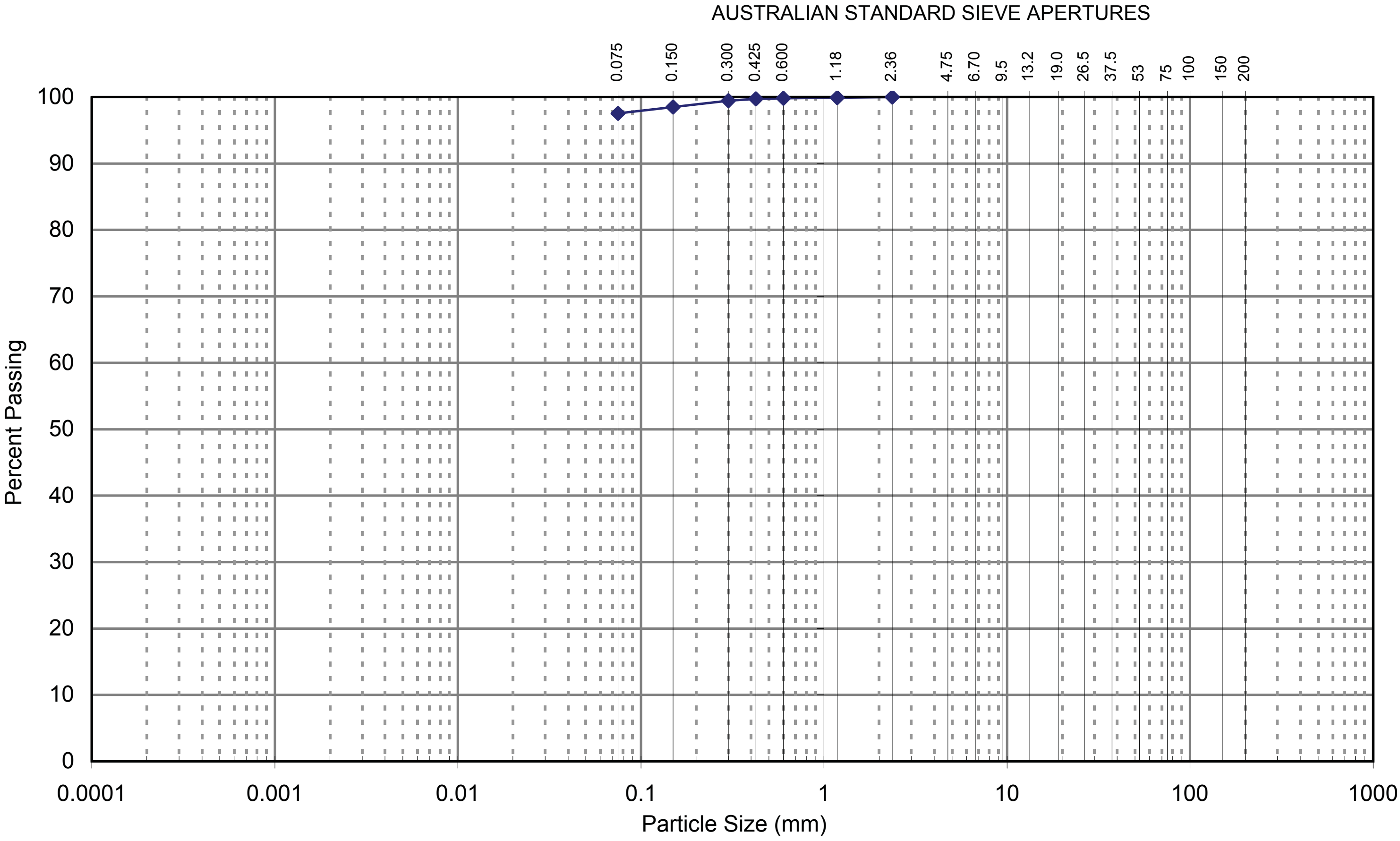
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone** **(02) 4960 9600
Fax: (02) 4960 9601
newcastle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	Johnson Property Group Pty Ltd	**Project No. :**	39823B
		Report No. :	N07-207a
Project :	Trinity Point Marina & Mixed Use Resort	**Report Date :**	1/11/2007
Location :	off Henry Street, Morisset	**Date Sampled:**	-
Test Location :	201	**Date of Test:**	25/10/2007
Depth / Layer :	2.4-2.75m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description: Silty CLAY

Test Method(s): AS 1289.3.6.1-1995

Sampling Method(s): AS 1289.1.2.1 (6.2) - 1998, AS 1289.1.1 - 2002

Method of Dispersion: Sodium Hexametaphosphate

Remarks:

NATA
ACCREDITED FOR TECHNICAL

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

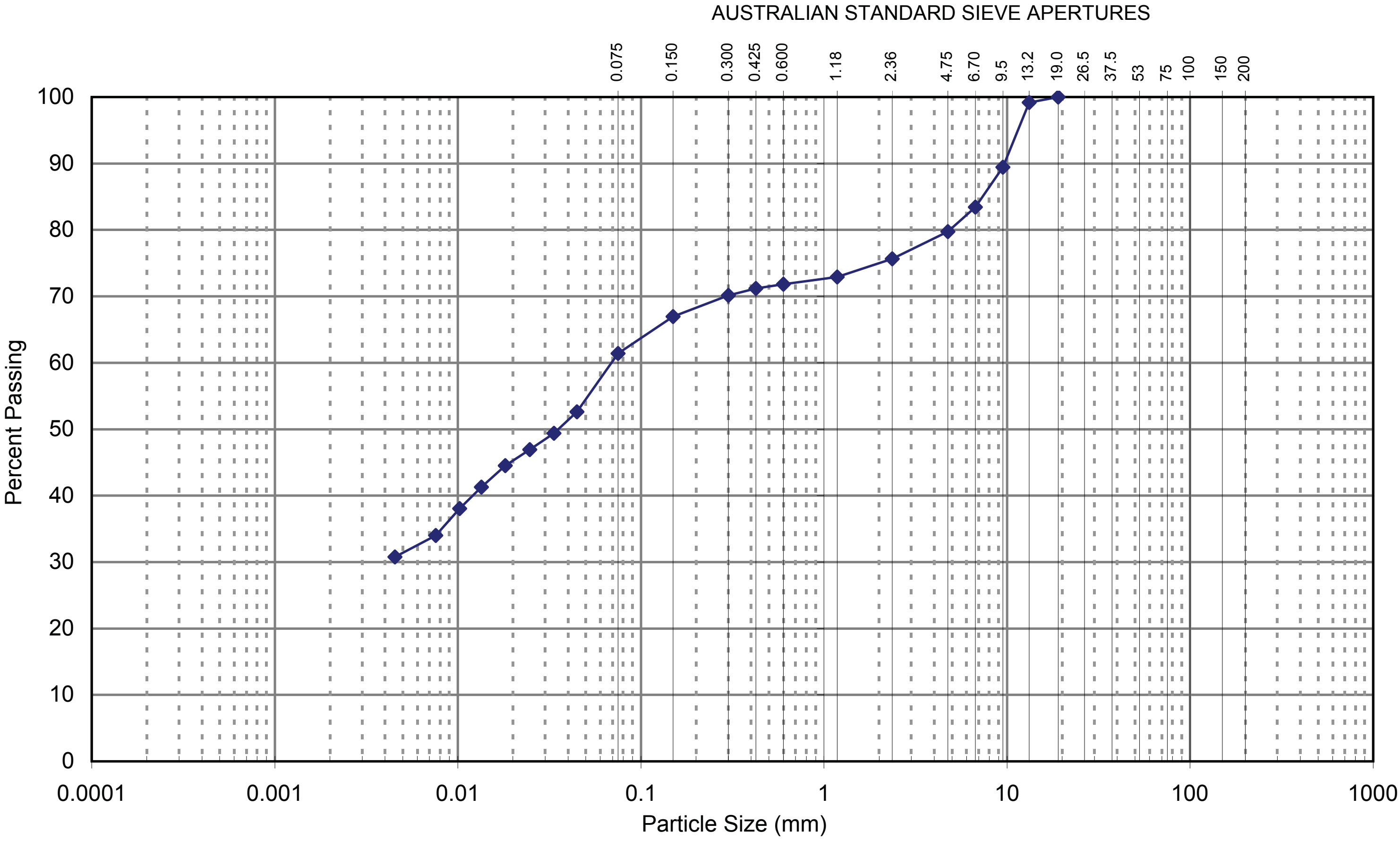
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone (02) 4960 9600
Fax: (02) 4960 9601
newcastle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	Johnson Property Group Pty Ltd	**Project No. :**	39823B
		Report No. :	N07-207b
Project :	Trinity Point Marina & Mixed Use Resort	**Report Date :**	1/11/2007
Location :	off Henry Street, Morisset	**Date Sampled:**	-
Test Location :	202	**Date of Test:**	25/10/2007
Depth / Layer :	0.0-0.45m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description:	Sandy Silty CLAY		
Test Method(s):	AS 1289.3.6.3-1995	**Loss in pretreatment:**	N/A
Sampling Method(s):	AS 1289.1.2.1 (6.2) - 1998, AS 1289.1.1 - 2002	**Type of Hydrometer:**	g/l
Method of Dispersion:	Sodium Hexametaphosphate		
Remarks:			

NATA
ACCREDITED FOR
TECHNICAL

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

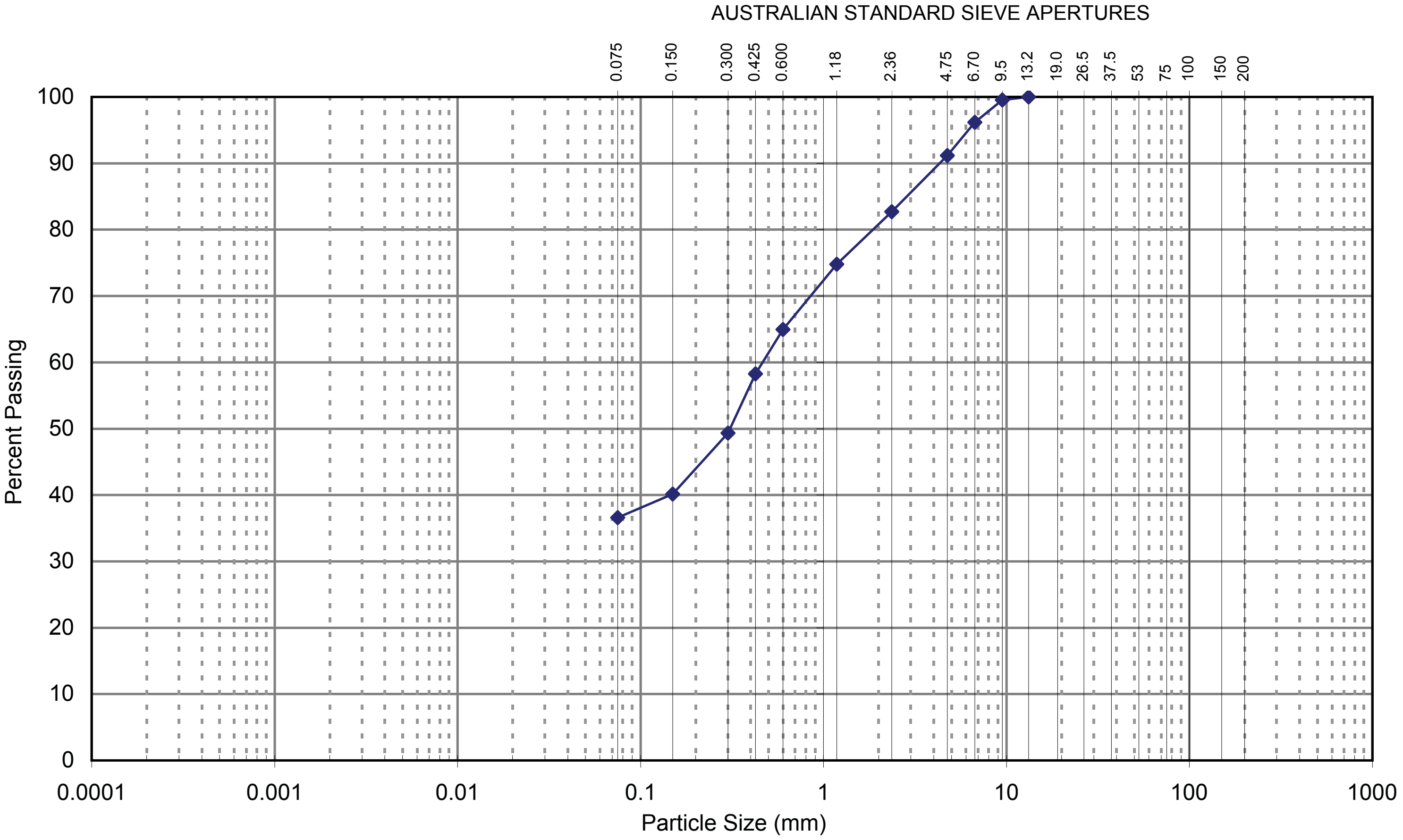
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone (02) 4960 9600
Fax: (02) 4960 9601
newcastle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client : Johnson Property Group Pty Ltd
Project No. : 39823B
Report No. : N07-207c
Project : Trinity Point Marina & Mixed Use Resort
Report Date : 1/11/2007
Location : off Henry Street, Morisset
Date Sampled: -
Test Location : 202
Date of Test: 25/10/2007
Depth / Layer : 4.0-4.45m
Page: 1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description: Clayey SAND

Test Method(s): AS 1289.3.6.1-1995

Sampling Method(s): AS 1289.1.2.1 (6.2) - 1998, AS 1289.1.1 - 2002

Method of Dispersion: Sodium Hexametaphosphate

Remarks:

NATA
ACCREDITED FOR TECHNICAL

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

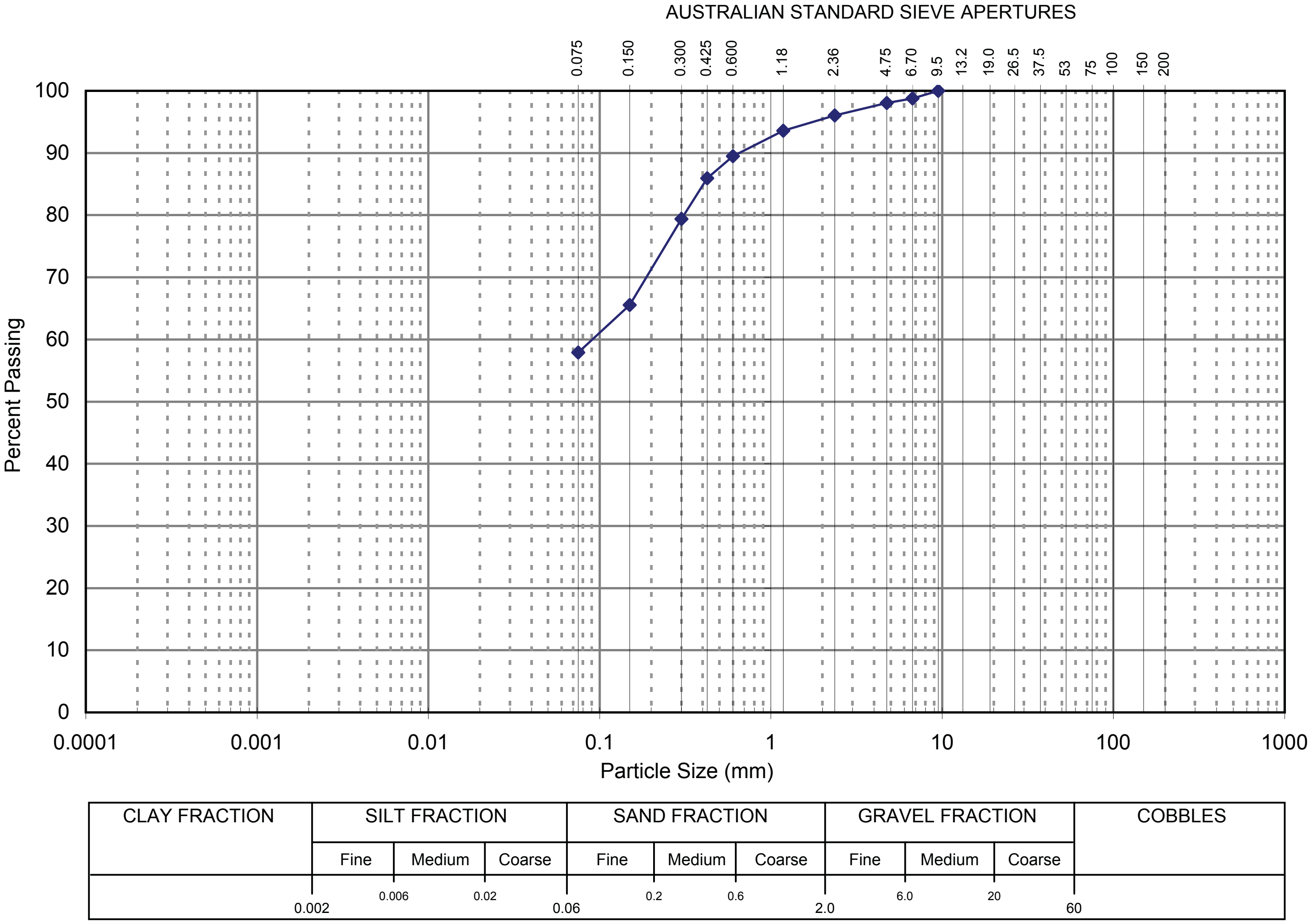
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone (02) 4960 9600
Fax: (02) 4960 9601
newcastle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	Johnson Property Group Pty Ltd	**Project No. :**	39823B
		Report No. :	N07-207d
Project :	Trinity Point Marina & Mixed Use Resort	**Report Date :**	1/11/2007
Location :	off Henry Street, Morisset	**Date Sampled:**	-
Test Location :	203	**Date of Test:**	25/10/2007
Depth / Layer :	2.5-2.95m	**Page:**	1 of 1



Description: Sandy Silty CLAY

Test Method(s): AS 1289.3.6.1-1995

Sampling Method(s): AS 1289.1.2.1 (6.2) - 1998, AS 1289.1.1 - 2002

Method of Dispersion: Sodium Hexametaphosphate

Remarks:

NATA
ACCREDITED FOR
TECHNICAL

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

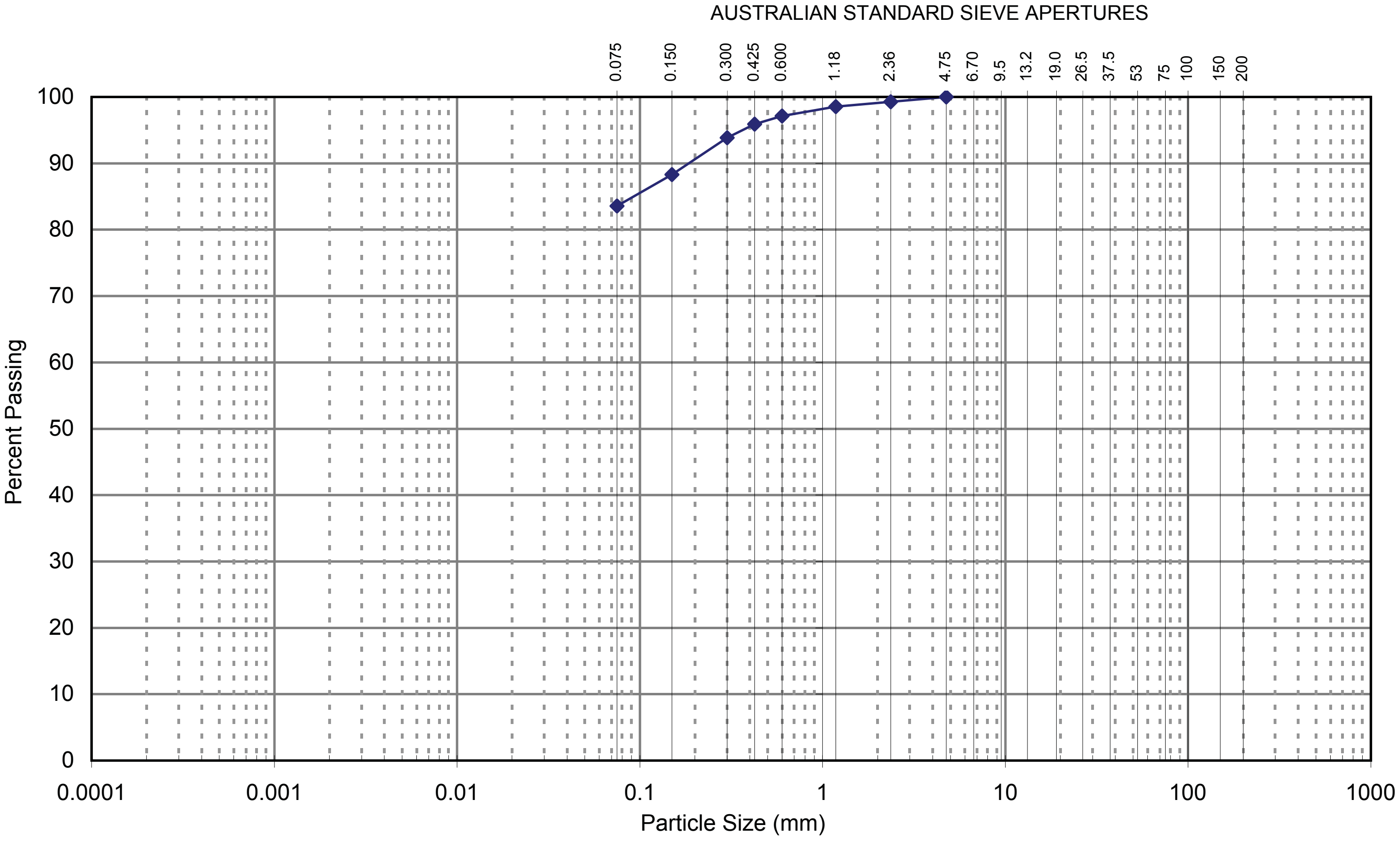
Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone** **(02) 4960 9600
Fax: (02) 4960 9601
newcastle@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	Johnson Property Group Pty Ltd	**Project No. :**	39823B
		Report No. :	N07-207e
Project :	Trinity Point Marina & Mixed Use Resort	**Report Date :**	1/11/2007
Location :	off Henry Street, Morisset	**Date Sampled:**	-
Test Location :	203	**Date of Test:**	25/10/2007
Depth / Layer :	5.0-5.45m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	

Description:	CLAY
Test Method(s):	AS 1289.3.6.1-1995
Sampling Method(s):	AS 1289.1.2.1 (6.2) - 1998, AS 1289.1.1 - 2002
Method of Dispersion:	Sodium Hexametaphosphate
Remarks:	

NATA
ACCREDITED FOR
TECHNICAL

NATA Accredited Laboratory Number: 828
This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

Approved Signatory:

Tested:	DR
Checked:	DM

Dave Millard
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

Box 324
Hunter Region Mail Centre NSW 2310
Australia

15 Callistemon Close
Warabrook NSW 2304

Phone (02) 4960 9600
Fax: (02) 4960 9601
newcastle@douglaspartners.com.au

RESULTS OF MOISTURE CONTENT, PLASTICITY AND LINEAR SHRINKAGE TESTS

Client: **Johnson Property Group Pty Ltd**

Project: Trinity Point Marina & Mixed Use Resort

Location: off Henry Street, Morisset

Project No: 39823B
Report No: N07-207f
Report Date: 5/11/2007

Date Sampled: -
Date of Test: 25/10/2007
Page: 1 of 1

TEST LOCATION	DEPTH (m)	DESCRIPTION	CODE	W_F %	W_L %	W_P %	PI %	*LS %
201	2.4-2.75	Silty CLAY	2,5	25.1	41	15	26	-
202	4.0-4.45	Clayey SAND	2,5	21.7	34	18	16	-
203	2.5-2.95	Sandy Silty CLAY	2,5	52.0	34	15	19	-
203	5.0-5.45	CLAY	2,5	23.8	58	15	43	-

Legend:

W_F	Field Moisture Content
W_L	Liquid limit
W_P	Plastic limit
PI	Plasticity index
LS	Linear shrinkage from liquid limit condition (Mould length 250mm)

Test Methods:

Moisture Content:	AS 1289 2.1.1 - 2005
Liquid Limit:	AS 1289 3.1.2 - 1995
Plastic Limit:	AS 1289 3.2.1 - 1995
Plasticity Index:	AS 1289 3.3.1 - 1995

Code
Sample history for plasticity tests
1. Air dried
2. Low temperature (<50ºC) oven dried
3. Oven (105ºC) dried
4. Unknown

Method of preparation for plasticity tests
5. Dry sieved
6. Wet sieved
7. Natural

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Remarks:

Approved Signatory:

Tested: LB
Checked: DM

D Millard
Laboratory Manager

NATA Accredited Laboratory Number: 828

This Document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

POINT LOAD TEST REPORT

CLIENT : JOHNSON PROPERTY GROUP PTY LTD
PROJECT : PROPOSED TRINITY POINT MARINA AND TOURIST DEVELOPMENT
LOCATION : 49 LAKEVIEW ROAD, MORISSET PARK
TEST METHC AS 4133.4.1

DATE: Oct-07
PROJECT NO : 39823
TESTED BY : CMR
SHEET: 1

BORE	DEPTH (m)	ROCK DESCRIPTION	TEST TYPE Axial (A), Diametral (D)	DIMENSIONS Min. Width (W) (mm)	Depth (D) (mm)	FAILURE READING (KN)	POINT LOAD INDEX Is_{50} Axial (A)	POINT LOAD INDEX Is_{50} Diametral (D)	INTERPRETED ROCK STRENGTH
101	13.95	CONGLOMERATE	D	51	51	0.68	-	0.26	LOW
101	13.95	CONGLOMERATE	A	51	40	1.72	0.67	-	MEDIUM
101	15.95	CONGLOMERATE	D	51	51	0.9	-	0.35	MEDIUM
101	15.95	CONGLOMERATE	A	51	23	1.18	0.70	-	MEDIUM
101	17.5	CLAYSTONE	D	51	51	0.12	-	0.05	V LOW
101	17.5	CLAYSTONE	A	51	25	0.13	0.07	-	V LOW
101	19.6	PEBBLY SANDSTONE	D	51	51	2.73	-	1.06	HIGH
101	19.6	PEBBLY SANDSTONE	A	51	26	2.9	1.57	-	HIGH
102	11.75	PEBBLY SANDSTONE	D	51	51	0.13	-	0.05	V LOW
102	11.75	PEBBLY SANDSTONE	A	51	31	0.09	0.04	-	V LOW
102	13.75	SANDSTONE	D	51	51	0.01	-	0.00	EXT LOW
102	13.75	SANDSTONE	A	51	40	0.03	0.01	-	EXT LOW
102	15.7	CONGLOMERATE	D	51	51	0.56	-	0.22	LOW
102	15.7	CONGLOMERATE	A	51	40	0.8	0.31	-	MEDIUM
102	17	CONGLOMERATE	D	51	51	1.28	-	0.50	MEDIUM
102	17	CONGLOMERATE	A	51	22	0.92	0.57	-	MEDIUM

CHECKED
Initials
Date

Douglas Partners
Geotechnics · Environment · Groundwater

POINT LOAD TEST REPORT

CLIENT : JOHNSON PROPERTY GROUP PTY LTD
PROJECT : TRINITY POINT MARINA AND TOURIST DEVELOPMENT
LOCATION : 49 LAKEVIEW ROAD, MORISSET PARK
TEST METHC AS 4133.4.1

DATE: Oct-07
PROJECT NO : 39823
TESTED BY : CMR
SHEET: 2

BORE	DEPTH (m)	ROCK DESCRIPTION	TEST TYPE Axial (A), Diametral (D)	DIMENSIONS Min. Width (W) (mm)	Depth (D) (mm)	FAILURE READING (KN)	POINT LOAD INDEX Is_{50} Axial (A)	POINT LOAD INDEX Is_{50} Diametral (D)	INTERPRETED ROCK STRENGTH
201	7.65	CONGLOMERATE	D	51	51	0.14	-	0.05	V LOW
201	7.65	CONGLOMERATE	A	51	30	0.13	0.06	-	V LOW
201	8.4	CONGLOMERATE	D	51	51	0.1	-	0.04	V LOW
201	8.4	CONGLOMERATE	A	51	30	0.09	0.04	-	V LOW
202	8.9	CLAYSTONE	D	51	51	0.31	-	0.12	LOW
202	8.9	CLAYSTONE	A	51	37	0.25	0.10	-	LOW
202	11.1	CONGLOMERATE	D	51	51	0.1	-	0.04	V LOW
202	11.1	CONGLOMERATE	A	51	28	0.05	0.03	-	EXT LOW
202	12.85	CONGLOMERATE	D	51	51	0.06	-	0.02	EXT LOW
202	12.85	CONGLOMERATE	A	51	28	0.07	0.04	-	V LOW
202	14.15	CONGLOMERATE	D	51	51	0.15	-	0.06	V LOW
202	14.15	CONGLOMERATE	A	51	30	0.22	0.11	-	LOW
203	11.75	CONGLOMERATE	D	51	51	0.07	-	0.03	EXT LOW
203	11.75	CONGLOMERATE	A	51	35	0.06	0.03	-	EXT LOW
203	13.2	CONGLOMERATE	D	51	51	0.04	-	0.02	EXT LOW
203	13.2	CONGLOMERATE	A	51	34	0.03	0.01	-	EXT LOW

CHECKED
Initials
Date

Douglas Partners
Geotechnics · Environment · Groundwater

18 October 2007

TEST REPORT

Douglas Partners Pty Ltd
Box 324
Hunter Region Mail Centre
NSW 2310

Your Reference: 39823, Trinity Point Marina & Mixed use
Report Number: 55715-R

Attention: Julie Wharton

Dear Julie

The following samples were received from you on the date indicated.

Samples: Qty.	4 Waters
Date of Receipt of Samples:	10/10/07
Date of Receipt of Instructions:	10/10/07
Date Preliminary Report Emailed:	Not Issued

These samples were analysed in accordance with your written instructions.
A copy of the instructions is attached with the analytical report.

The results and associated quality control are contained in the following pages of this report.
Unless otherwise stated, solid samples are expressed on a dry weight basis (moisture has been supplied for your information only), air and liquid samples as received.

Should you have any queries regarding this report please contact the undersigned.

This report cancels and supersedes report No. 55715 issued on 18/10/2007 by SGS Environmental Services due correction in sample ID.

Yours faithfully
SGS ENVIRONMENTAL SERVICES

Ly Kim Ha
Senior Organic Chemist

Edward ibrahim

Edward Ibrahim
Laboratory Services Manager

Inorganics Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55715-R-1 101 Water 09/10/07	55715-R-2 103 Water 09/10/07	55715-R-3 104 Water 09/10/07
Total Phosphorus as P	mg/L	0.40	0.13	<0.10
Total Nitrogen	mg/L	4.6	<1.0	1.0
Total Kjeldahl Nitrogen	mg/L	4.6	0.7	1.0

Anions in water Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55715-R-1 101 Water 09/10/07	55715-R-2 103 Water 09/10/07	55715-R-3 104 Water 09/10/07
Nitrite as N	mg/L	<0.05	<0.05	<0.1
Nitrate as N	mg/L	<0.05	0.06	<0.1
Chloride, Cl	mg/L	850	190	2,600
Sulphate, SO4	mg/L	110	44	180

Trace HM (ICP-MS)-Dissolved Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55715-R-1 101 Water 09/10/07	55715-R-2 103 Water 09/10/07	55715-R-3 104 Water 09/10/07	55715-R-4 D1 Water 09/10/07
Arsenic	µg/L	<1.0	<1.0	<1.0	<1.0
Cadmium	µg/L	<0.10	<0.10	0.64	<0.10
Chromium	µg/L	1.2	<1.0	15	<1.0
Copper	µg/L	<1.0	1.1	3.9	<1.0
Lead	µg/L	<1.0	5.4	40	<1.0
Zinc	µg/L	12	33	110	14
Nickel	µg/L	<1.0	3.4	13	<1.0
Cobalt	µg/L	<1.0	2.1	16	<1.0
Manganese	µg/L	260	77	300	250
Molybdenum	µg/L	2.5	<1.0	<1.0	2.5
Selenium	µg/L	<2.0	<2.0	<2.0	<2.0
Antimony	µg/L	<1.0	<1.0	<1.0	<1.0
Beryllium	µg/L	<1.0	<1.0	3.6	<1.0
Barium	µg/L	33	40	140	34
Boron	µg/L	470	53	120	480

Metals in water by ICP-OES Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55715-R-1 101 Water 09/10/07	55715-R-2 103 Water 09/10/07	55715-R-3 104 Water 09/10/07
Iron (Total)	mg/L	2.4	0.25	15

Metals in water by ICP-OES Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55715-R-1 101 Water 09/10/07	55715-R-2 103 Water 09/10/07	55715-R-3 104 Water 09/10/07	55715-R-4 D1 Water 09/10/07
Tin (Dissolved)	mg/L	<0.03	<0.03	<0.03	<0.03

Mercury Cold Vapor/Hg Analyser Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55715-R-1 101 Water 09/10/07	55715-R-2 103 Water 09/10/07	55715-R-3 104 Water 09/10/07	55715-R-4 D1 Water 09/10/07
Mercury (Dissolved)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005

Method ID	Methodology Summary
SEI-067	Total Phosphorus - Jirka modification, followed by colorimetric determination using an Ascorbic Acid method, in accordance with APHA 20th ED, 4500-P-F. Analysis is carried out by SGS Environmental Services Welshpool.
SEI-033	Total Kjeldahl Nitrogen - determined titrimetrically, in accordance with APHA 20th ED, 4500-Norg B.
SEI-038	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 20th ED, 4110-B.
AN318	Determination of elements at trace levels in waters by ICP-MS. Method based on USEPA 6020A
SEM-010	Metals - Determination of various metals by ICP-AES following aqua regia digest.
SEM-005	Mercury - Determination of Mercury by Cold Vapour Generation Atomic Absorption Spectroscopy.

QUALITY CONTROL Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Total Phosphorus as P	mg/L	0.1	SEI-067	<0.10	55715-1	0.40 || 0.42 || RPD: 5	55715-1	105 || [N/T]
Total Nitrogen	mg/L	1	SEI-033	<1.0	55715-1	4.6 || 4.5 || RPD: 2	[NR]	[NR]
Total Kjeldahl Nitrogen	mg/L	0.2	SEI-033	<0.5	55715-1	4.6 || 4.5 || RPD: 2	55715-1	104 || [N/T]

QUALITY CONTROL Anions in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Nitrite as N	mg/L	0.05	SEI-038	<0.05	[NT]	[NT]	LCS	102 || [N/T]
Nitrate as N	mg/L	0.05	SEI-038	<0.05	[NT]	[NT]	LCS	104 || [N/T]
Chloride, Cl	mg/L	0.1	SEI-038	<0.1	[NT]	[NT]	LCS	101 || [N/T]
Sulphate, SO4	mg/L	0.4	SEI-038	<0.4	[NT]	[NT]	LCS	102 || [N/T]

QUALITY CONTROL Trace HM (ICP-MS)-Dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Arsenic	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	104 || [N/T]
Cadmium	µg/L	0.1	AN318	<0.10	[NT]	[NT]	LCS	103 || [N/T]
Chromium	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	104 || [N/T]
Copper	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	102 || [N/T]
Lead	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	107 || [N/T]
Zinc	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	101 || [N/T]
Nickel	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	98 || [N/T]
Cobalt	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	101 || [N/T]
Manganese	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	107 || [N/T]
Molybdenum	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	101 || [N/T]
Selenium	µg/L	2	AN318	<2.0	[NT]	[NT]	LCS	107 || [N/T]
Antimony	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	114 || [N/T]
Beryllium	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	99 || [N/T]
Barium	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	105 || [N/T]
Boron	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	102 || [N/T]

QUALITY CONTROL **Metals in water by ICP-OES**	**UNITS**	**PQL**	**METHOD**	**Blank**	**Duplicate Sm#**	**Duplicate** **Base + Duplicate + %RPD**	**Spike Sm#**	**Matrix Spike % Recovery** **Duplicate + %RPD**
Iron (Total)	mg/L	0.01	SEM-010	<0.01	[NT]	[NT]	LCS	98 || [N/T]

QUALITY CONTROL Metals in water by ICP-OES	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Tin (Dissolved)	mg/L	0.03	SEM-010	<0.03	[NT]	[NT]	LCS	97 || [N/T]

QUALITY CONTROL Mercury Cold Vapor/Hg Analyser	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Mercury (Dissolved)	mg/L	0.0005	SEM-005	<0.0005	[NT]	[NT]	LCS	97 || [N/T]

QUALITY CONTROL Trace HM (ICP-MS)-Dissolved	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Arsenic	µg/L	55715-1	<1.0 || <1.0
Cadmium	µg/L	55715-1	<0.10 || <0.10
Chromium	µg/L	55715-1	1.2 || 1.1 || RPD: 9
Copper	µg/L	55715-1	<1.0 || <1.0
Lead	µg/L	55715-1	<1.0 || <1.0
Zinc	µg/L	55715-1	12 || 12 || RPD: 0
Nickel	µg/L	55715-1	<1.0 || <1.0
Cobalt	µg/L	55715-1	<1.0 || <1.0
Manganese	µg/L	55715-1	260 || 260 || RPD: 0
Molybdenum	µg/L	55715-1	2.5 || 2.5 || RPD: 0
Selenium	µg/L	55715-1	<2.0 || <2.0
Antimony	µg/L	55715-1	<1.0 || <1.0
Beryllium	µg/L	55715-1	<1.0 || <1.0
Barium	µg/L	55715-1	33 || 34 || RPD: 3
Boron	µg/L	55715-1	470 || 470 || RPD: 0

Result Codes

[INS] : Insufficient Sample for this test
[NR] : Not Requested
[NT] : Not tested
[HBG] : Results not Reported due to High Background Interference
* : Not part of NATA Accreditation
[N/A] : Not Applicable

Result Comments

The LOR for sample number/s _3____ has been raised by a dilution factor of ___2__ respectively due to sample matrix interference.NO2,NO3
Date Organics extraction commenced: N/A
NATA Corporate Accreditation No. 2562, Site No 4354
Note: Test results are not corrected for recovery (excluding Dioxins/Furans* and PAH in XAD and PUF).
This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

Quality Control Protocol

Reagent Blank: Sample free reagents carried through the preparation/extraction/digestion procedure and analysed at the beginning of every sample batch analysis. For larger projects, a reagent blank is prepared and analysed with every 20 samples.
Duplicate: A separate portion of a sample being analysed which is treated the same as the other samples in the batch. A duplicate is prepared at least every 10 samples.
Matrix Spike Duplicates: Sample replicates spiked with identical concentrations of target analyte(s). The spiking occurs during the sample preparation and prior to the extraction/digestion procedure. They are used to document the precision and bias of a method in a given sample matrix. Where there is not enough sample available to prepare a spiked sample, another known soil/sand or water (or Milli-Q water) may be used. A duplicate spiked sample is prepared at least every 20 samples.
Surrogate Spike: Added to all samples requiring analysis for organics (where relevant) prior to extraction. Used to determine the extraction efficiency. They are organic compounds which are similar to the target analyte(s) in chemical composition and behaviour in the analytical process, but which are not normally found in environmental samples.
Internal Standard: Added to all samples requiring analysis for organics (where relevant) after the extraction process; the compounds serve to give a standard of retention time and response, which is invariant from run-to-run with the instruments.
Control Standards: Prepared from a source independent of the calibration standards. At least one control standard is included in each run to confirm calibration validity.
Additional QC Samples: A calibration standard and blank are run after every 20 samples of an instrumental analysis run to assess analytical drift.

SGS

19 October 2007

TEST REPORT

Douglas Partners Pty Ltd
Box 324
Hunter Region Mail Centre
NSW 2310

Your Reference: 39823, Trinity Point Marina & Mixed use
Report Number: 55771

Attention: Julie Wharton

Dear Julie
The following samples were received from you on the date indicated.

Samples: Qty.	1 Water
Date of Receipt of Samples:	12/10/07
Date of Receipt of Instructions:	12/10/07
Date Preliminary Report Emailed:	Not Issued

These samples were analysed in accordance with your written instructions.
A copy of the instructions is attached with the analytical report.

The results and associated quality control are contained in the following pages of this report. Unless otherwise stated, solid samples are expressed on a dry weight basis (moisture has been supplied for your information only), air and liquid samples as received.

Should you have any queries regarding this report please contact the undersigned.

Yours faithfully
SGS ENVIRONMENTAL SERVICES

Ly Kim Ha **Senior Organic Chemist**	**Edward Ibrahim** **Laboratory Services Manager**	**Alexandra Stenta** **Key Account Representative**

Inorganics Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55771-1 102 Water 11/10/07
Total Phosphorus as P	mg/L	<0.5
Total Nitrogen	mg/L	3.3
Total Kjeldahl Nitrogen	mg/L	3.3

Anions in water Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55771-1 102 Water 11/10/07
Nitrite as N	mg/L	<1
Nitrate as N	mg/L	<1
Chloride, Cl	mg/L	8,400
Sulphate, SO4	mg/L	1,300

Trace HM (ICP-MS)-Dissolved Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55771-1 102 Water 11/10/07
Arsenic	µg/L	6.4
Cadmium	µg/L	<0.10
Chromium	µg/L	6.3
Copper	µg/L	1.3
Lead	µg/L	<1.0
Zinc	µg/L	120
Nickel	µg/L	11
Cobalt	µg/L	22
Manganese	µg/L	1,300
Molybdenum	µg/L	2.6
Selenium	µg/L	23
Antimony	µg/L	<1.0
Beryllium	µg/L	<1.0
Barium	µg/L	190
Boron	µg/L	1,500

Metals in water by ICP-OES Our Reference: Your Reference Sample Type Date Sampled	 UNITS ------------- ------------	 55771-1 102 Water 11/10/07
Iron (Total)	mg/L	25

Metals in water by ICP-OES Our Reference: Your Reference Sample Type Date Sampled	UNITS ------------- ------------	55771-1 102 Water 11/10/07
Tin (Dissolved)	mg/L	0.03

Mercury Cold Vapor/Hg Analyser		
Our Reference:	UNITS	55771-1
Your Reference	-------------	102
Sample Type	------------	Water
Date Sampled		11/10/07
Mercury (Dissolved)	mg/L	<0.0005

Method ID	Methodology Summary
SEI-067	Total Phosphorus - Jirka modification, followed by colorimetric determination using an Ascorbic Acid method, in accordance with APHA 20th ED, 4500-P-F. Analysis is carried out by SGS Environmental Services Welshpool.
SEI-033	Total Kjeldahl Nitrogen - determined titrimetrically, in accordance with APHA 20th ED, 4500-Norg B.
SEI-038	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 20th ED, 4110-B.
AN318	Determination of elements at trace levels in waters by ICP-MS. Method based on USEPA 6020A
SEM-010	Metals - Determination of various metals by ICP-AES following aqua regia digest.
SEM-005	Mercury - Determination of Mercury by Cold Vapour Generation Atomic Absorption Spectroscopy.

QUALITY CONTROL Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Total Phosphorus as P	mg/L	0.1	SEI-067	<0.10	55771-1	<0.5 || <0.5	55771-1	93 || [N/T]
Total Nitrogen	mg/L	1	SEI-033	<1.0	55771-1	3.3 || [N/T]	[NR]	[NR]
Total Kjeldahl Nitrogen	mg/L	0.5	SEI-033	<0.5	55771-1	3.3 || [N/T]	55771-1	104 || [N/T]
QUALITY CONTROL Anions in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Nitrite as N	mg/L	0.05	SEI-038	<0.05	[NT]	[NT]	LCS	103 || [N/T]
Nitrate as N	mg/L	0.05	SEI-038	<0.05	[NT]	[NT]	LCS	105 || [N/T]
Chloride, Cl	mg/L	0.1	SEI-038	<0.1	[NT]	[NT]	LCS	102 || [N/T]
Sulphate, SO4	mg/L	0.4	SEI-038	<0.4	[NT]	[NT]	LCS	102 || [N/T]
QUALITY CONTROL Trace HM (ICP-MS)-Dissolved	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Arsenic	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	104 || [N/T]
Cadmium	µg/L	0.1	AN318	<0.10	[NT]	[NT]	LCS	103 || [N/T]
Chromium	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	104 || [N/T]
Copper	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	102 || [N/T]
Lead	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	107 || [N/T]
Zinc	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	101 || [N/T]
Nickel	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	98 || [N/T]
Cobalt	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	101 || [N/T]
Manganese	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	107 || [N/T]
Molybdenum	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	101 || [N/T]
Selenium	µg/L	2	AN318	<2.0	[NT]	[NT]	LCS	107 || [N/T]
Antimony	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	114 || [N/T]
Beryllium	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	99 || [N/T]
Barium	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	105 || [N/T]
Boron	µg/L	1	AN318	<1.0	[NT]	[NT]	LCS	102 || [N/T]

QUALITY CONTROL **Metals in water by ICP-OES**	**UNITS**	**PQL**	**METHOD**	**Blank**	**Duplicate Sm#**	**Duplicate** **Base + Duplicate + %RPD**	**Spike Sm#**	**Matrix Spike % Recovery** **Duplicate + %RPD**
Iron (Total)	mg/L	0.01	SEM-010	<0.01	[NT]	[NT]	LCS	107 || [N/T]
QUALITY CONTROL Metals in water by ICP-OES	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Tin (Dissolved)	mg/L	0.03	SEM-010	<0.03	[NT]	[NT]	LCS	99 || [N/T]
QUALITY CONTROL Mercury Cold Vapor/Hg Analyser	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
Mercury (Dissolved)	mg/L	0.0005	SEM-005	<0.0005	[NT]	[NT]	LCS	90 || [N/T]

Result Codes

[INS]	:	Insufficient Sample for this test	[HBG]	:	Results not Reported due to High Background Interference
[NR]	:	Not Requested	*	:	Not part of NATA Accreditation
[NT]	:	Not tested	[N/A]	:	Not Applicable

Result Comments

Nitrate and Nitrate LOR for sample # 1 has been raised by a dilution factor of 20 due to sample matrix interference.

Total Phosphorus LOR for sample # 1 has been raised by a dilution factor of 5 due to sample matrix interference.

Date Organics extraction commenced: N/A
NATA Corporate Accreditation No. 2562, Site No 4354
Note: Test results are not corrected for recovery (excluding Dioxins/Furans* and PAH in XAD and PUF).

Quality Control Protocol

Reagent Blank: Sample free reagents carried through the preparation/extraction/digestion procedure and analysed at the beginning of every sample batch analysis. For larger projects, a reagent blank is prepared and analysed with every 20 samples.
Duplicate: A separate portion of a sample being analysed which is treated the same as the other samples in the batch. A duplicate is prepared at least every 10 samples.
Matrix Spike Duplicates: Sample replicates spiked with identical concentrations of target analyte(s). The spiking occurs during the sample preparation and prior to the extraction/digestion procedure. They are used to document the precision and bias of a method in a given sample matrix. Where there is not enough sample available to prepare a spiked sample, another known soil/sand or water (or Milli-Q water) may be used. A duplicate spiked sample is prepared at least every 20 samples.
Surrogate Spike: Added to all samples requiring analysis for organics (where relevant) prior to extraction. Used to determine the extraction efficiency. They are organic compounds which are similar to the target analyte(s) in chemical composition and behaviour in the analytical process, but which are not normally found in environmental samples.
Internal Standard: Added to all samples requiring analysis for organics (where relevant) after the extraction process; the compounds serve to give a standard of retention time and response, which is invariant from run-to-run with the instruments.
Control Standards: Prepared from a source independent of the calibration standards. At least one control standard is included in each run to confirm calibration validity.
Additional QC Samples: A calibration standard and blank are run after every 20 samples of an instrumental analysis run to assess analytical drift.

SGS

25 October 2007

TEST REPORT

Douglas Partners Pty Ltd
Box 324
Hunter Region Mail Centre
NSW 2310

Your Reference:	39823, Trinity Point
Report Number:	55935
Attention:	Julie Wharton

Dear Julie

The following samples were received from you on the date indicated.

Samples: Qty.	2 Soils
Date of Receipt of Samples:	18/10/07
Date of Receipt of Instructions:	18/10/07
Date Preliminary Report Emailed:	Not Issued

These samples were analysed in accordance with your written instructions.
A copy of the instructions is attached with the analytical report.

The results and associated quality control are contained in the following pages of this report.
Unless otherwise stated, solid samples are expressed on a dry weight basis (moisture has been supplied for your information only), air and liquid samples as received.

Should you have any queries regarding this report please contact the undersigned.

Yours faithfully
SGS ENVIRONMENTAL SERVICES

Edward Ibrahim

Edward Ibrahim
Lab Manager

Inorganics Our Reference: Your Reference Sample Type	UNITS ------------- ------------	55935-1 B101/2.5-2.95 Soil	55935-2 B102/5.5-5.95 Soil
pH 1:5 soil:water	pH Units	8.0	7.5
Chloride, Cl 1:5 soil:water	mg/kg	14	820
Sulphate, SO4 1:5 soil:water	mg/kg	26	170

Moisture Our Reference: Your Reference Sample Type	UNITS ------------- ------------	55935-1 B101/2.5-2.95 Soil	55935-2 B102/5.5-5.95 Soil
Moisture	%	14	15

Method ID	Methodology Summary
AN101	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
SEI-038	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 20th ED, 4110-B.
AN002	Preparation of soils, sediments and sludges undergo analysis by either air drying, compositing, subsampling and 1:5 soil water extraction where required. Moisture content is determined by drying the sample at 105 ± 5°C.

QUALITY CONTROL Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
pH 1:5 soil:water	pH Units	0	AN101	0.00	[NT]	[NT]	[NR]	[NR]
Chloride, Cl 1:5 soil:water	mg/kg	0.5	SEI-038	<0.5	[NT]	[NT]	LCS	100 || [N/T]
Sulphate, SO4 1:5 soil:water	mg/kg	2	SEI-038	<2	[NT]	[NT]	LCS	102 || [N/T]

QUALITY CONTROL Moisture	UNITS	PQL	METHOD	Blank
Moisture	%	1	AN002	<1

Result Codes

[INS] : Insufficient Sample for this test
[NR] : Not Requested
[NT] : Not tested
[HBG] : Results not Reported due to High Background Interference
* : Not part of NATA Accreditation
[N/A] : Not Applicable

Result Comments

Date Organics extraction commenced: N/A
NATA Corporate Accreditation No. 2562, Site No 4354
Note: Test results are not corrected for recovery (excluding Dioxins/Furans* and PAH in XAD and PUF).
This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

Quality Control Protocol

Reagent Blank: Sample free reagents carried through the preparation/extraction/digestion procedure and analysed at the beginning of every sample batch analysis. For larger projects, a reagent blank is prepared and analysed with every 20 samples.
Duplicate: A separate portion of a sample being analysed which is treated the same as the other samples in the batch. A duplicate is prepared at least every 10 samples.
Matrix Spike Duplicates: Sample replicates spiked with identical concentrations of target analyte(s). The spiking occurs during the sample preparation and prior to the extraction/digestion procedure. They are used to document the precision and bias of a method in a given sample matrix. Where there is not enough sample available to prepare a spiked sample, another known soil/sand or water (or Milli-Q water) may be used. A duplicate spiked sample is prepared at least every 20 samples.
Surrogate Spike: Added to all samples requiring analysis for organics (where relevant) prior to extraction. Used to determine the extraction efficiency. They are organic compounds which are similar to the target analyte(s) in chemical composition and behaviour in the analytical process, but which are not normally found in environmental samples.
Internal Standard: Added to all samples requiring analysis for organics (where relevant) after the extraction process; the compounds serve to give a standard of retention time and response, which is invariant from run-to-run with the instruments.
Control Standards: Prepared from a source independent of the calibration standards. At least one control standard is included in each run to confirm calibration validity.
Additional QC Samples: A calibration standard and blank are run after every 20 samples of an instrumental analysis run to assess analytical drift.

PILE CAPACITY ESTIMATE

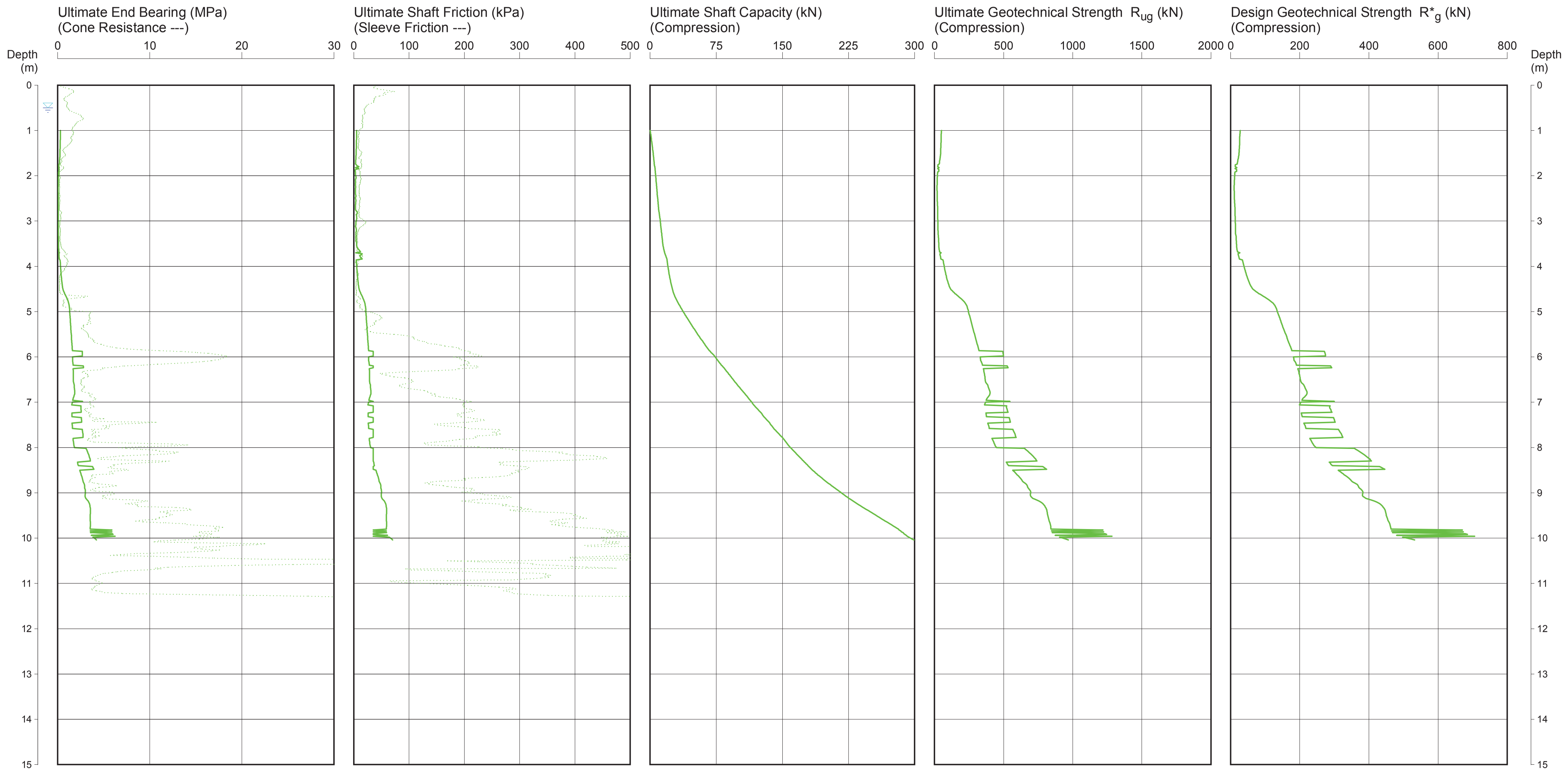
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.45
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 1

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.665



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date	
Plotted	
Checked	

Water depth after test: 0.50m depth

File: P:\39823\Field\39823-01.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

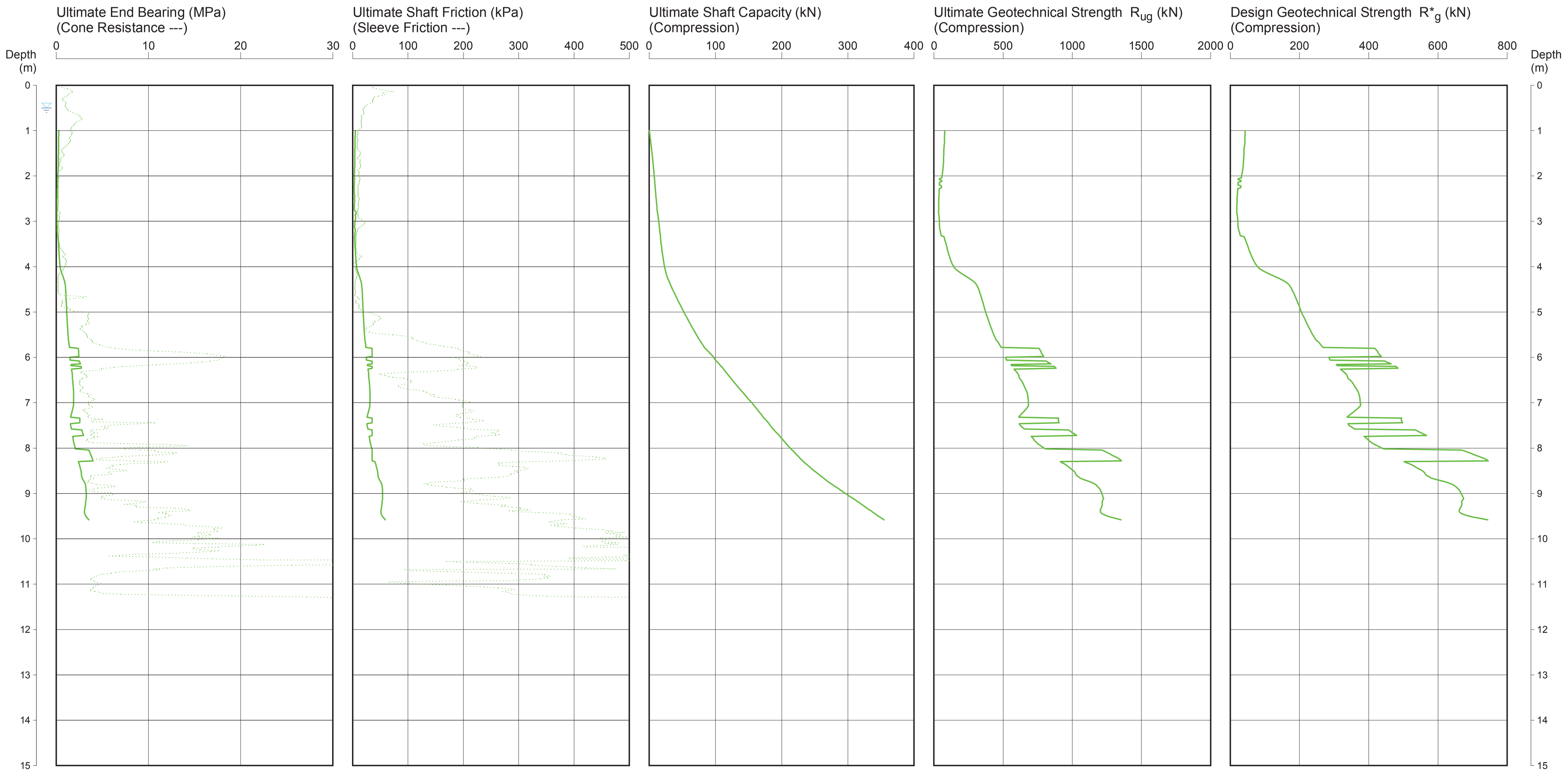
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 1

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.665



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.50m depth

File: P:\39823\Field\39823-01.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

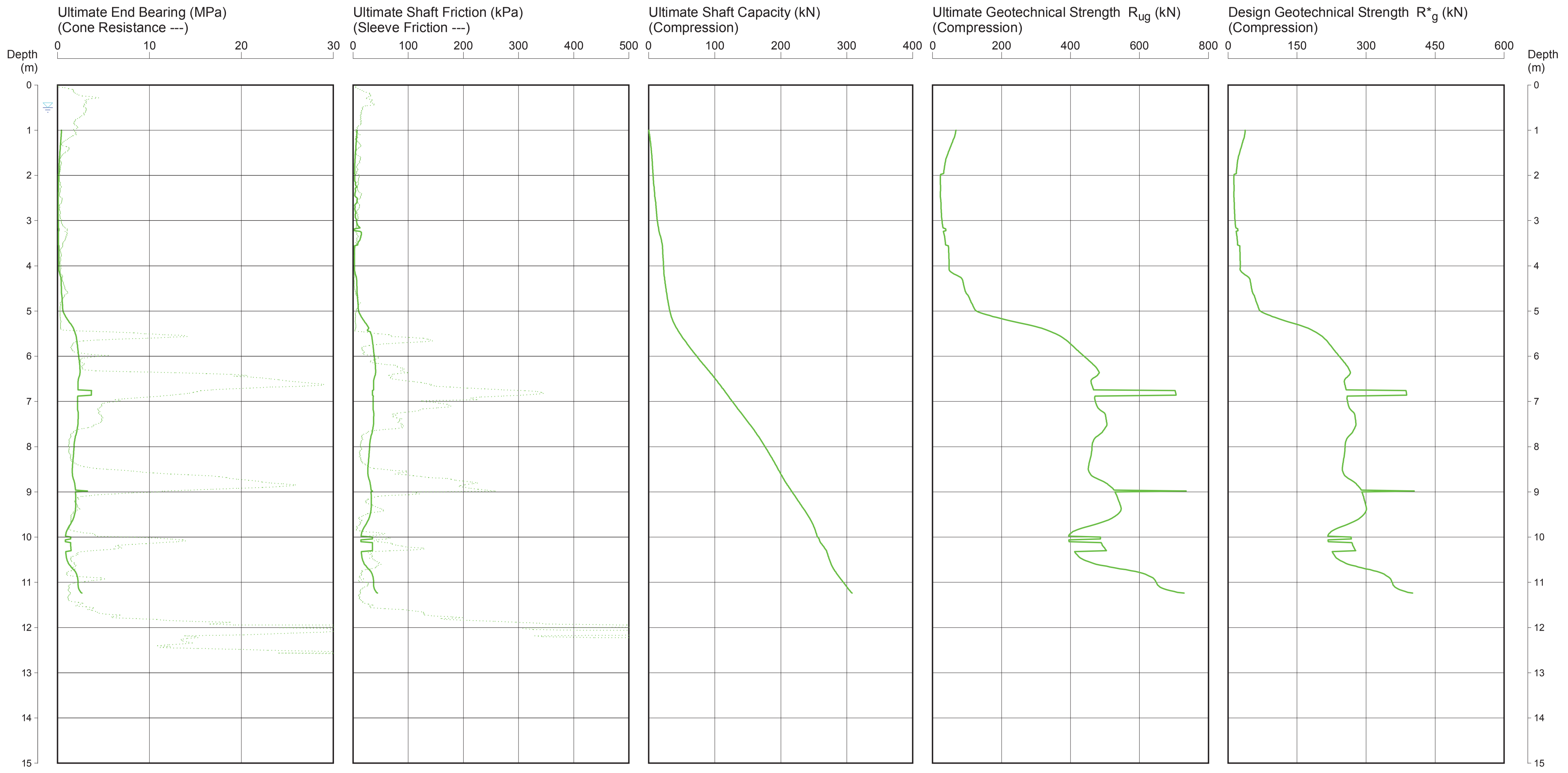
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.45
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 2

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.81



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.5m

File: P:\39823\Field\39823-02.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

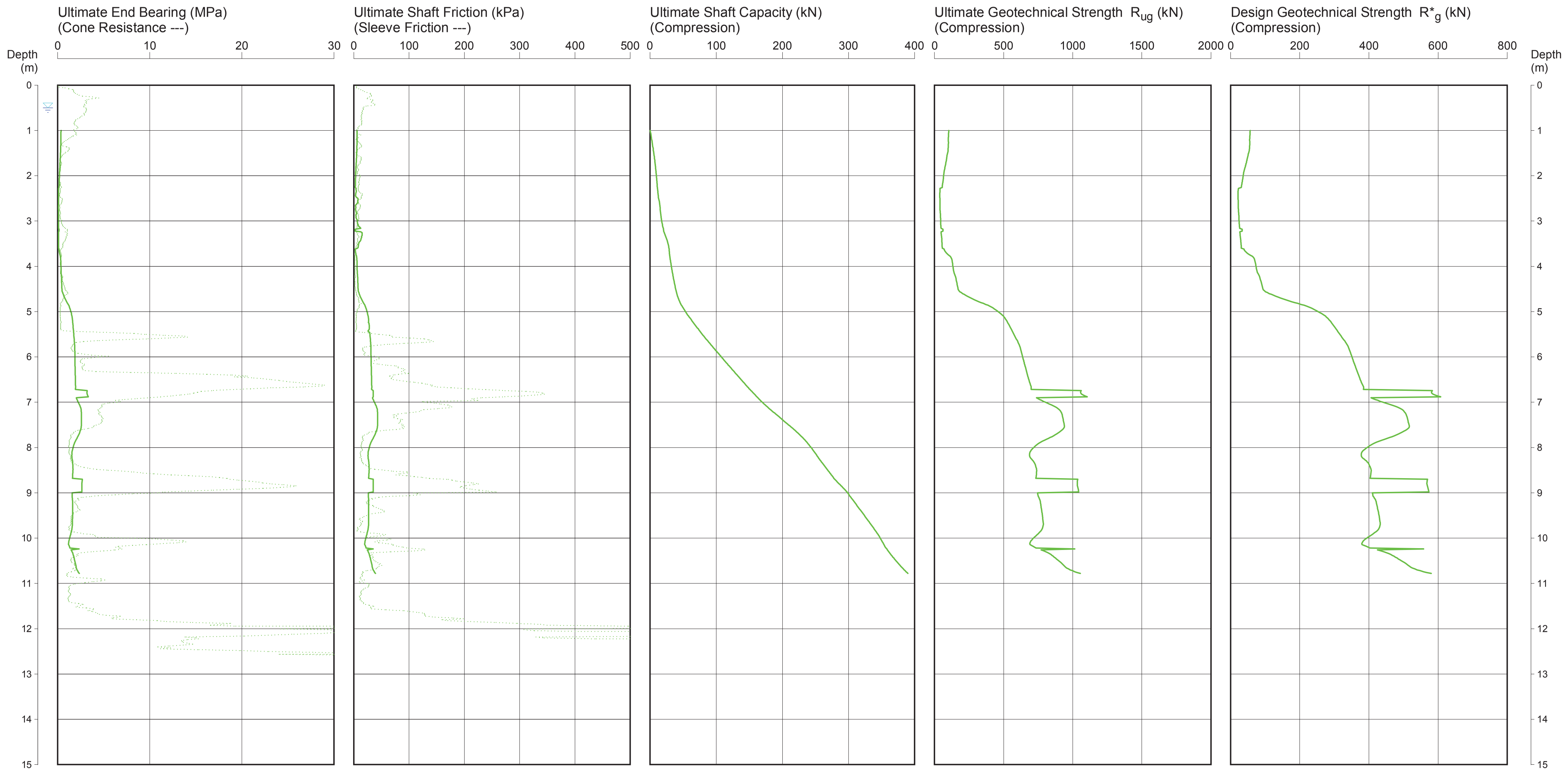
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 2

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.81



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.5m

File: P:\39823\Field\39823-02.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

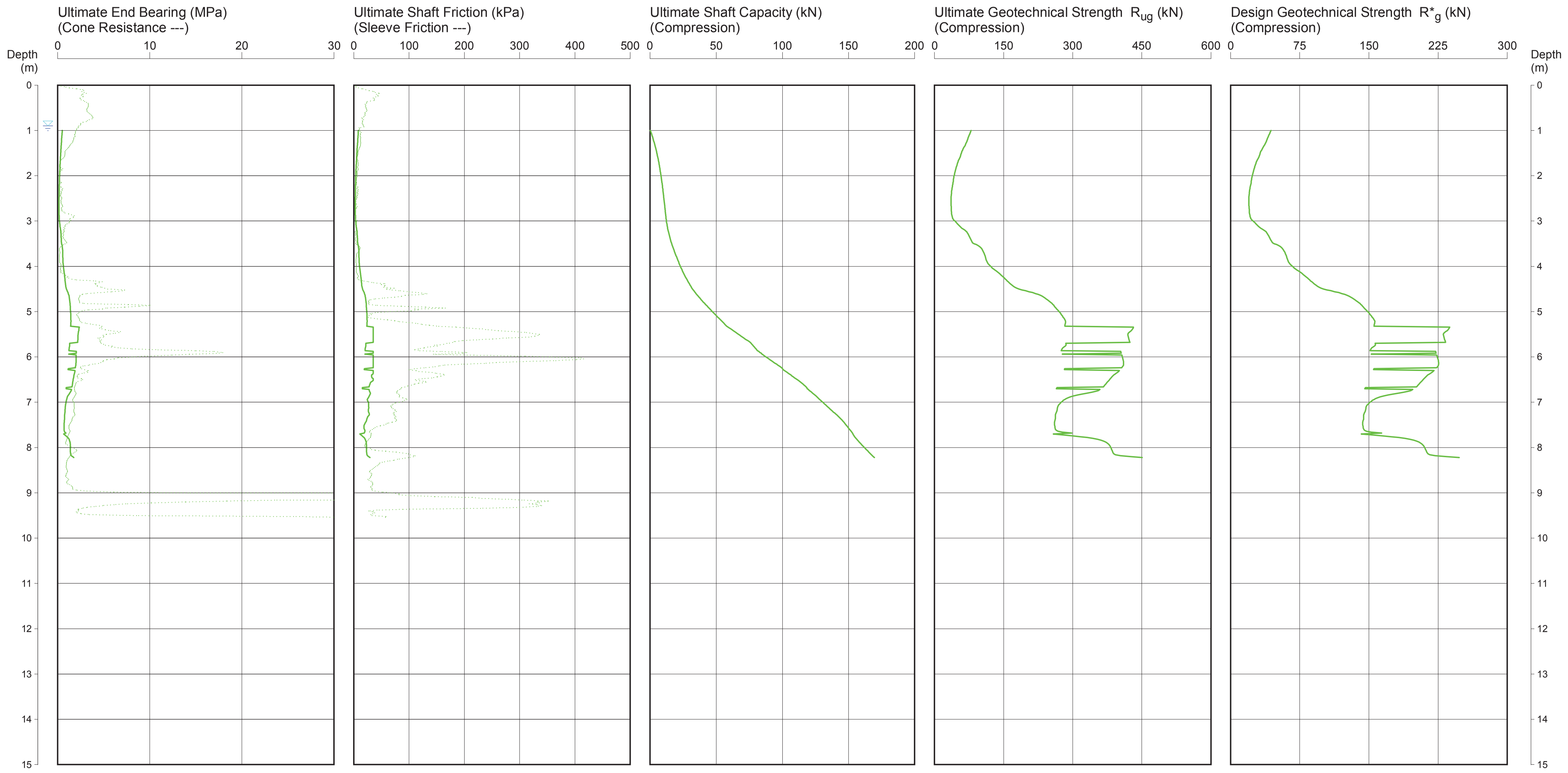
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.45
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 3

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.92



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.90m depth

File: P:\39823\Field\39823-03.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

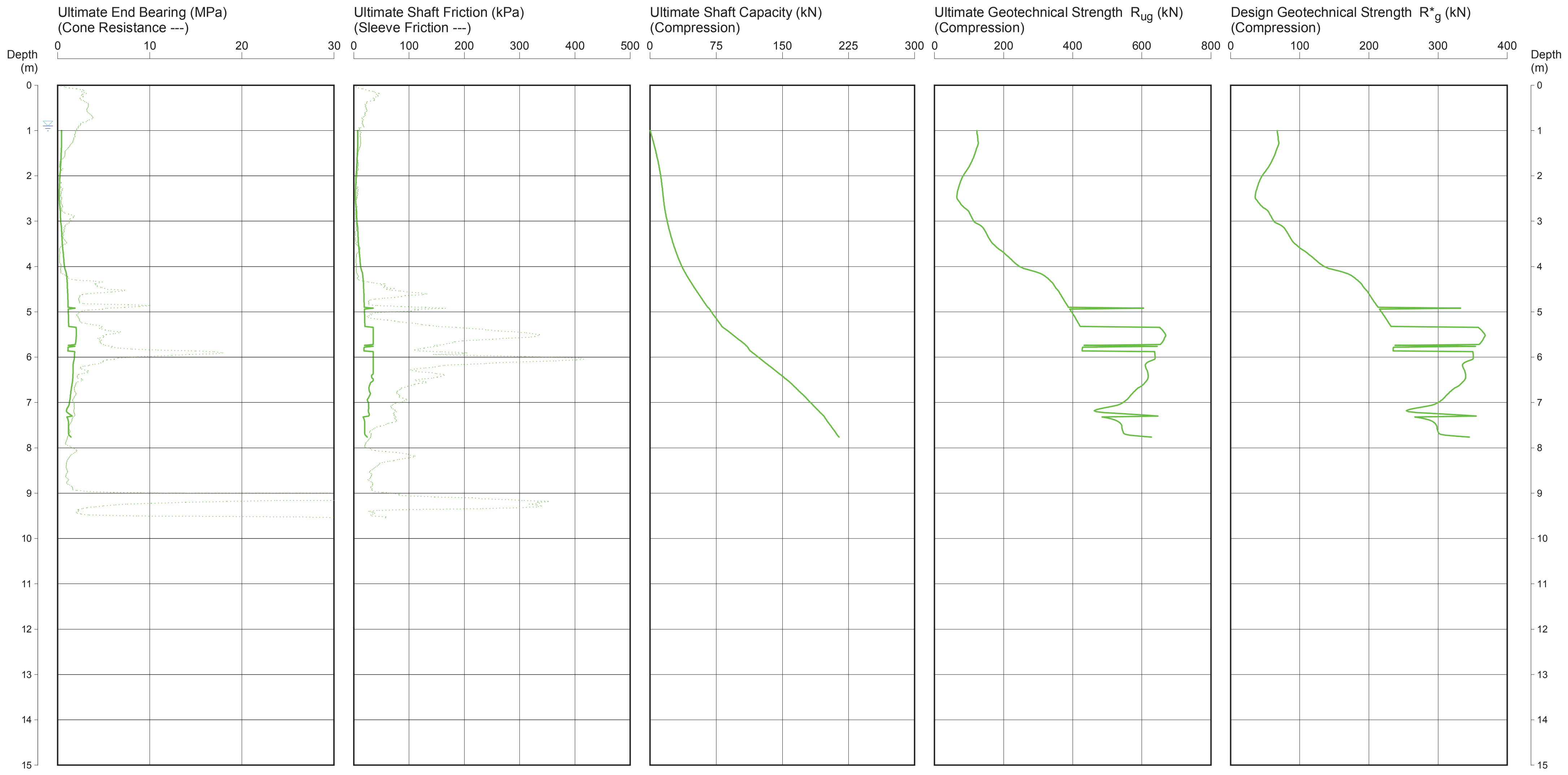
LOCATION: OFF HENRY ROAD, MORISSET PARK

CLIENT: JOHNSON PROPERTY GROUP

CPT 3

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.92



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.90m depth

File: P:\39823\Field\39823-03.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

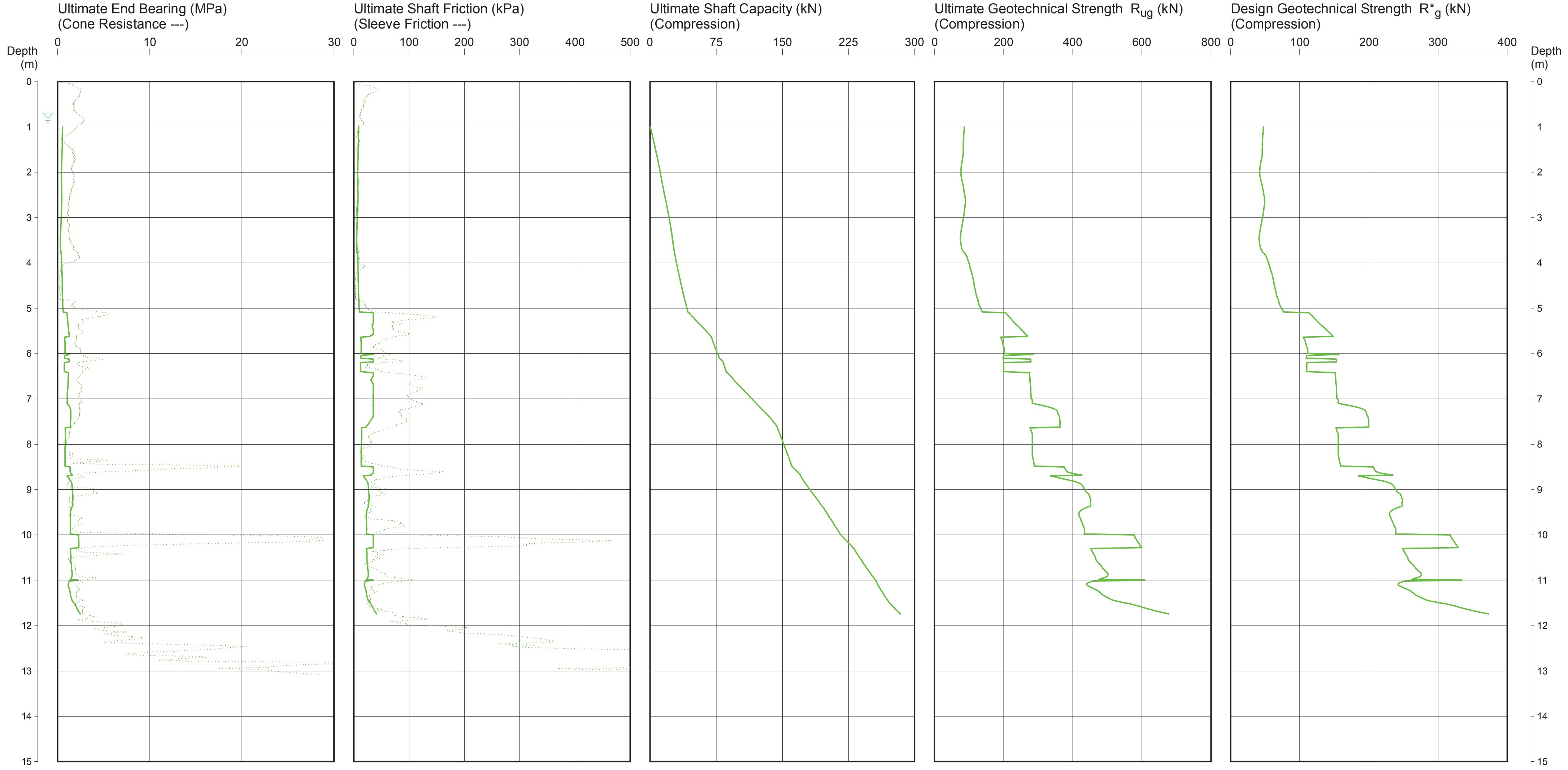
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.45
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 4

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.99



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.80m depth

File: P:\39823\Field\39823-04.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

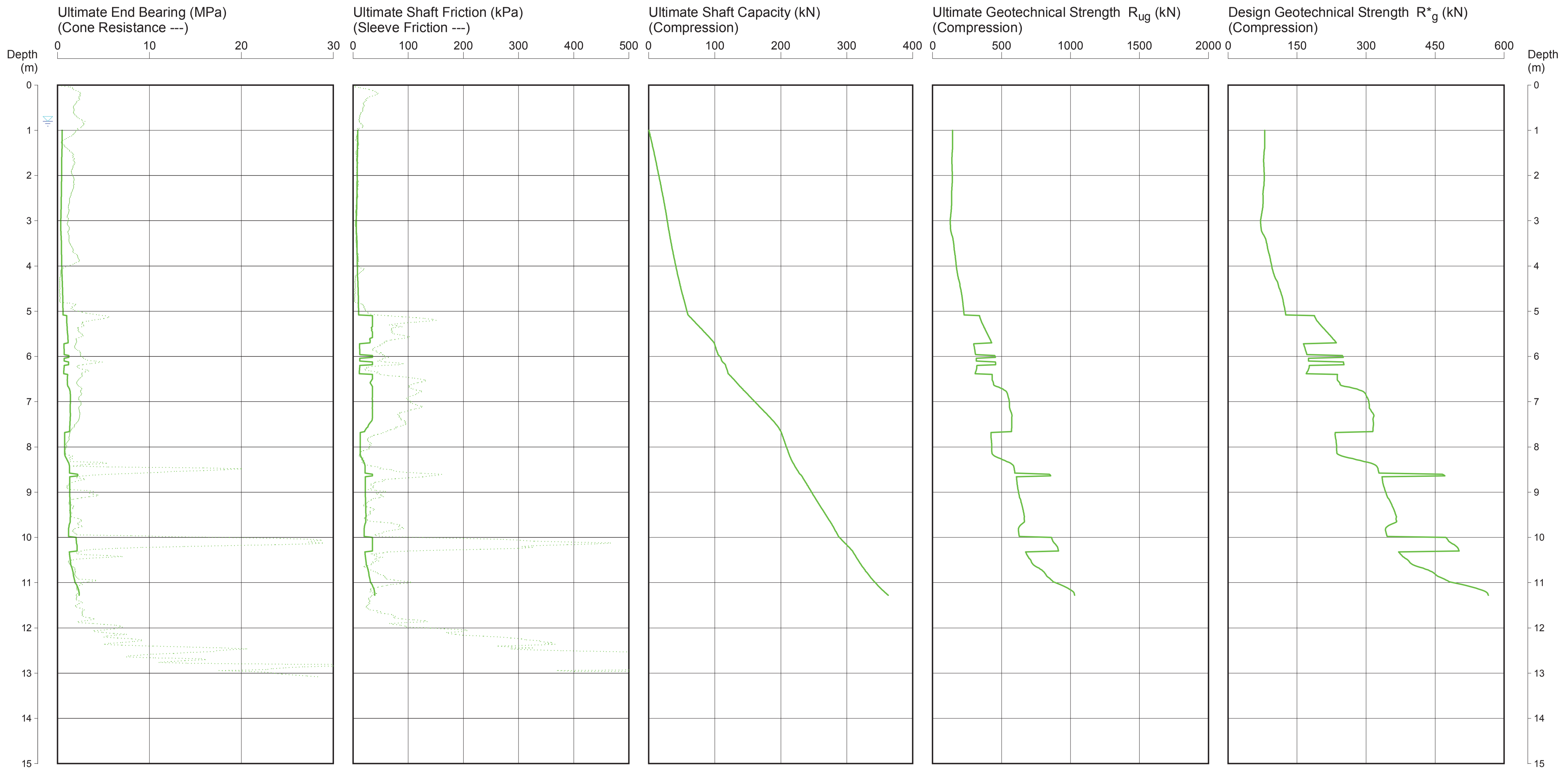
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 4

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.99



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.80m depth

File: P:\39823\Field\39823-04.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.45
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

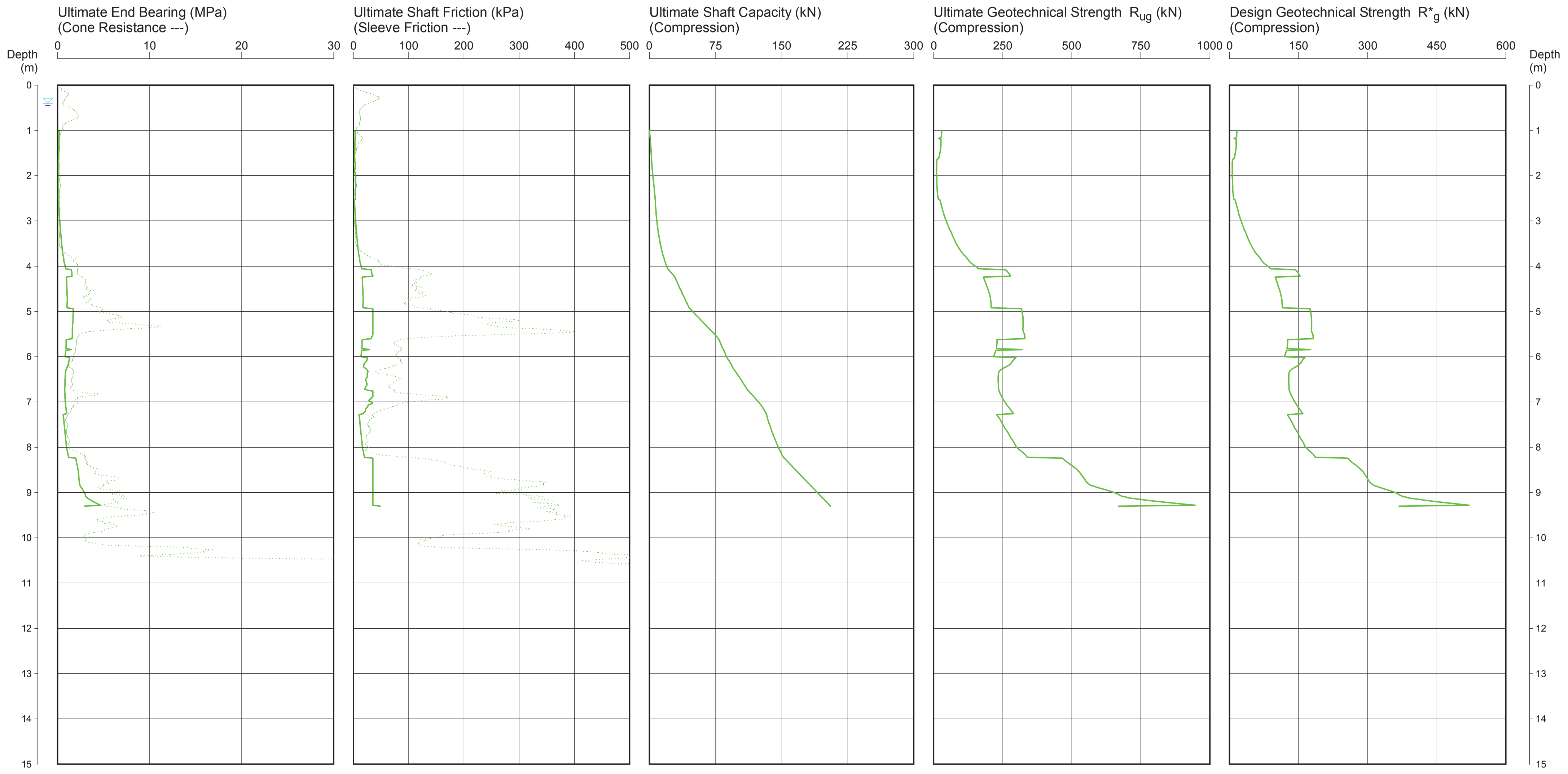
LOCATION: OFF HENRY ROAD, MORISSET PARK

CLIENT: JOHNSON PROPERTY GROUP

CPT 5

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.78



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.40m depth

File: P:\39823\Field\39823-05.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

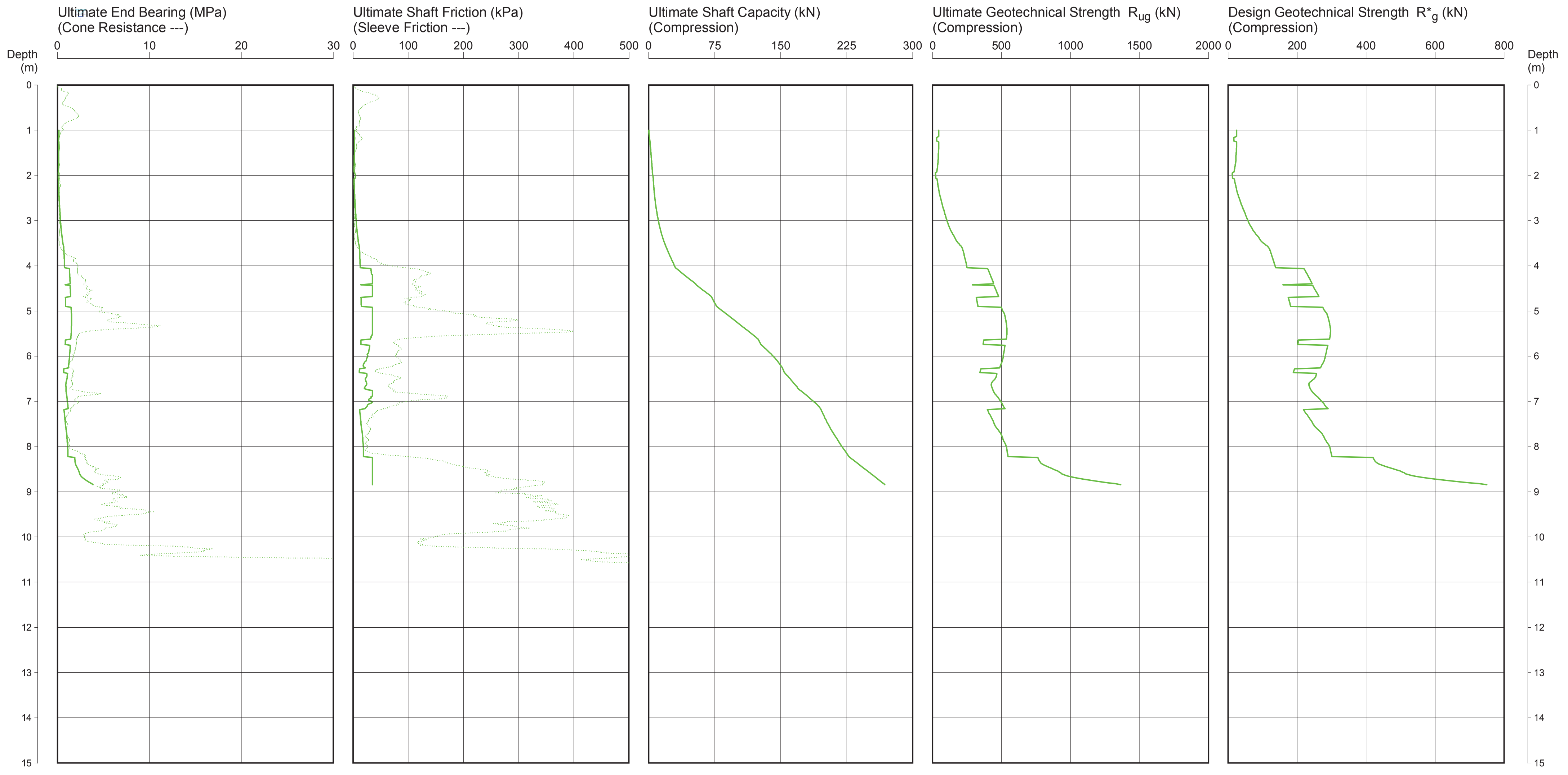
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 5

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.78



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.40m depth

File: P:\39823\Field\39823-05.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1
© 2003 Douglas Partners Pty Ltd

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

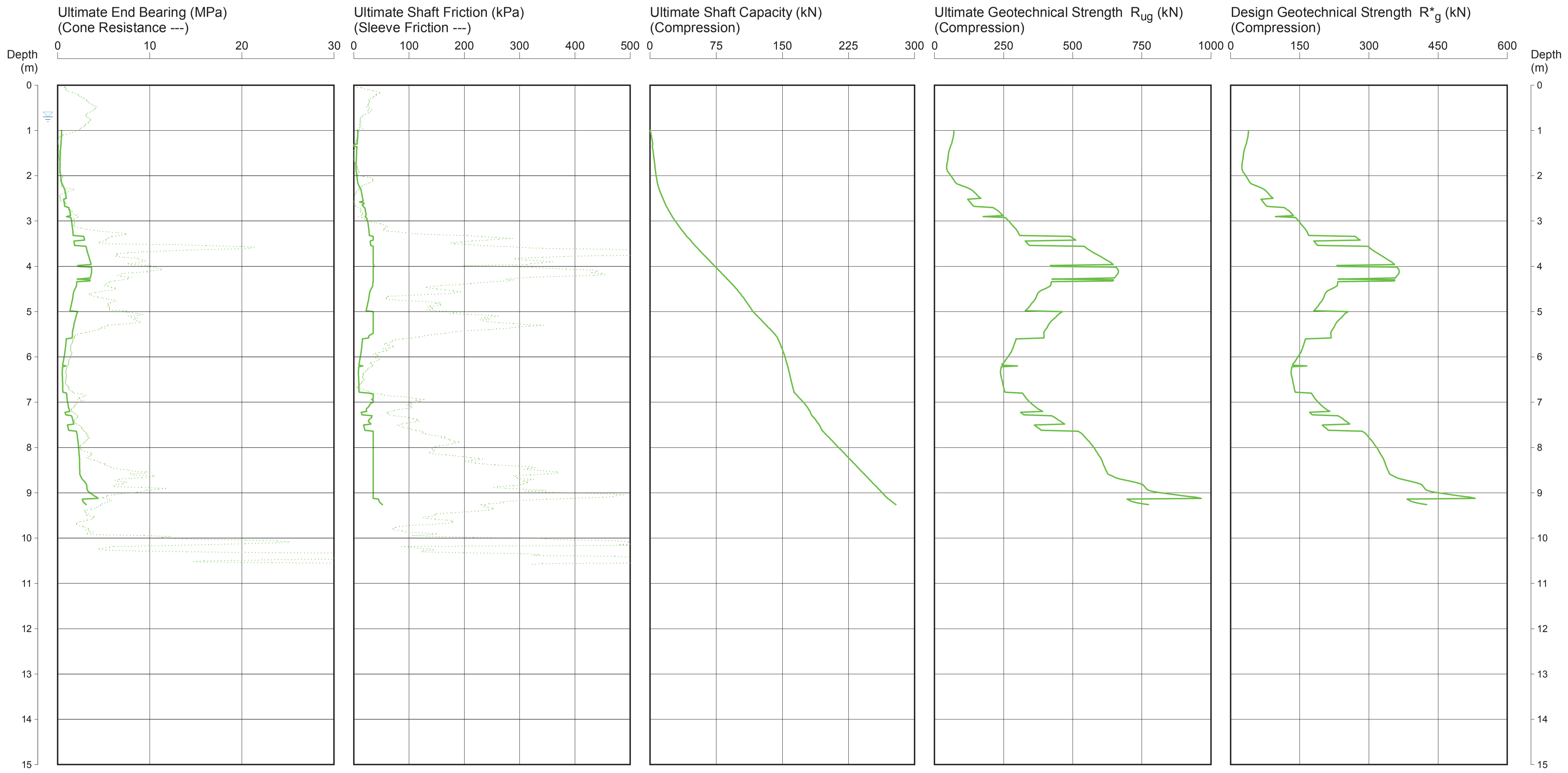
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.45
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 6

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 1.05



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.70m depth

File: P:\39823\Field\39823-06.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

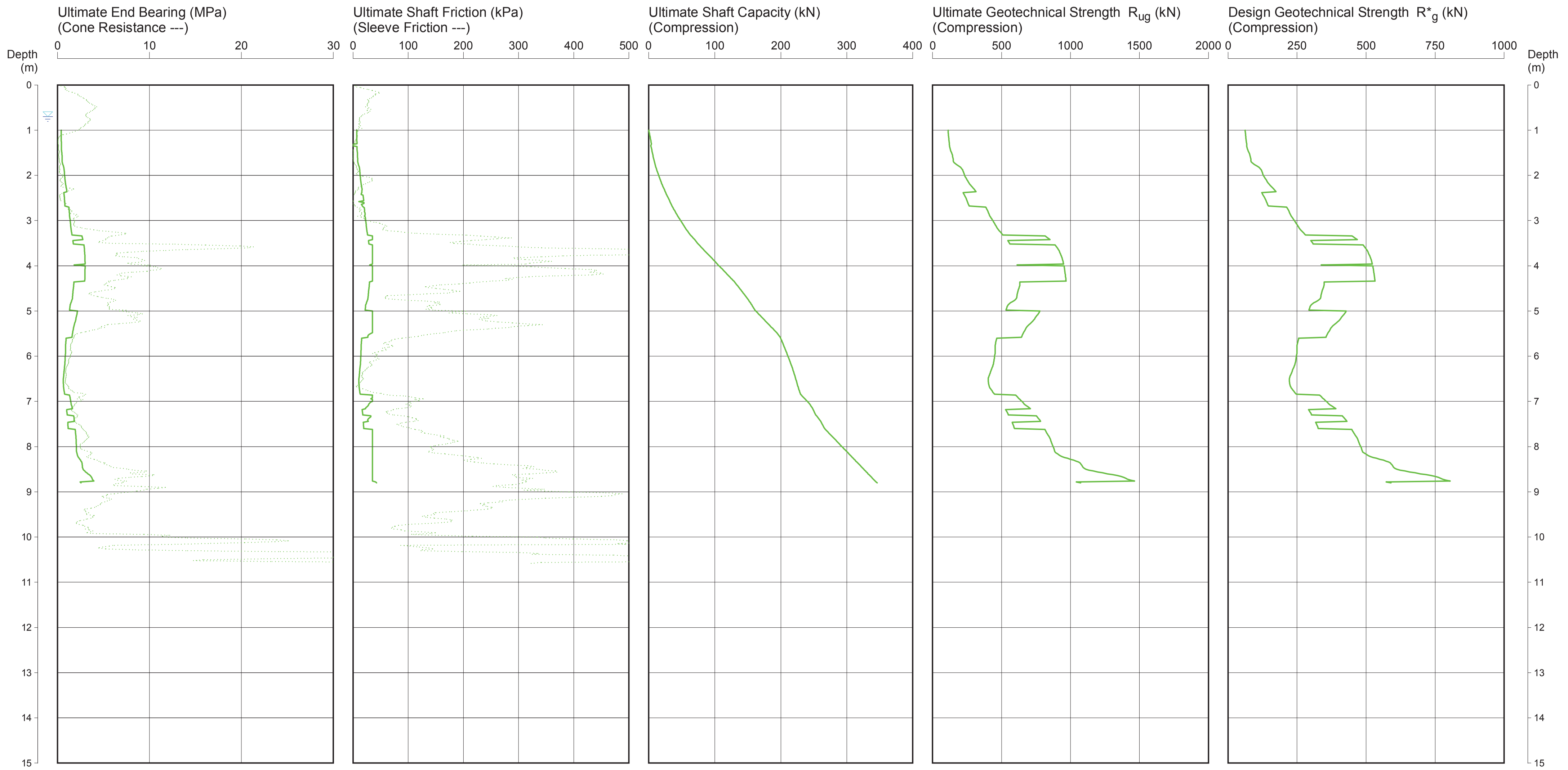
PILE TYPE: Bored Concrete
PILE SHAPE: Round
PILE SIZE: Diameter = 0.60
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 6

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 1.05



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.70m depth

File: P:\39823\Field\39823-06.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

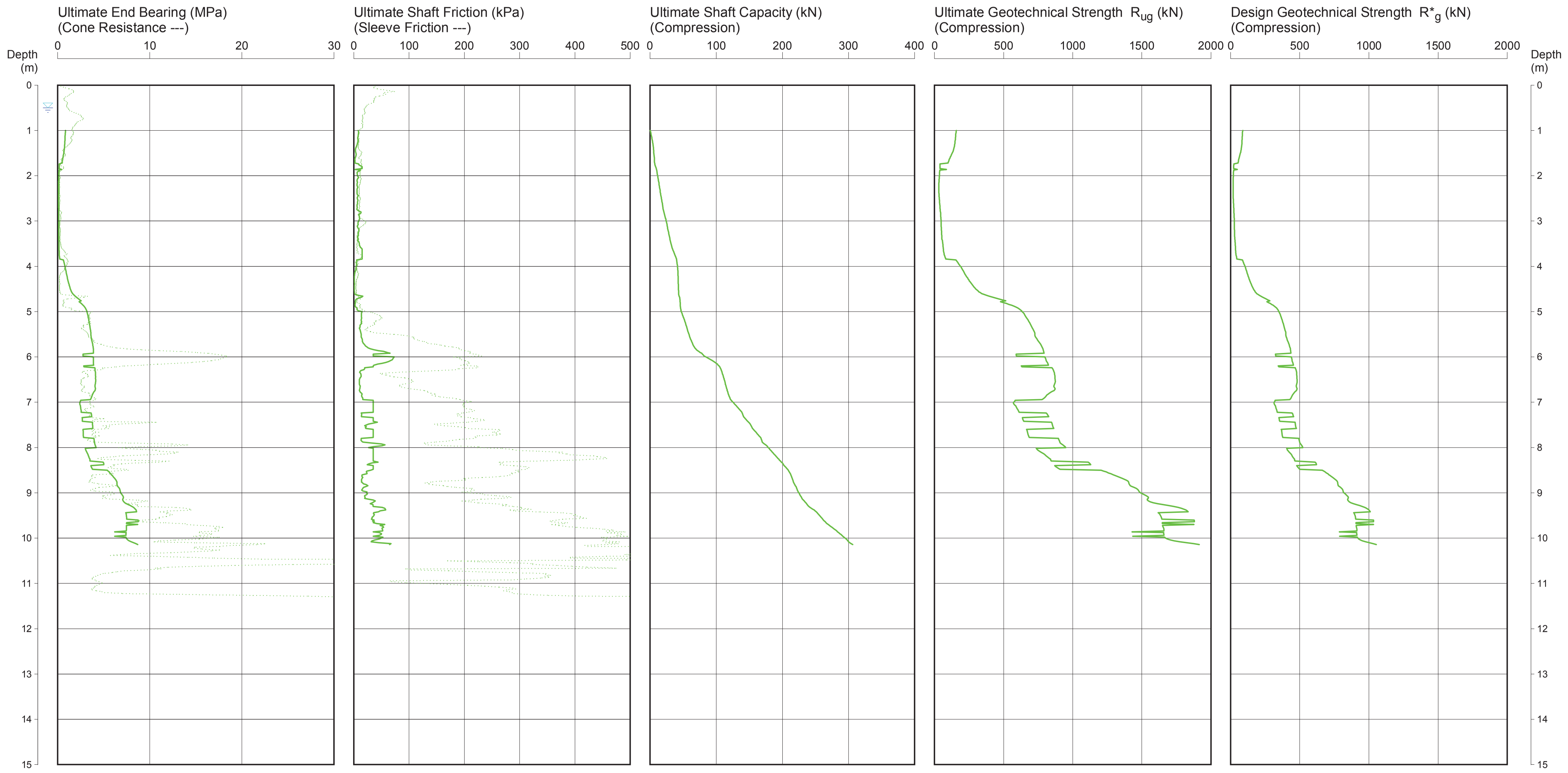
PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.41 Outer Diameter = 0.56
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 1

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.665



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.50m depth

File: P:\39823\Field\39823-01.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1
© 2003 Douglas Partners Pty Ltd

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR Ø$_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

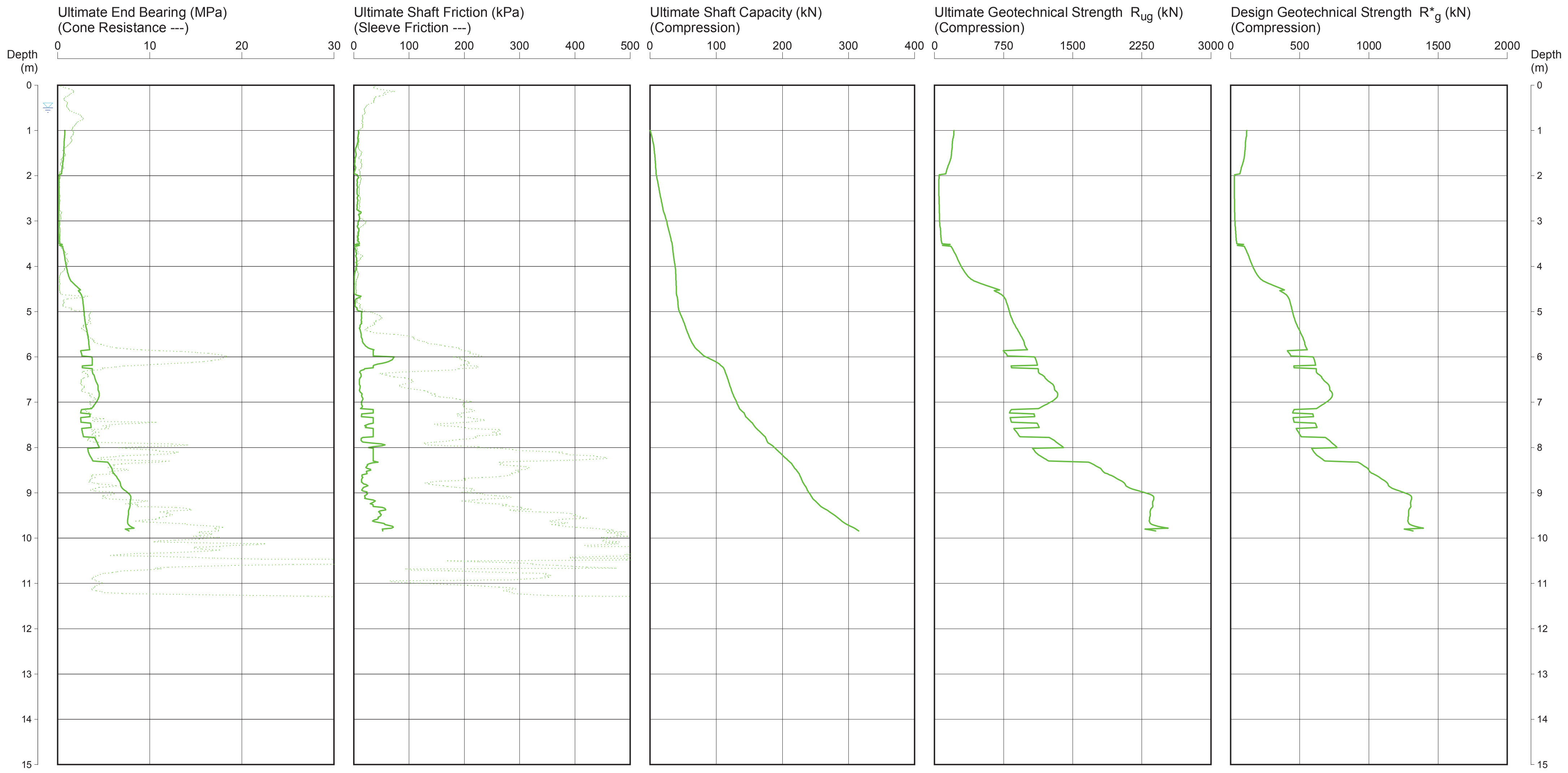
LOCATION: OFF HENRY ROAD, MORISSET PARK

CLIENT: JOHNSON PROPERTY GROUP

CPT 1

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.665



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.50m depth

File: P:\39823\Field\39823-01.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

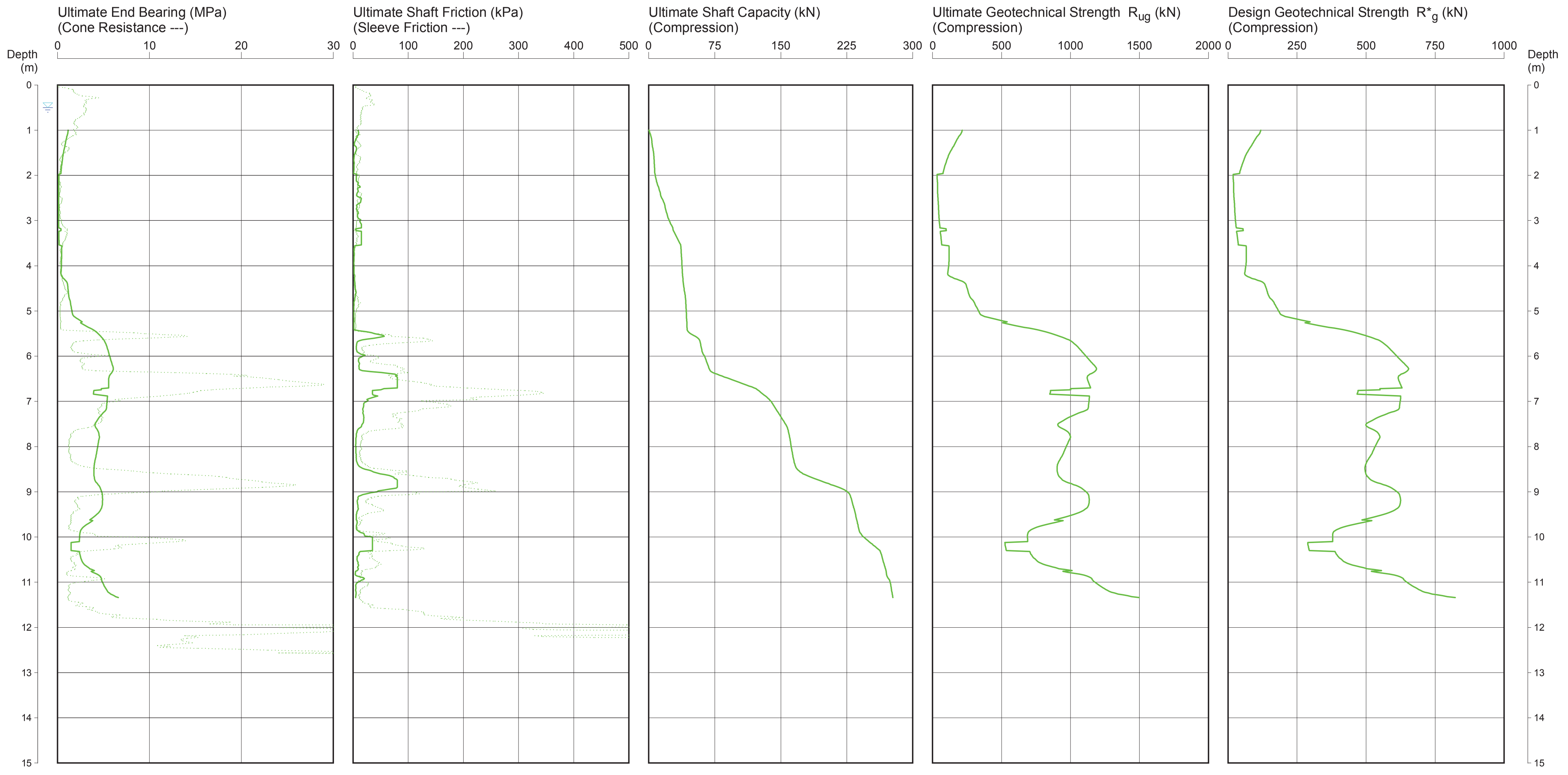
PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.41 Outer Diameter = 0.56
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 2

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.81



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.5m

File: P:\39823\Field\39823-02.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

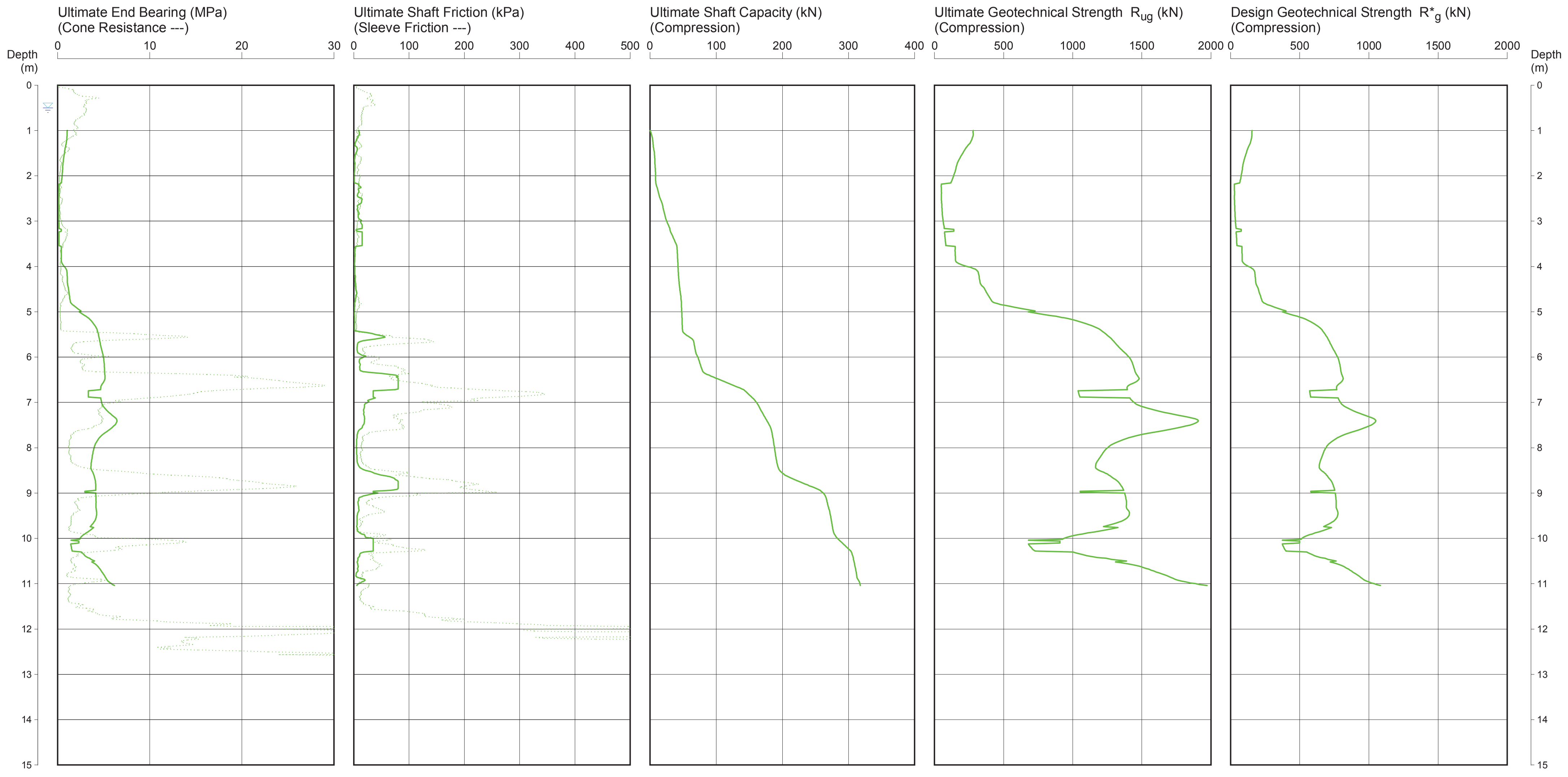
PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 2

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.81



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.5m

File: P:\39823\Field\39823-02.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

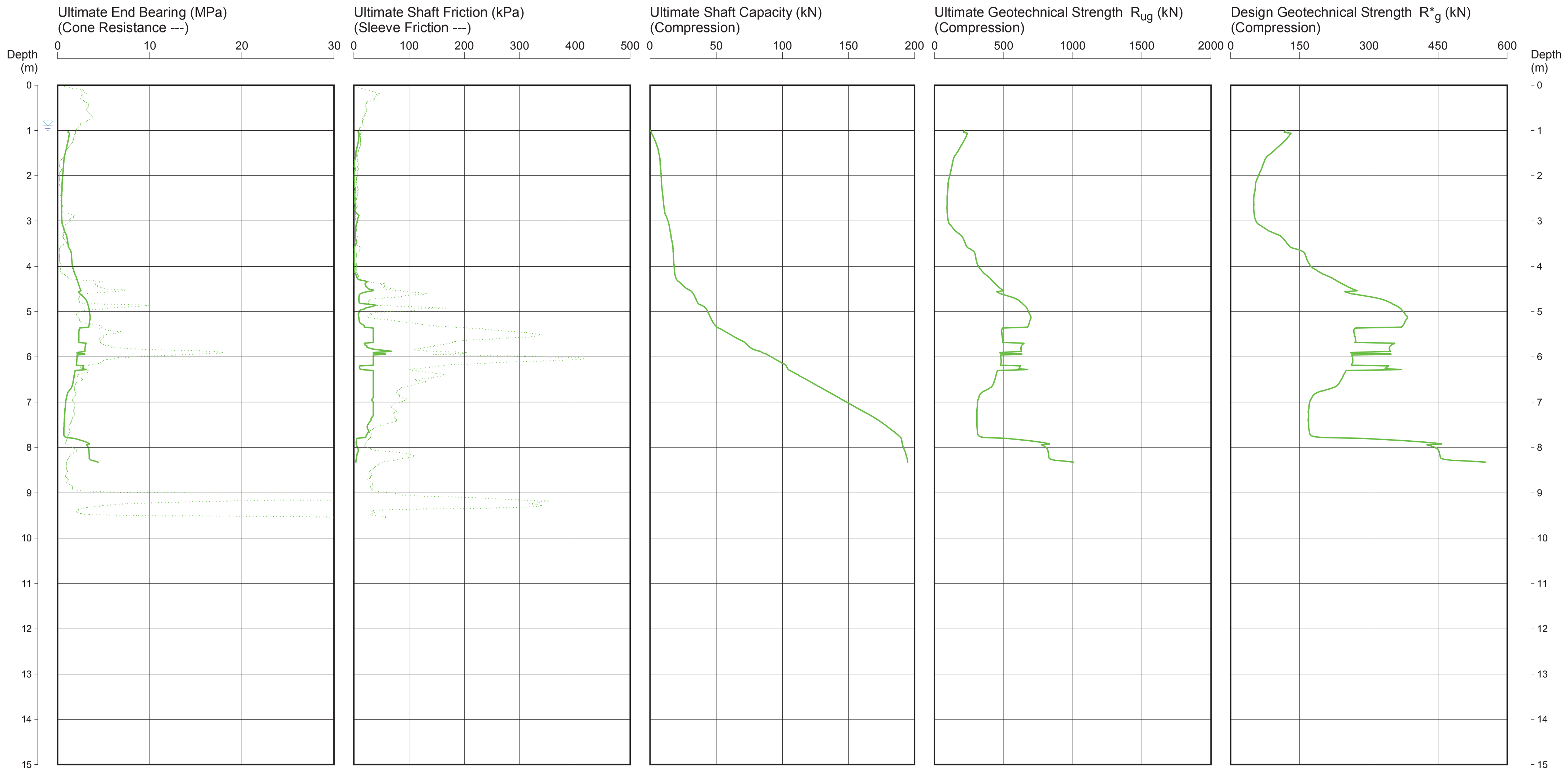
PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.41 Outer Diameter = 0.56
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 3

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.92



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.90m depth

File: P:\39823\Field\39823-03.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

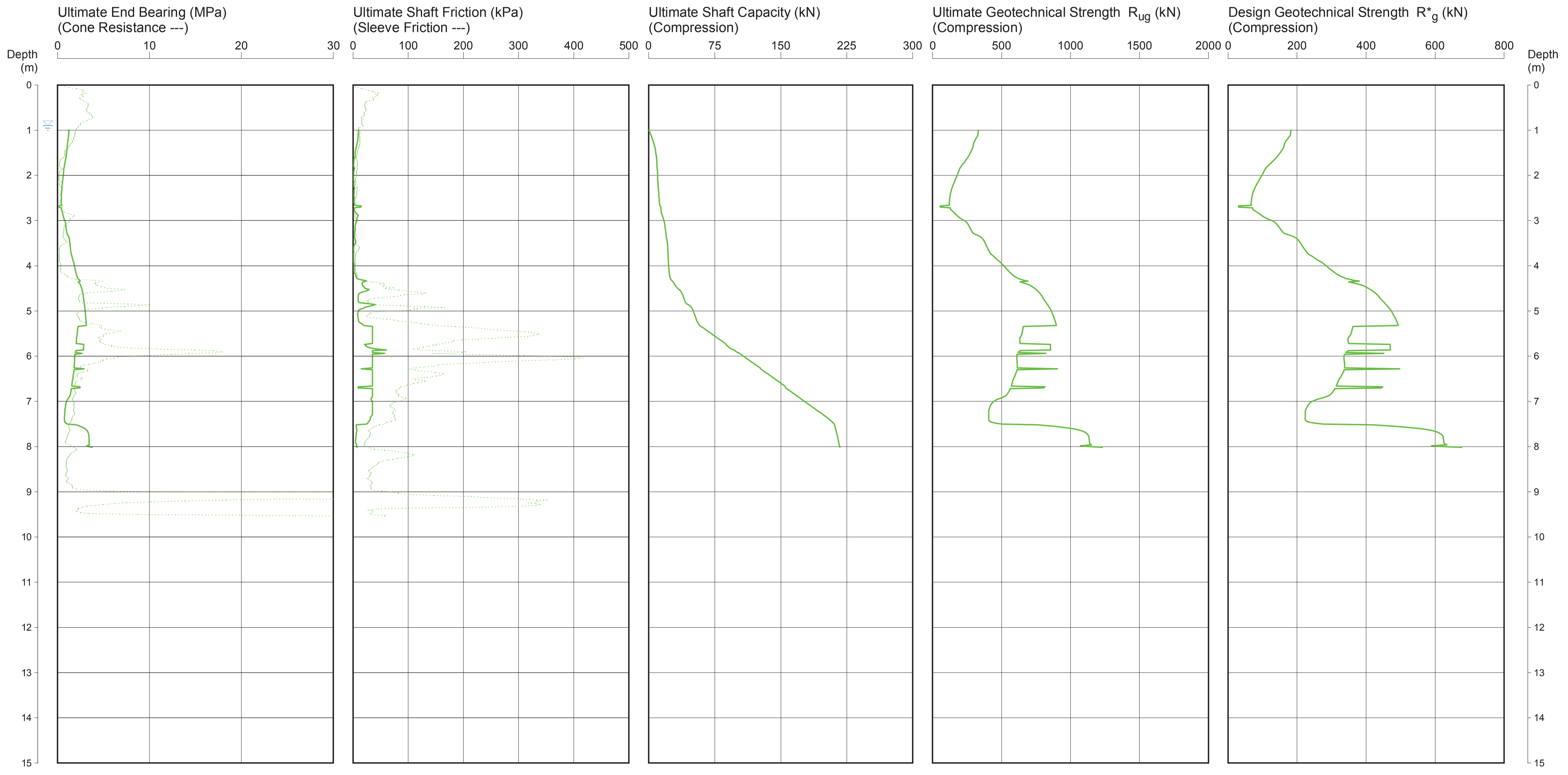
PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 3

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.92



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.90m depth

File: P:\39823\Field\39823-03.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.41 Outer Diameter = 0.56
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

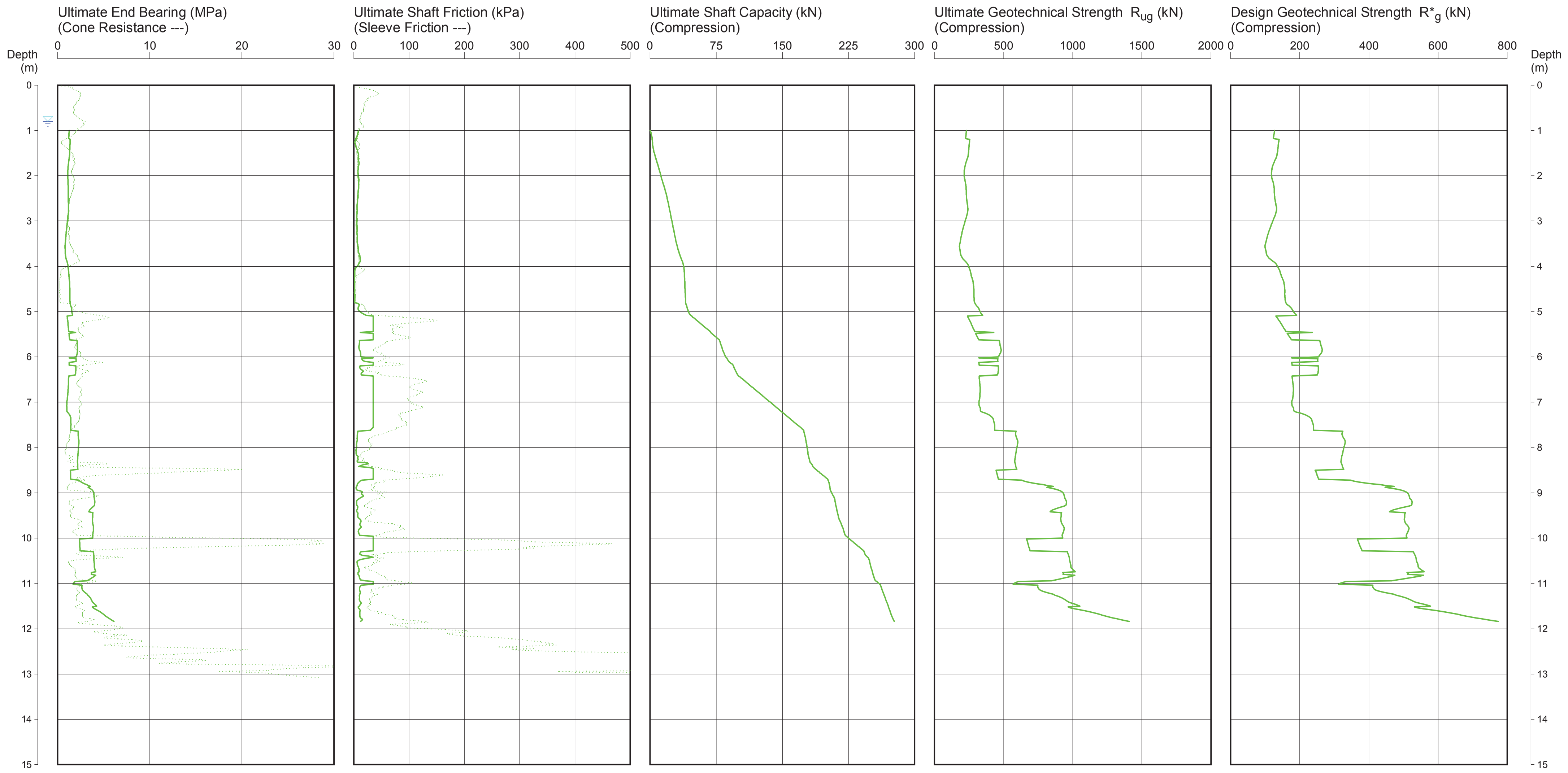
LOCATION: OFF HENRY ROAD, MORISSET PARK

CLIENT: JOHNSON PROPERTY GROUP

CPT 4

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.99



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.80m depth

File: P:\39823\Field\39823-04.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

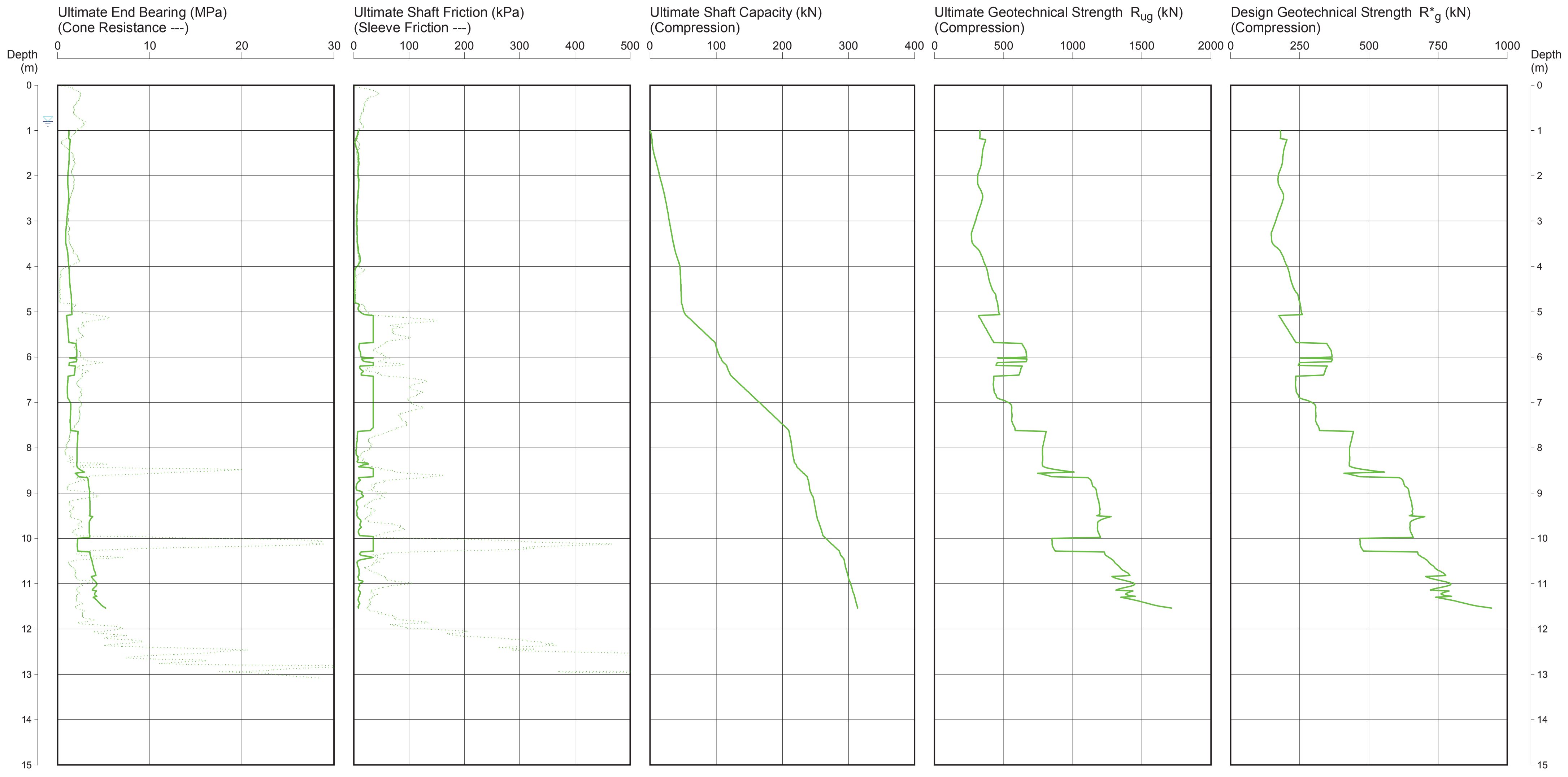
PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 4

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.99



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.80m depth

File: P:\39823\Field\39823-04.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.41 Outer Diameter = 0.56
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

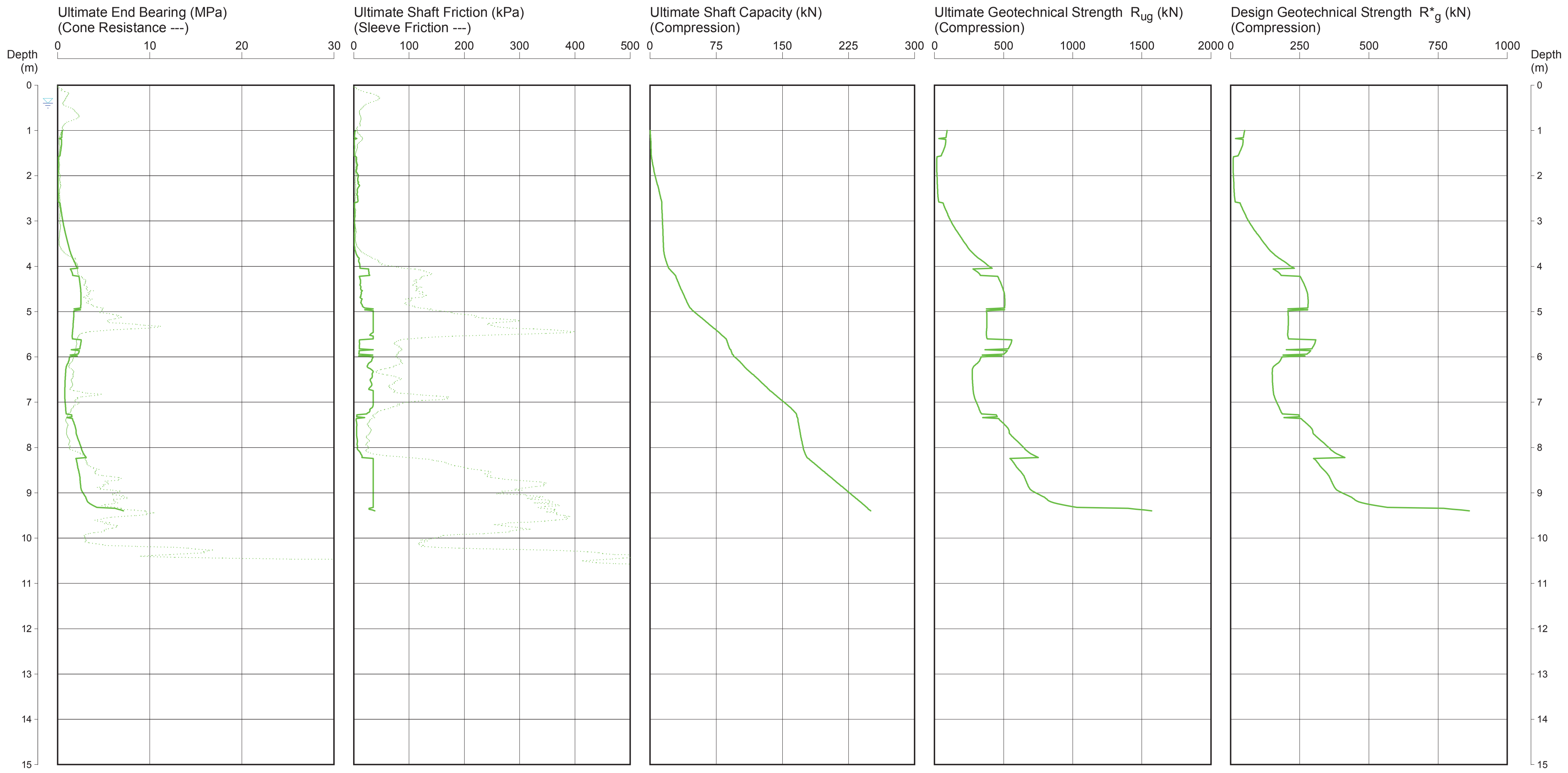
LOCATION: OFF HENRY ROAD, MORISSET PARK

CLIENT: JOHNSON PROPERTY GROUP

CPT 5

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.78



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.40m depth

File: P:\39823\Field\39823-05.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1
© 2003 Douglas Partners Pty Ltd

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT

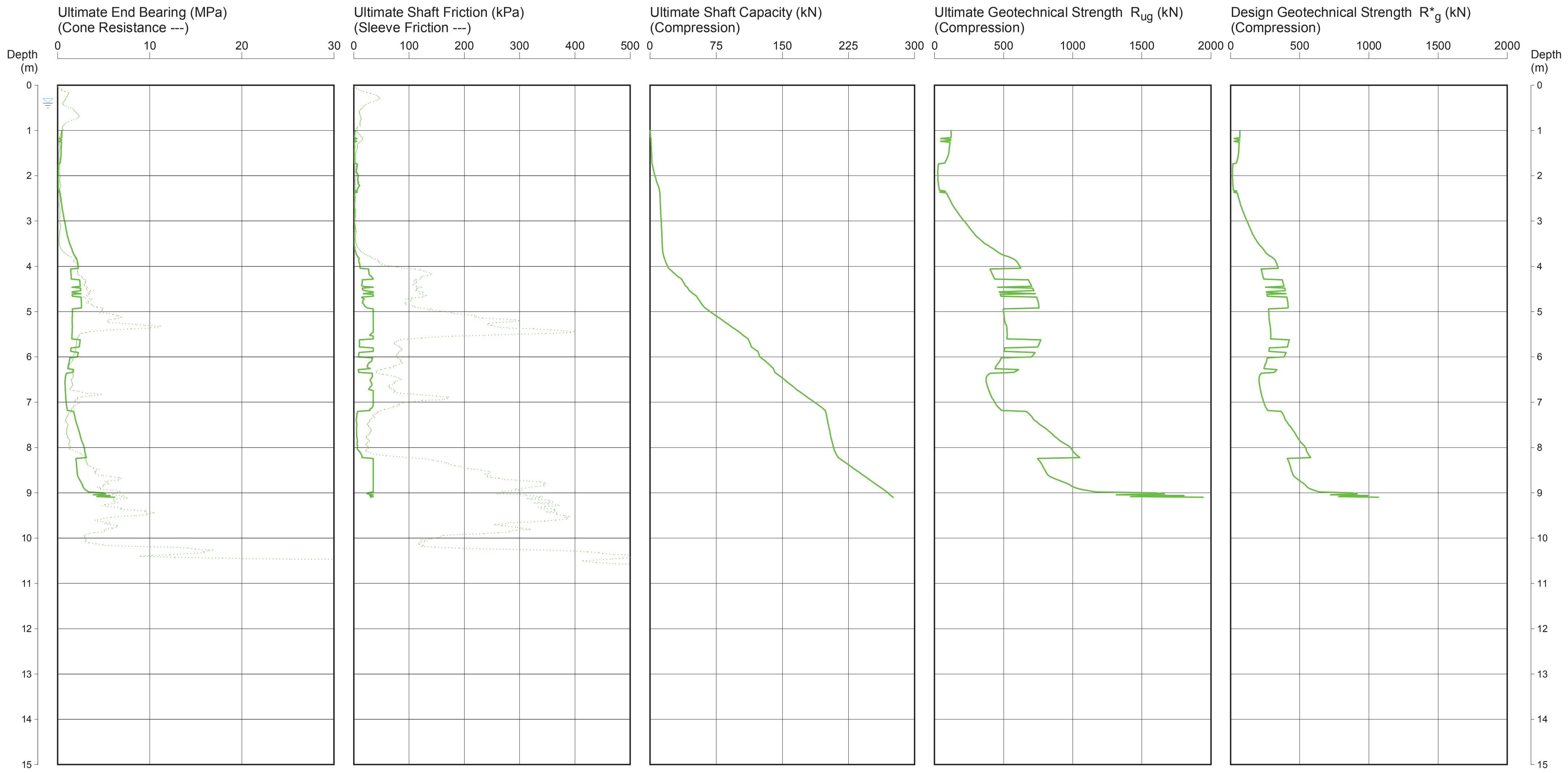
LOCATION: OFF HENRY ROAD, MORISSET PARK

CLIENT: JOHNSON PROPERTY GROUP

CPT 5

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 0.78



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.40m depth

File: P:\39823\Field\39823-05.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

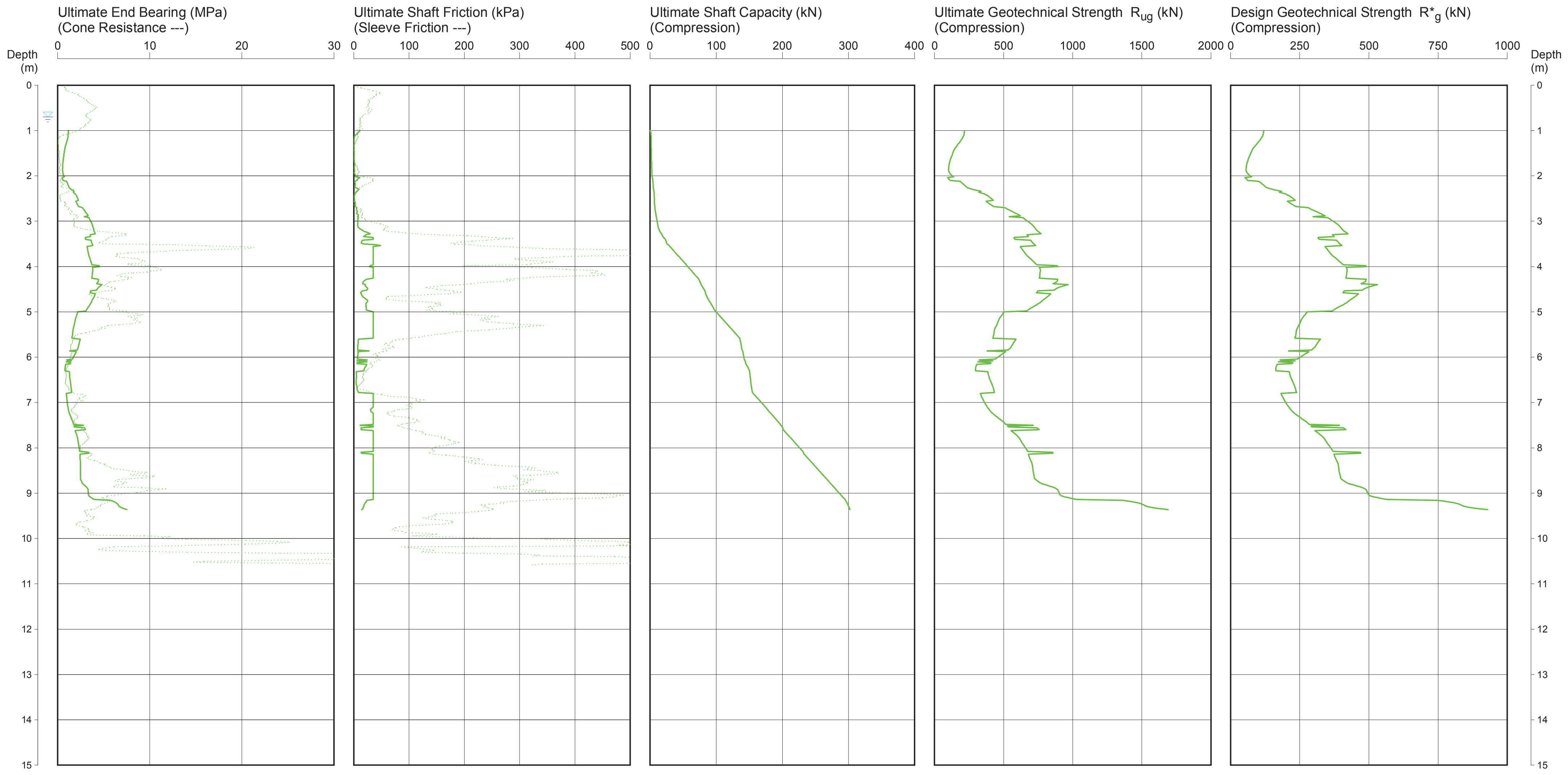
PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.41 Outer Diameter = 0.56
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 6

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 1.05



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.70m depth

File: P:\39823\Field\39823-06.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

PILE CAPACITY ESTIMATE

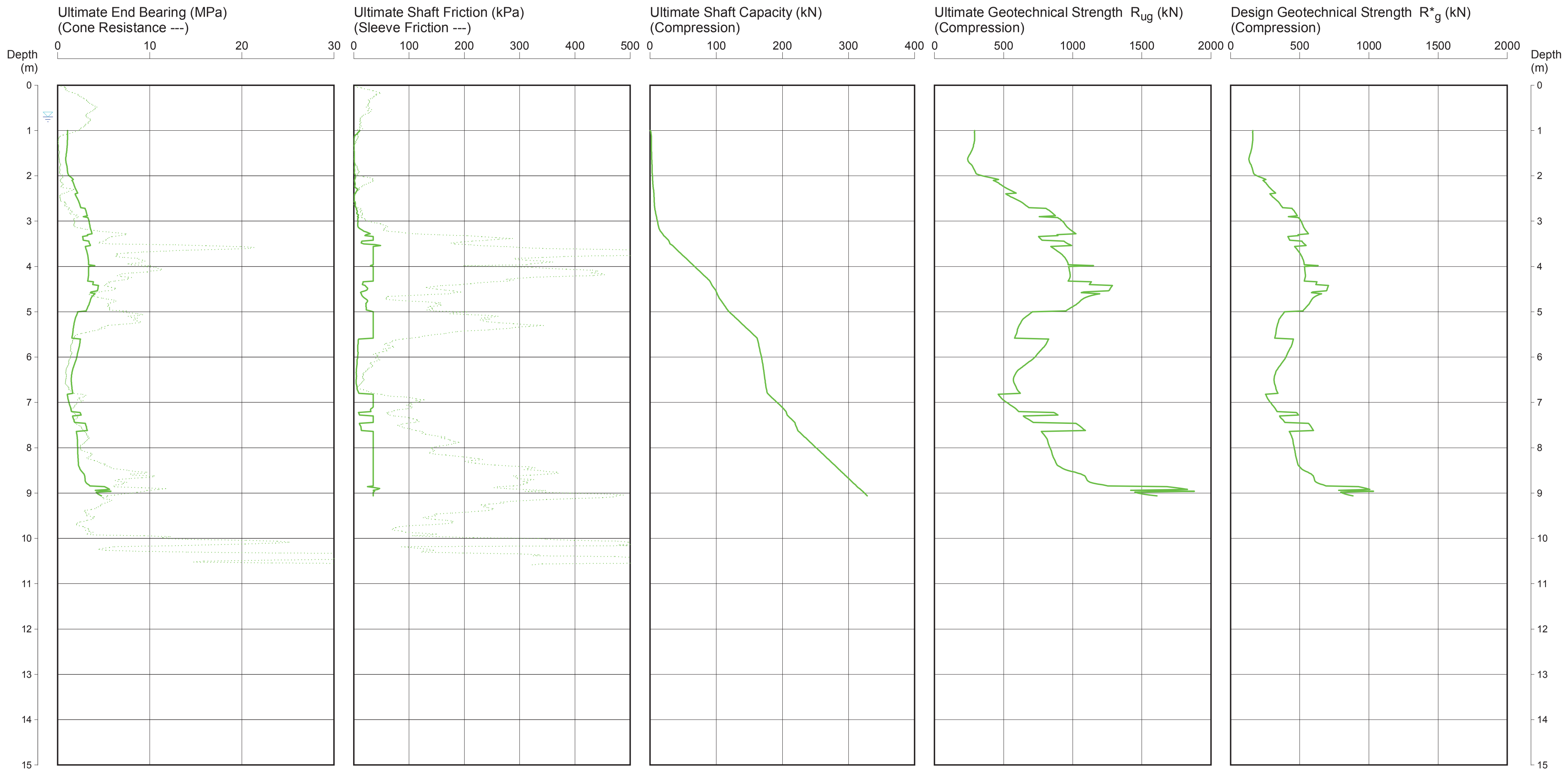
PILE TYPE: Screw Cast Concrete
PILE SHAPE: Round Screw
PILE SIZE: Inner Diameter = 0.51 Outer Diameter = 0.66
STRENGTH REDUCTION FACTOR $Ø_g$: 0.55
CALCULATION METHOD: Douglas Method

PROJECT: TRINITY POINT MARINA & MIXED USE RESORT
LOCATION: OFF HENRY ROAD, MORISSET PARK
CLIENT: JOHNSON PROPERTY GROUP

CPT 6

Page 1 of 1

DATE 25/09/2007
PROJECT No: 39823
SURFACE RL: 1.05



DISCLAIMER:
These capacities have been estimated using accepted static theory, and are a guide only. Suitable verification procedures should be adopted (refer to AS2159), and piling contractors should confirm pile suitability and capacities. Structural capacity should be checked, and due allowance made for inclined or eccentric loads, and possible corrosion effects.

Date
Plotted
Checked

Water depth after test: 0.70m depth

File: P:\39823\Field\39823-06.CP5
Cone ID: 413 **Type:** 2 Standard

ConePile Version 5.8.1

Douglas Partners
Geotechnics · Environment · Groundwater

In reply please send to: Head Office

Our reference: FN80-02100L0

Your reference:

Contact: Greg Cole-Clark

MINE
SUBSIDENCE
BOARD

HEAD OFFICE:
PO Box 488G
Newcastle 2300
Telephone: (02) 4908 4395
Facsimile: (02) 4929 1032

NEWCASTLE:
NSW Government Offices
117 Bull Street
Newcastle West 2302
PO Box 488G
Newcastle 2300
Telephone: (02) 4908 4300
Facsimile: (02) 4929 1032
DX 4322 Newcastle West

SPEERS POINT:
143 Main Road
Speers Point 2284
PO Box 9 Boolaroo 2284
Telephone: (02) 4950 8088
Facsimile: (02) 4950 8101
DX 7820 Newcastle

WYONG:
Suite 3 Feldwin Court
30 Hely Street
Wyong 2259
PO Box 157 Wyong 2259
Telephone: (02) 4352 1646
Facsimile: (02) 4352 1757
DX 7317 Wyong

SINGLETON:
Coal Services Building
1 Civic Avenue
Singleton 2330
PO Box 524 Singleton 2330
Telephone: (02) 6572 4344
Facsimile: (02) 6572 4504

PICTON:
100 Argyle Street
Picton 2571
PO Box 40 Picton 2571
Telephone: (02) 4677 1967
Facsimile: (02) 4677 2040
DX 26053 Picton

EMAIL:
mail@minesub.nsw.gov.au

WEBSITE:
www.minesub.nsw.gov.au

Mr Bryan Garland
Development Manager
Johnson Property Group
PO Box 34
COORANBONG NSW 2265

12 January 2007

Dear Bryan,

Preliminary Concept Plan - Trinity Point Marina.

Thank you for meeting with the Board on 11th December 2006 to discuss the above project.

A formal Development Application will need to be submitted for Stage 1 and approval will be subject to the decision of a Board Meeting. However, as a general guideline, the Mine Subsidence Board would consider development of structures up to seven storeys in Stage 1 (Concept Plan - Preliminary dated 29 November 2006).

Any approval would be subject to conditions including;-

1. The submission of final drawings prior to the commencement of construction, and containing a certification by a qualified structural engineer that the improvements have been constructed for the following parameters and any damage would be slight, localized and readily repairable.

(a)	Maximum vertical subsidence	150 mm
(b)	Maximum ground strains	± 2 mm/m
(c)	Maximum tilt	2 mm/m

2. The final drawings are to be submitted to the Mine Subsidence Board prior to commencement of construction. The drawings are to show brickwork articulation in accordance with the Building Code of Australia.

3. Upon completion of construction, work as executed certification by a qualified structural engineer is to be forwarded to the Board confirming construction was in accordance with the plans submitted.

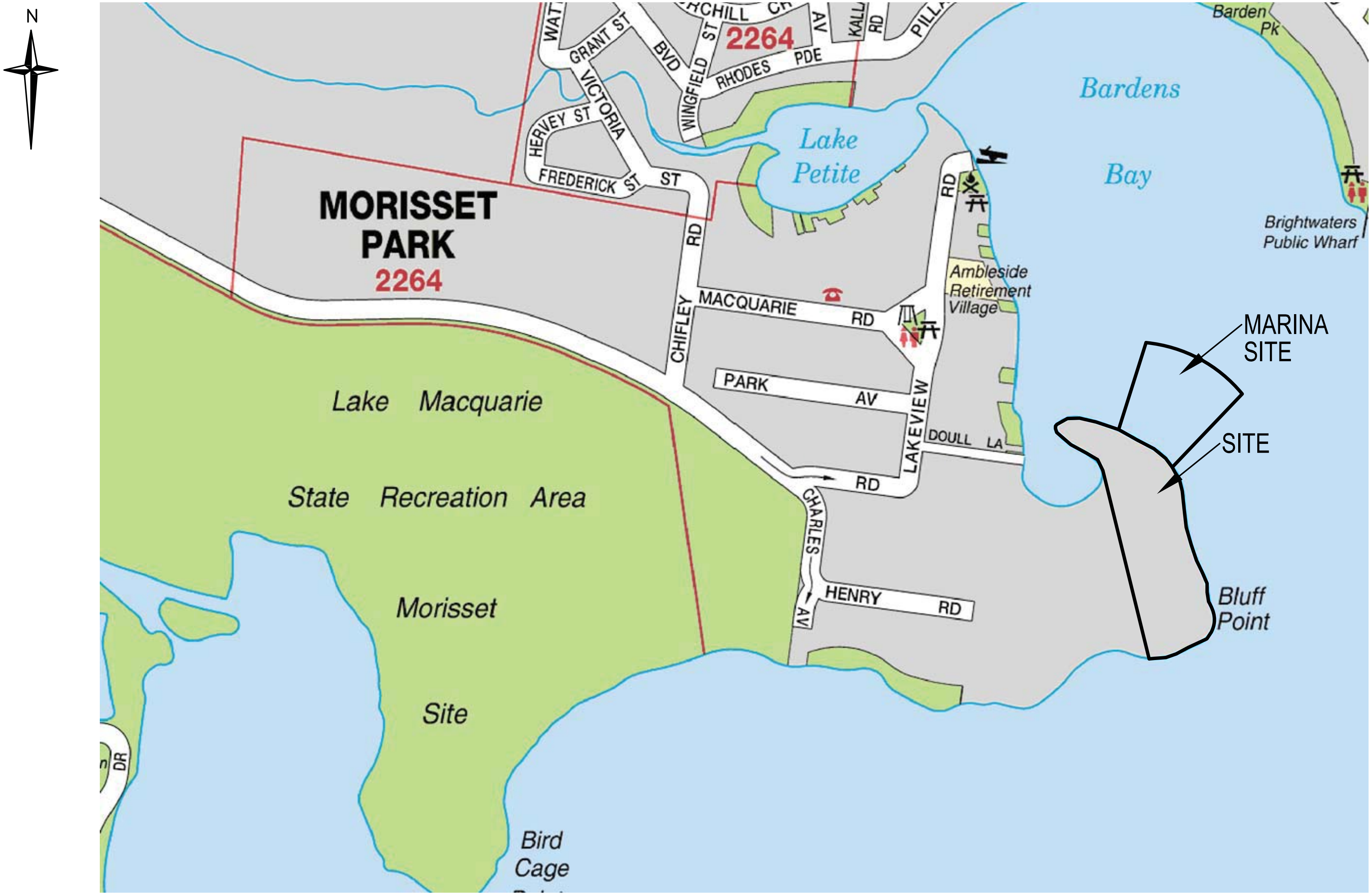
As explained, other stages of the project will be subject to surface development guidelines. The guidelines control the amount of subdivision and type of structures that can be built given the risk of mine subsidence damage.

Please do not hesitate to contact Mr Paul Gray or myself if we can be of further assistance.

Yours faithfully

Mr G J Cole-Clark
Chief Executive Officer

Cc P Gray

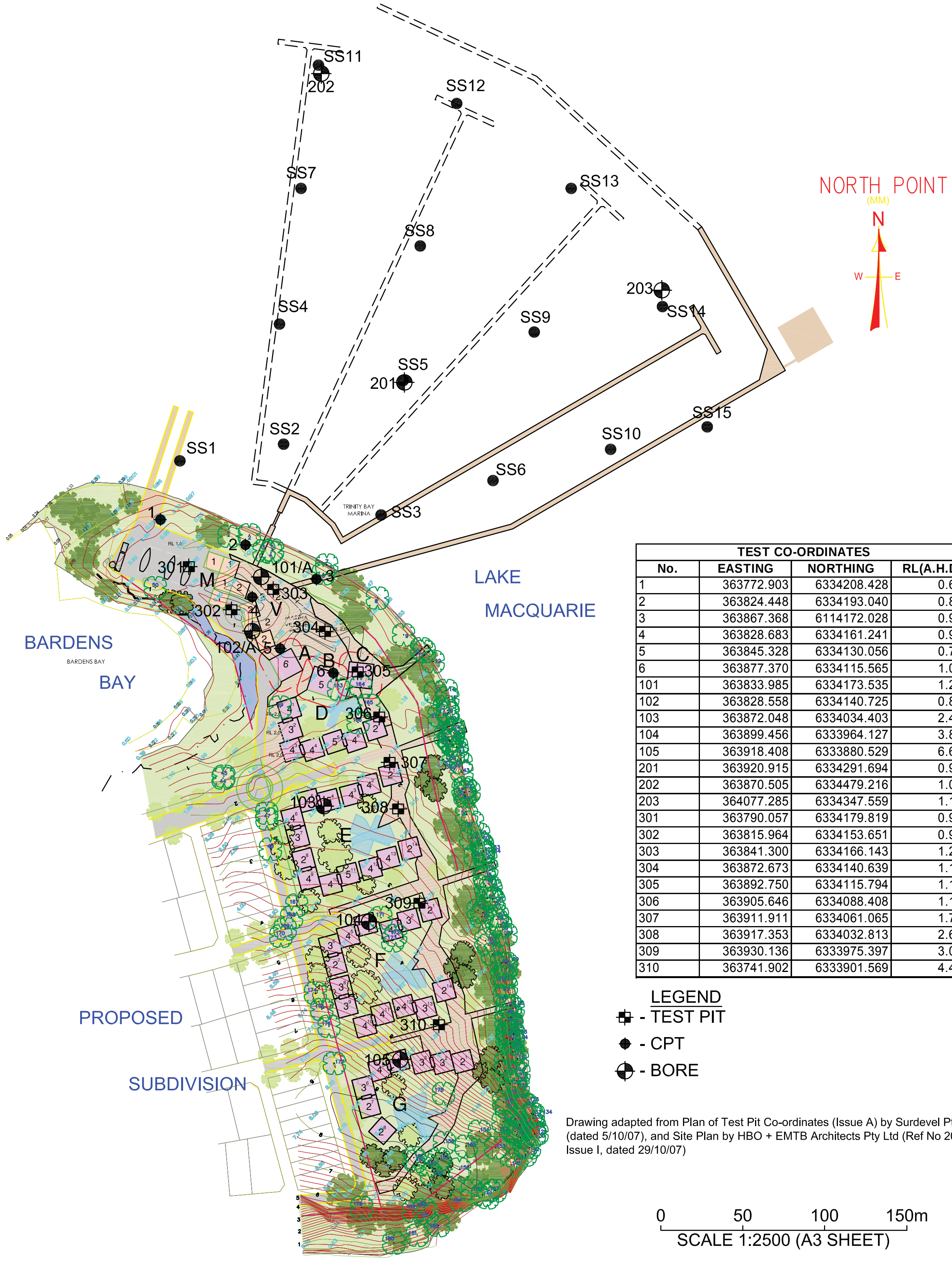


Douglas Partners
Geotechnics Environment Groundwater

Sydney, Newcastle, Brisbane,
Melbourne, Perth, Wyong,
Campbelltown, Townsville,
Cairns, Wollongong, Darwin

TITLE: LOCALITY PLAN
PROPOSED TRINITY POINT MARINA & TOURIST RESORT
49 LAKEVIEW ROAD, MORISSET PARK

CLIENT: JOHNSON PROPERTY GROUP PTY LTD
DRAWN BY: PLH
SCALE: NTS
PROJECT No: 39823
OFFICE: NEWCASTLE
APPROVED BY:
DATE:
DRAWING No: 1



TEST CO-ORDINATES			
No.	EASTING	NORTHING	RL(A.H.D)
1	363772.903	6334208.428	0.665
2	363824.448	6334193.040	0.810
3	363867.368	6114172.028	0.920
4	363828.683	6334161.241	0.985
5	363845.328	6334130.056	0.775
6	363877.370	6334115.565	1.050
101	363833.985	6334173.535	1.270
102	363828.558	6334140.725	0.885
103	363872.048	6334034.403	2.465
104	363899.456	6333964.127	3.820
105	363918.408	6333880.529	6.620
201	363920.915	6334291.694	0.990
202	363870.505	6334479.216	1.005
203	364077.285	6334347.559	1.100
301	363790.057	6334179.819	0.960
302	363815.964	6334153.651	0.965
303	363841.300	6334166.143	1.205
304	363872.673	6334140.639	1.160
305	363892.750	6334115.794	1.145
306	363905.646	6334088.408	1.115
307	363911.911	6334061.065	1.775
308	363917.353	6334032.813	2.600
309	363930.136	6333975.397	3.000
310	363741.902	6333901.569	4.400

LEGEND

⊞ - TEST PIT

● - CPT

⊕ - BORE

Drawing adapted from Plan of Test Pit Co-ordinates (Issue A) by Surdevel Pty Ltd (dated 5/10/07), and Site Plan by HBO + EMTB Architects Pty Ltd (Ref No 202669, Issue I, dated 29/10/07)

0 50 100 150m

SCALE 1:2500 (A3 SHEET)

Douglas Partners
Geotechnics Environment Groundwater

Sydney, Newcastle,
Brisbane, Melbourne,
Perth, Wyong,

Wollongong, Campbelltown,
Townsville, Cairns, Darwin

TITLE: TEST LOCATION PLAN - GEOTECHNICAL INVESTIGATION
PROPOSED TRINITY POINT MARINA AND TOURIST DEVELOPMENT
49 LAKEVIEW ROAD, MORISSET PARK

CLIENT: JOHNSON PROPERTY GROUP PTY LTD
OFFICE: NEWCASTLE
DRAWN BY: PLH
SCALE: 1:2500
PROJECT No. 39823
APPROVED BY:
DATE:
DRAWING No: 2

APPENDIX C

REPORT ON ACID SULFATE SOILS INVESTIGATION

Cardno® Geotech Solutions
Shaping the Future

Douglas Partners
Geotechnics • Environment • Groundwater

Integrated Practical Solutions

ACID SULPHATE SOIL ASSESSMENT

PROPOSED TRINITY POINT MARINA AND TOURIST DEVELOPMENT
49 LAKEVIEW ROAD, MORISSET PARK

Prepared for
JOHNSON PROPERTY GROUP PTY LTD

Project 39823A
DECEMBER 2007

ACID SULPHATE SOIL ASSESSMENT

PROPOSED TRINITY POINT MARINA AND TOURIST DEVELOPMENT
49 LAKEVIEW ROAD, MORISSET PARK

Prepared for

JOHNSON PROPERTY GROUP PTY LTD

Project 39823A

DECEMBER 2007

Douglas Partners Pty Ltd
ABN 75 053 980 117

Box 324
Hunter Region Mail Centre
NSW 2310 Australia

15 Callistemon Close
Warabrook, NEWCASTLE

Phone: 02 4960 9600
Fax: 02 4960 9601
newcastle@douglaspartners.com.au

TABLE OF CONTENTS

ATTACHMENTS

Notes Relating to this Report
Sample Record Sheet (SS1 to SS15)
Borehole Logs – Bores 101 to 105, and 201 to 203)
Test Pit Logs – Pits 301 to 310
Laboratory Test Results
Drawing 1 – Locality Plan
Drawing 2 – Test Location Plan

JAW:kd
Project No: 39823A
P:\39823A\Docs\39823A.doc
4 December 2007

ACID SULPHATE SOIL ASSESSMENT
PROPOSED TRINITY POINT MARINA AND TOURIST DEVELOPMENT
49 LAKEVIEW ROAD, MORISSET PARK

---

1. INTRODUCTION

This report presents the results of an acid sulphate soil assessment at the site of the proposed Trinity Point Marina and Tourist Development, located at 49 Lakeview Drive, Morisset Park (Lot 31, Part Lot 32 and Part Lot 33, DP 1117408). The work was carried out for Johnson Property Group Pty Ltd.

This acid sulphate assessment includes the lake bed sediments as well the on-land portions of the site.

The project is subject to other reports currently underway by Douglas Partners Pty Ltd (DP) which includes a geotechnical assessment and geochemical analysis within the proposed marina. A draft waste classification report was recently completed for the northern part of the site.

2. PROPOSED DEVELOPMENT

2.1 General

The Trinity Point Marina and Tourist Resort comprises a number of components, including the Marina, Marina Village and clusters of multi-storey accommodation buildings (Blocks A to G).

The Marina and Marina Village development will include an approximately 300 berth marina, along with an associated breakwater, boat maintenance facilities (travel lift, hardstand and workshop), and other related commercial infrastructure such as café, restaurant and function facilities.

Immediately south of the Marina Village is a cluster of multi storey buildings, up to six stories in height for short to medium term tourist accommodation. These areas are shown as Blocks A, B, C and D on the attached Drawing 2. These buildings will include under-croft car parking.

Another three clusters of multi-storey accommodation buildings are located further to the south (shown as Blocks E, F and G on attached Drawing 2). These three clusters comprise apartment style accommodation, in two to five storey buildings, associated car parking (underground parking), access roadways, footpaths, boardwalks, jetties and landscaping.

2.2 Proposed Marina Village Centre and Floating Marina Berths

The proposed marina and village centre will include a 308 berth marina consisting of up to four arms of floating pontoons, a floating helipad pontoon, marina administration offices, a breakwater, a travel lift with associated hardstand area for boat repairs and maintenance, and a workshop. It is understood that the marina has been configured to avoid any dredging.

The marina will comprise a system of floating walkways, and associated berths. The floating walkways would be located between vertical piles driven into the lake bed. It is understood that the preferred pile type is tubular steel piles.

The marina will incorporate a breakwater around the southern and eastern boundaries. The proposed breakwater will consist of two rows of parallel tubular steel piles driven in to the lake bed, with timber slats supported on outer side of each row of piles. The breakwater will also have a timber walkway, allowing access around the perimeter of the marina, and for access to the helipad.

The helipad will be an approximately 25 m by 25 m floating steel pontoon anchored to the lake bed, with an access gangway directly from the breakwater walkway. The current preference is that the anchors would be steel piles driven into the lake bed similar to piles for the breakwater and pontoons, however the piles would be cut off at the lake bed level.

In addition to the marina, there will be an associated on-shore village centre incorporating a café, restaurant, function centres, chandlery, general store and commercial offices.

2.3 Proposed Tourist/Accommodation Development

The southern portion of the site will incorporate apartment style accommodation (serviced tourist and permanent residential) with two to five storey buildings arranged in a series of three building clusters (Blocks E, F and G), with basement car parking proposed.

2.4 Pavements

Proposed pavement areas for the site include access roads and parking areas. It is understood that the majority of parking proposed for Blocks A to D will be offered via under-croft parking beneath the proposed multi-storey buildings. It is understood that the under-croft parking in this area of the site will be at about RL 1.2 (AHD).

The buildings within Blocks E, F and G will include basement car parking with preliminary basement floor levels ranging from 0.35 m to 4.85 m AHD.

2.5 Cut/Fill

Preliminary levels for under-croft car parking and basement car parking floor levels suggest approximate cut and fill depths could be in the order of the following:

Building Cluster	Approximate Ground Surface Level (AHD)	Preliminary Under-croft/Basement Floor Level (AHD)	Preliminary Approx Fill Depth (m)	Preliminary Approx Excavation Depth (m)
A	0.8	1.2	0.4	-
B	0.9	1.2	0.3	-
C	0.9	1.2	0.3	-
D	0.9 – 1.9	1.2	0.3	0.7
E	1.6 – 3.4	0.35	-	1.25 – 3.05
F	2.6 – 6.8	1.65 to 3.53	-	0.95 – 3.29
G	4.0 – 8.5	4.85	0.85	3.65

It is anticipated that excavations could also be required for installation of utilities, and also for swimming pool construction, although the final locations of these features are unknown at this time.

3. SITE DESCRIPTION AND REGIONAL GEOLOGY

The site is located to the north of, and on, Bluff Point on the Morisset Peninsula of the western shores of Lake Macquarie. The site is described as 49 Lakeview Road (Lot 31, Part Lot 32 and Part Lot 33, DP 1117408), Morisset Park. A plan showing the approximate location of the site is shown on Drawing 1, attached.

It is understood that the site used to contain several buildings, however these have been demolished. At the time of the investigation, the site was grassed with several stands of mature trees, particularly along the shoreline. Several stockpiles of building rubble and vegetation were located towards the southern part of the site.

Site elevations range from water level in the northern and eastern parts of the site up to about 8.5 m (AHD) at the southern end, which is known as Bluff Point. The site is relatively level in the northern part, where the marina is to be constructed, and slopes up to the high point at about 2° to 6°.

The following photographs show the general site area at the time of the investigation.

Photo 1 – set up on Bore 101, in the area of the proposed marina village

Photo 2 – view of site from the Lake

Photo 3 – looking south towards the crest of Bluff Point, from the area of the proposed tourist village

Reference to the 1:100,000 Newcastle Coalfield Geological series sheet indicates that the site is underlain the Narabeen Group of rocks. The Narabeen Group includes both the Terrigal Formation and the Clifton Subgroup. The Terrigal Formation typically includes sandstone and siltstone, while the Clifton Subgroup typically includes conglomerate, sandstone, siltstone and claystone.

4. FIELD WORK

4.1 Methods

The field work was undertaken on 3 October 2007, and comprised the backhoe excavation of ten test pits to depths of up to 3 m (Pits 301 to 310). In addition, seven on-land test bores (Bores 101 to 105, 101A and 102A), three over-water test bores (Bores 201 to 203) and collection of 15 samples of lake bed sediment (Samples SS1 to SS15) were undertaken during various other phases of the consultancy services for this project. The results from this other work have been included, where relevant.

The tests were set out by a geoenvironmental engineer from DP who also logged the subsurface profile in each pit and took regular samples for laboratory testing and identification purposes. Pocket penetrometer and dynamic cone penetrometer tests were performed at selected depths and locations.

All test locations were set out by measuring from existing site features. The pits were staked on completion and subsequently surveyed by project surveyors, SurDevel Pty Ltd. The locations of the pits are indicated on attached Drawing 2.

4.2 Results

The subsurface conditions encountered are presented in detail in the attached sample record sheet, borehole logs and test pit logs. These should be read in conjunction with the general notes preceding them, which explain the descriptive terms and classification methods used in the reports.

In general, the lake bed sediments comprised a mixture of sand, silt and clay in varying proportions. The over-water bores (Bores 201 to 203) encountered soft lake sediment which ranged in thickness from about 1.7 m to 3.0 m. The underlying soils generally comprised clay, gravelly clay and clayey sand, which was in turn underlain by bedrock at depths which ranged from 5.8 m to 7.9 m below the lake bed.

Bores 101/A and 102/A, and Pits 301 to 306 generally encountered sandy soils with variable proportions of clay, silt and gravel to depths of about 5 m. In the bores, the sandy soils were underlain by clay, sandy clay and gravelly clay. Rock was encountered in the bores at depths of 12.8 m and 11.4 m respectively.

Bores 103 to 105, and Pits 307 to 310 generally encountered filling (with the exception of Pit 309) to depths of up to 1.15 m over generally sandy and clayey soils. The clay in Pit 309 graded to clayey sand/extremely weathered sandstone below about 1.0 m, and backhoe refusal was encountered at 1.8 m depth. Rock was also encountered in Bores 104 and 105, with pebbly sandstone encountered below 4.2 m in Bore 104, and residual clay grading to an extremely low strength conglomerate below 4 m in Bore 105.

In addition, a sulphurous odour was observed during excavation of two of the test pits. This can be an indicator of acid sulphate conditions.

Groundwater seepage was encountered in seven of the 10 test pits during field work. It should be noted that the pits were only open for a relatively short period of time, and hence the groundwater observations in the pits are not necessarily representative of static water levels. Monitoring wells were installed in the seven on-land test bores, allowing additional groundwater measurements.

The following table summarises the groundwater observations made during field work.

Table 1 – Summary of Groundwater Observations

Location	Approximate Surface Level (AHD)	Depth to Groundwater Seepage During Field Work (m)
301	0.96	1.5
302	0.97	1.3
303	1.21	1.4
304	1.16	1.0
305	1.15	1.0
306	1.12	1.1
307	1.78	1.5
308	2.6	Not encountered
309	3.0	Not encountered
310	4.4	Not encountered

Other field work undertaken on the site during the same period, including measurements in groundwater monitoring wells, indicated groundwater levels in the ranges shown in Table 2, below. Groundwater pH and EC were also measured in the wells, with the results summarised in Table 3:

Table 2 – Summary of Groundwater Measurements in Bores

Bore	Approximate Surface Level (AHD)	Range of Groundwater Levels Observed (AHD)
101	1.27	0.07
101A	1.27	0.05 to 0.12
102	0.89	0.0 to 0.23
102A	0.89	-0.1 to 0.1
103	2.47	0.84 to 0.96
104	3.82	0.9 to 1.0
105	6.62	Dry

Table 3 – Summary of Groundwater pH and EC Ranges in Bores

Bore	Observed pH Ranges	Observed EC Ranges (mS/cm)
101	7.1 to 7.3	1.7 to 3.8
101A	7.2 to 7.7	0.6 to 0.8
102	6.8 to 7.3	8.7 to 2.1
102A	7.4 to 7.7	1.2 to 2.1
103	5.0	0.6
104	4.1 to 4.2	5.6 to 6.8
105	Bore dry	Bore dry

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

5. ACID SULPHATE SOIL ASSESSMENT

5.1 Methods

An acid sulphate soil assessment was undertaken with reference to the ASSMAC "Acid Sulphate Soils Manual" (Ref 1) and QASSIT "Soil Management Guidelines" (Ref 2), and comprised the following:

- review of available acid sulphate risk maps;
- 57 screening tests on selected soil samples from the on-land test pits for pH in water (pH_F) and pH in hydrogen peroxide (pH_{FOX});
- 25 screening tests on selected samples of lake bed sediment, and soil from the over water bores for pH in water (pH_F) and pH in peroxide (pH_{FOX});
- 12 samples tested for more detailed acid sulphate testing, comprising either full chromium suite or POCAS testing to assess acid sulphate potential.

Samples collected for the assessment of acid sulphate soil conditions were wrapped in plastic wrap and plastic bags to exclude air, and stored and transported on ice. Samples were then refrigerated in the DP laboratory.

5.2 Published Data

Reference to the DLWC Acid Sulphate Soil Risk Maps for Swansea and Catherine Hill Bay indicate that the northern part of the site lies in area with a high probability of acid sulphate soil conditions within 1 m of the ground surface. The southern part of the site is located in an area mapped as having no known occurrence of acid sulphate soils.

In addition, there is a high probability of the occurrence of acid sulphate soils within the lake bed sediments of the adjoining portions of Lake Macquarie.

5.3 Laboratory Testing

Laboratory testing comprised 79 acid sulphate screening tests on samples collected from the test pits (57) and also lake bed sediments (22) collected during earlier field work. The results of the screening tests are presented in Tables 4 and 5, below.

Table 4 – Results of Acid Sulphate Soil Screening Tests – On-land Soils

Pit	Sample Depth[a] (m)	Approx Sample RL (m AHD)	Sample Description	Screening Test Results		
				pH_F	pH_{FOX}	pH_F - pH_{FOX}
301	0.1	0.86	Silty sand	5.8	4.0	**1.8**
	0.5	0.46	Sand	6.2	5.6	0.6
	1.0	-0.04	Clayey sand	6.5	**2.4**	**4.1**
	1.5	-0.54	Clayey sand	6.5	**2.2**	**4.3**
	2.0	-1.04	Clayey sand	6.8	**2.3**	**4.5**
	2.5	-1.54	Gravelly sand	7.2	3.9	**3.3**
302	0.1	0.87	Silty sand	7.1	4.0	**3.1**
	0.5	0.47	Sand	7.1	5.7	**1.4**
	1.0	-0.03	Clayey sand	7.2	6.3	0.9
	1.5	-0.53	Clayey sand	7.3	**2.2**	**5.1**
	2.0	-1.03	Clayey sand	7.2	**2.1**	**5.1**
	2.5	-1.53	Clayey sand	7.2	**2.2**	**5.0**
303	0.1	1.11	Silty sand	5.8	4.6	**1.2**
	0.5	0.71	Sand	6.0	5.4	0.6
	1.0	0.21	Clayey sand	6.2	5.9	0.3
	1.5	-0.29	Clayey sand	6.4	**2.1**	**4.3**
	2.0	-0.79	Gravelly sand	6.0	**2.7**	**3.3**
	2.5	-1.29	Gravelly sand	5.7	**2.6**	**3.1**
304	0.1	1.06	Silty sand	6.0	3.6	**2.4**
	0.5	0.66	Sand	6.0	5.7	0.3
	1.0	0.16	Sandy gravel	5.9	4.5	**1.4**
	1.5	-0.34	Gravelly clayey sand	4.2	**2.3**	**1.9**
	2.0	-0.84	Sandy gravel	4.6	**2.3**	**2.3**
305	0.1	1.05	Silty sand	5.2	4.7	0.5
	0.5	0.65	Gravelly sand	5.8	5.2	0.6
	1.0	0.15	Gravelly sand	6.0	5.3	0.7
	1.5	-0.35	Gravelly sand	5.5	**2.4**	**3.1**
	2.0	-0.85	Sand	4.7	**2.1**	**2.6**

Table 4 – Results of Acid Sulphate Soil Screening Tests – On-land Soils (continued)

Pit	Sample Depth[a] (m)	Approx Sample RL (m AHD)	Sample Description	Screening Test Results		
				pH_F	pH_{FOX}	$pH_F - pH_{FOX}$
306	0.1	1.02	Silty sand	5.1	**3.4**	**1.7**
	0.5	0.62	Gravelly sand	5.5	5.3	0.2
	1.0	0.12	Gravelly sand	5.2	3.8	**1.4**
	1.5	-0.38	Gravelly sand	4.5	**2.7**	**1.8**
	2.0	-0.88	Gravelly sand	4.9	**2.3**	**2.6**
307	0.1	1.68	Filling – sandy silt	5.5	**3.3**	**2.2**
	0.5	1.28	Filling – sandy silt	5.4	3.9	**1.5**
	1.0	0.78	Clayey gravelly sand	4.9	4.4	0.5
	1.5	0.28	Clayey gravelly sand	5.8	4.3	**1.5**
	2.0	-0.22	Clayey sand	5.3	4.2	**1.1**
	2.5	-0.72	Silty clay	4.1	4.0	0.1
	3.0	-1.22	Silty clay	4.6	4.4	0.2
308	0.1	2.5	Filling – silty clayey sand	5.7	**3.0**	**2.7**
	0.5	2.1	Silty sand	5.2	4.4	0.8
	1.0	1.6	Sand	5.6	5.0	0.6
	1.5	1.1	Sandy clay	5.3	4.6	0.7
	2.0	0.6	Sandy clay	4.5	4.5	0.0
	2.5	0.1	Sandy clay	4.3	4.0	0.3
	3.0	-0.4	Silty clay	**3.9**	3.5	0.4
309	0.1	2.9	Silty sand	5.8	4.6	**1.2**
	0.5	2.5	Silty sand	5.9	5.4	0.5
	1.0	2.0	Silty sandy clay	5.4	5.0	0.4
	1.5	1.5	Silty sandy clay	5.3	4.8	0.5
310	0.1	4.3	Filling – sandy clay	5.3	4.2	**1.1**
	0.5	3.9	Filling – sandy clay	6.5	6.7	-0.2
	1.0	3.4	Sandy clay	7.1	6.3	0.8
	1.5	2.9	Sandy clay	5.0	4.5	0.5
	2.0	2.4	Sandy clay	4.8	4.8	0.0
	2.5	1.9	Sandy clay/clayey sand	4.7	4.5	0.2
ASSMAC and QASSIT Action Criteria				<4[b]	<3.5[c]	≥1.0[c]

Notes to Table 4:

a Depth below ground surface
b For actual acid sulphate soils (ASS)
c Indicative value only for Potential Acid Sulphate Soils (PASS)
Shaded and Bold results indicate an exceedence of ASSMAC and QASSIT criteria (Refs 1 and 2)
NA – Not applicable

Table 5 – Results of Acid Sulphate Soil Screening Tests – Lake Bed Sediment and Soil

Sample Location	Sample Depth[a] (m)	Approx Sample RL (m AHD)	Sample Description	Screening Test Results		
				pH_F	pH_{FOX}	$pH_F - pH_{FOX}$
SS1	0 – 0.3	Not measured	Silty clayey sand	7.2	4.9	**2.3**
SS2	0 – 0.3	Not measured	Silty clayey sand	7.5	5.0	**2.5**
SS3	0 – 0.3	Not measured	Silty sand / sandy silt	7.6	5.1	**2.5**
SS4	0 – 0.3	Not measured	Silty sand / sandy silt	7.6	6.3	**1.3**
SS5	0 – 0.3	Not measured	Silty sand / sandy silt	7.9	6.3	**1.6**
SS6	0 – 0.3	Not measured	Silty sand / sandy silt	8.0	6.0	**2.0**
SS7	0 – 0.3	Not measured	Sandy clayey silt	7.8	6.5	**1.3**
SS8	0 – 0.3	Not measured	Sandy clayey silt	7.7	6.5	**1.2**
SS9	0 – 0.3	Not measured	Sandy silty clay	7.7	6.4	**1.3**
SS10	0 – 0.3	Not measured	Sandy silty clay	7.7	6.5	**1.2**
SS11	0 – 0.3	Not measured	Sandy silty clay	7.8	6.3	**1.5**
SS12	0 – 0.3	Not measured	Sandy silty clay	8.0	6.5	**1.5**
SS13	0 – 0.3	Not measured	Sandy silty clay	7.8	6.8	**1.0**
SS14	0 – 0.3	Not measured	Sandy silty clay	7.8	6.9	0.9
SS15	0 – 0.3	Not measured	Sandy silty clay	7.8	6.5	**1.3**
201	1.0	-6.86	Sandy silt/silty sand	7.7	6.1	**1.6**
	2.4	-8.26	Silty clay	7.0	6.9	0.1
	3.9	-9.76	Silty clay	5.0	4.5	0.5
	5.5	-11.36	Sand	5.2	4.6	0.6
202	2.5	-7.65	Gravelly silty clay	7.4	7.1	0.6
203	4.5	-9.85	Clay	6.9	7.3	-0.4
	6.5	-11.85	Gravelly clay	5.1	4.5	0.6
ASSMAC and QASSIT Action Criteria				<4[b]	<3.5[c]	≥1.0[c]

Notes to Table 5:

a Depth below lake bed
b For actual acid sulphate soils (ASS)
c Indicative value only for Potential Acid Sulphate Soils (PASS)
Shaded and Bold results indicate an exceedence of ASSMAC and QASSIT criteria (Refs 1 and 2)
NA – Not applicable

The ASSMAC and QASSIT guidelines suggest that a soil $pH_F<4$ in water is an indicator of actual acid sulphate soils. The results of screening tests therefore indicate the absence of actual acid sulphate soils at the locations and depths tested, although one sample did return a pH_F of marginally less than 4 (Pit 308/3.0 m).

The ASSMAC and QASSIT guidelines also suggest that indicators of potential acid sulphate soils (PASS) include the following:

- soil pH <3.5 in H_2O_2 (ie. pH_{FOX}), but preferably less than 3.0;
- drop of 1 pH unit or more between pH_F and pH_{FOX}.

34 of the samples tested exhibited a pH drop of greater than one unit and of these, 18 samples also exhibited a soil pH following oxidation below 3.5.

It is noted that the above test method is a qualitative method only and gives an indication of the intensity of total acidification (pH). The ASSMAC guidelines indicate that peroxide may also oxidise organic matter (in addition to pyrite) to produce acids which are unlikely to form under natural conditions, thus giving a falsely high indication of acid sulphate potential.

Based on the results of the screening tests, 12 soil samples were selected for detailed laboratory testing, comprising either the Full Chromium Suite or POCAS testing in accordance with the ASSMAC and QASSIT guidelines (Refs 1, 2 and 3).

Detailed test results are contained in the attached laboratory report sheets, and are summarised in Table 6, below.

Table 6 – Summary of Detailed Acid Sulphate Soil Testing

Location	Sample Depth[a] (m)	Approximate Sample RL (m AHD)	Sample Description	Laboratory Results						
				pH_{KCL}	s-TAA %S	s-TPA %S	s-TSA %S	Scr (%)	s-ANC$_E$ %S	Net Acidity[b] %S
SS2	0 – 0.3	NM	Silty clayey sand	7.4	<0.01	-	-	0.23	0.32	0.01
SS3	0 – 0.3	NM	Silty sand / sandy silt	8.1	<0.01	-	-	0.64	1.9	<0.01
201	3.9	-9.76	Silty clay	4.7	0.03	0.02	<0.01	-	<0.01	0.03
203	6.5	-11.85	Gravelly clay	5.7	0.02	<0.01	<0.01	-	<0.01	0.02
301	0.5	0.46	Sand	5.9	<0.01	<0.01	<0.01	-	<0.01	<0.01
	1.0	-0.04	Clayey sand	5.6	0.01	0.65	0.64	-	<0.01	**0.72**
	1.5	-0.54	Clayey sand	5.8	<0.08	0.26	0.26	-	<0.01	**0.20**
302	2.0	-1.04	Clayey sand	8.2	<0.01	0.15	0.15	-	<0.01	**0.45**
306	2.0	-0.85	Gravelly sand	4.9	0.05	0.74	0.69	-	<0.01	**0.72**
307	2.5	-0.725	Silty clay	4.5	0.08	0.09	0.02	-	<0.01	**0.08**
308	0.1	2.5	Filling – silty clayey sand	5.3	0.02	<0.01	<0.01	-	<0.01	0.02
	3.0	-0.4	Silty clay	4.6	0.07	0.07	<0.01	-	<0.01	**0.07**
ASSMAC and QASSIT Action Criteria (Refs 1 and 2)				Coarse texture (sand)						0.03[c]/0.03[d]
				Medium texture – sandy loams						0.06[c]/0.03[d]
				Fine texture – medium to heavy clays						0.1/0.03[d]

Notes to Table 6:

a Depth below ground surface or lake bed, as appropriate
b Calculated from ABA equation in ASS Laboratory Methods Guidelines (Ref 3)
c Action criteria for less than 1000 tonnes of soil disturbed
d Action Criteria for more than 1000 tonnes disturbed
Shaded and bold results indicate an exceedence of ASSMAC and QASSIT criteria (Refs 1 and 2) for more than 1000 tonnes disturbed
NM – Not measured

6. COMMENTS

The results of detailed laboratory testing indicate the presence of actual and potential acid sulphate soils at the site.

Based on the results of this assessment, the proposed development will need to consider the presence of acid sulphate soils, particularly in the low-lying portions of the on-land marina development.

Of the on-land soil samples tested, four of the eight samples exceed the action criteria for the situation where less than 1000 tonnes of soil is excavated. If however the results are compared to the criteria for when more than 1000 tonnes of soil is excavated, then the number of samples exceeding the action criteria increases to six of the eight samples.

Therefore, all excavations within the low lying portions of the site covering the Marina, Marina Village and Blocks A, B, C and D have the potential to disturb acid sulphate soils. Excavations in these areas should be undertaken with specific reference to an Acid Sulphate Soil Management Plan. Treatment typically includes neutralising the soil by mixing with lime.

It is understood that dredging is not proposed in the marina area, and that driven piles will be utilised. Therefore, the current project proposal does not indicate that lake bed sediments will be exposed to oxidising conditions during construction.

Dewatering of excavations, if required, also has the potential to oxidise acid sulphate soils, and will also need to be undertaken with reference to an Acid Sulphate Management Plan.

It is considered possible that excavations within some of the other areas of the site could also encounter acid sulphate soils, eg. the basement excavation to RL 0.15 for Block E. The risk is likely to diminish as surface elevations increase to the south. However, it is recommended that additional targeted acid sulphate soil investigations be undertaken during the design stage of the project to further delineate the presence of acid sulphate soils.

7. LIMITATIONS

Conditions on site different to those identified during this assessment may exist. Therefore Douglas Partners Pty Ltd (DP) cannot provide unqualified warranties nor does DP assume any liability for site conditions not recorded in the data available for this assessment.

This report and associated documentation and the information herein have been prepared solely for the use of Johnson Property Group Pty Ltd. Any reliance on this report assumed by other parties shall be at such party's own risk. Any ensuing liability resulting from use of the report by other parties cannot be transferred to DP.

DOUGLAS PARTNERS PTY LTD

Reviewed by:

Julie Wharton
Associate

John Harvey
Principal

REFERENCES

1. New South Wales Acid Sulphate Soil Management Advisory Committee "Acid Sulphate Soil Manual", August 1998.

2. Dear SE, Moore NG, Dobos SK, Watling KM and Ahern CR "Soil Management Guidelines" in "Queensland Acid Sulphate Soil Technical Manual", Department of Natural Resources and Mines, November 2002.

3. Ahern CR, Sullivan LA, McElnea AE "Acid Sulphate Soils Laboratory Methods Guidelines" in "Queensland Acid Sulphate Soil Technical Manual", Department of Natural Resources and Mines, June 2004.

Douglas Partners
Geotechnics · Environment · Groundwater

NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring 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.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT “N” Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling 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 with 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.

Details of the type and method of sampling are given in the report.

Drilling Methods.

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

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of 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 sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole 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 in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water 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 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength 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 short of full penetration, 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 tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6) \text{ N (blows per 300 mm)}$$

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

$$q_c = (12 \text{ to } 18)\ c_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. 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 relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is 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.

Bore Logs

The bore logs presented herein 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. 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 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, the frequency of sampling and the possibility of other than ‘straight line’ variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it 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.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations 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.

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 (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). 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 condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

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

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, the Company requests that it immediately be notified. Most problems are much 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.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical 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.

AN ENGINEERING CLASSIFICATION OF SEDIMENTARY ROCKS IN THE SYDNEY AREA

This classification system provides a standardized terminology for the engineering description of the sandstone and shales in the Sydney area, but the terms and definitions may be used elsewhere when applicable.

Under this system rocks are classified by Rock Type, Degree of Weathering, Strength, Stratification Spacing, and Degree of Fracturing. These terms do not cover the full range of engineering properties. Descriptions of rock may also need to refer to other properties (e.g. durability, abrasiveness, etc.) where these are relevant.

ROCK TYPE DEFINITIONS

Rock Type	Definition
Conglomerate:	More than 50% of the rock consists of gravel sized (greater than 2mm) fragments
Sandstone:	More than 50% of the rock consists of sand sized (.06 to 2mm) fragments
Siltstone:	More than 50% of the rock consists of silt-sized (less than 0.06mm) granular particles and the rock is not laminated
Claystone:	More than 50% of the rock consists of clay or sericitic material and the rock is not laminated
Shale:	More than 50% of the rock consists of silt or clay sized particles and the rock is laminated

Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, e.g. clayey sandstone, sandy shale.

DEGREE OF WEATHERING

Term	Symbol	Definition
Extremely Weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - i.e. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly Weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately Weathered	MW	Rock substance affected by weathering to the extent that staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is no longer recognisable.
Slightly Weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	Fs	Rock substance unaffected by weathering, limonite staining along joints.
Fresh	Fr	Rock substance unaffected by weathering.

STRATIFICATION SPACING

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

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics (Reference).

Strength Term	Is(50) MPa	Field Guide	Approx. qu MPa*
Extremely Low:	0.03	Easily remoulded by hand to a material with soil properties	0.7
Very Low:	0.1	May be crumbled in the hand. Sandstone is “sugary” and friable.	2.4
Low:	0.3	A piece of core 150 mm long x 50 mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	7
Medium:	1	A piece of core 150 mm long x 50 mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.	24
High:	3	A piece of core 150 mm long x 50 mm dia. cannot be broken by unaided hands, can be slightly scratched or scored with knife.	70
Very High:	10	A piece of core 150 mm long x 50 mm dia. may be broken readily with hand held hammer. Cannot be scratched with pen knife.	240
Extremely High:		A piece of core 150 mm long x 50 mm dia. is difficult to break with hand held hammer. Rings when struck with a hammer.	

* The approximate unconfined compressive strength (qu) shownin the table is based on an assumed ratio to the point load index of 24:1. This ratio may vary widely.

DEGREE OF FRACTURING

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but exclude known artificial fractures such as drilling breaks

Term	Description
Fragmented:	The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than the core diameter.
Highly Fractured:	Core lengths are generally less than 20 mm - 40 mm with occasional fragments.
Fractured:	Core lengths are mainly 30 mm - 100 mm with occasional shorter and longer sections.
Slightly Fractured:	Core lengths are generally 300 mm - 1000 mm with occasional longer sections and occasional sections of 100 mm - 300 mm.
Unbroken:	The core does not contain any fracture.

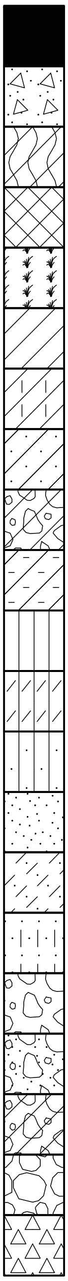
REFERENCE

International Society of Rock Mechanics, Commission on Standardisation of Laboratory and Field Tests, Suggested Methods for Determining the Uniaxial Compressive Strength of Rock Materials and the Point Load Strength Index, Committee on Laboratory Tests Document No. 1 Final Draft October 1972

Log!GRAPHIC-SYMBOLS 24/11/2003 4:38:57 PM

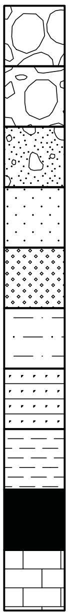
GRAPHIC SYMBOLS FOR SOIL & ROCK

SOIL



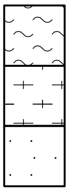
- BITUMINOUS CONCRETE
- CONCRETE
- TOPSOIL
- FILLING
- PEAT
- CLAY
- SILTY CLAY
- SANDY CLAY
- GRAVELLY CLAY
- SHALY CLAY
- SILT
- CLAYEY SILT
- SANDY SILT
- SAND
- CLAYEY SAND
- SILTY SAND
- GRAVEL
- SANDY GRAVEL
- CLAYEY GRAVEL
- COBBLES/BOULDERS
- TALUS

SEDIMENTARY ROCK



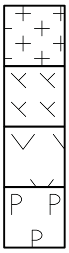
- BOULDER CONGLOMERATE
- CONGLOMERATE
- CONGLOMERATIC SANDSTONE
- SANDSTONE FINE GRAINED
- SANDSTONE COARSE GRAINED
- SILTSTONE
- LAMINITE
- MUDSTONE, CLAYSTONE, SHALE
- COAL
- LIMESTONE

METAMORPHIC ROCK



- SLATE, PHYLITTE, SCHIST
- GNEISS
- QUARTZITE

IGNEOUS ROCK



- GRANITE
- DOLERITE, BASALT
- TUFF
- PORPHYRY

Douglas Partners
Geotechnics · Environment · Groundwater

SAMPLE RECORD

CLIENT: Johnson Property Group Pty Ltd

DATE: 25.9.07

PROJECT: Proposed Trinity Point Marina

PROJECT NO: 39823A

LOCATION: Morisset Park, Lake Macquarie

Sample No	Container Type	Sample/Material Description	PID Reading (ppm)	Depth of Water at Time of Sampling (m)
SS1	2 jars and 1L bag and snap lock	Dark grey silty clayey sand, trace shell	1.1	1.8
SS2	2 jars and 1L bag and snap lock	Dark grey fine to medium grained silty clayey sand	0.8	3.3
SS3	2 jars and 1L bag and snap lock 2L water	Dark grey low plasticity silty sand/sandy silt, some clay	1.1	3.3
SS4	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity silty sand/sandy silt, some clay	0.9	4.1
SS5/QA1	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity silty sand/sandy silt, some clay	1.1	4.8
SS6	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity silty sand/sandy silt, some clay	1.1	4.2
SS7	2 jars, 1L bag and snap lock and 2L water	Dark grey sandy clayey silt with trace shells	1.7	5.1
SS8	2 jars, 1L bag and snap lock and 2L water	Dark grey sandy clayey silt with trace shells	1.2	5.2
SS9	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity sandy silty clay, trace shells	0.8	5.3
SS10	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity sandy silty clay, trace shells	1.2	5.4
SS11	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity sandy silty clay, trace shells	0.9	5.1
SS12	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity sandy silty clay, trace shells	1.3	5.2
SS13	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity sandy silty clay, trace shells	1.2	5.3
SS14	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity sandy silty clay, trace shells	1.2	5.3
SS15	2 jars, 1L bag and snap lock and 2L water	Dark grey low plasticity sandy silty clay, trace shells	0.8	5.4

P:\39823A\Field\39823A - record of samples.doc

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: 1.27 AHD
EASTING: 363834
NORTHING: 6334174
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 39823
DATE: 26/9/07
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering EW HW MW SW FS FR	Graphic Log	Rock Strength Ex Low, Very Low, Low, Medium, High, Very High, Ex High	Water	Fracture Spacing (m) 0.01 0.05 0.10 0.50 1.00	Discontinuities B - Bedding J - Joint S - Shear D - Drill Break	Type	Core Rec. %	RQD %	Test Results & Comments
		FILLING: Generally comprising brown fine to coarse grained gravelly silty sand, humid										
	0.35	GRAVELLY SAND: Very loose to loose grey-brown fine to coarse grained gravelly sand, with trace silt and clay, damp From 0.6m, moist to wet From 1.0m, saturated				▼			A A S			 1,0,1 N = 1
	1.7	GRAVELLY CLAYEY SAND: Very loose to loose grey-brown fine to coarse grained gravelly sand, with some silt, shell fragments, saturated							S			1,0,0 N = 0
	3.0	GRAVEL: Loose grey and brown fine to medium sized gravel, with some sand and shells and trace silt, saturated										
	4.05	GRAVELLY SAND: Loose grey fine to medium grained silty gravelly sand, with some shells, saturated							S			5,2,2 N = 4
	5.5	GRAVELLY CLAY: Very stiff to hard grey-brown and brown gravelly clay, with some sand, M~Wp							S			5,14,16 N = 30
	6.3	GRAVELLY SANDY CLAY: Very stiff light grey-brown gravelly sandy clay, M~Wp										
	7.0	SILTY CLAY: Very stiff grey-brown and red-brown silty clay, M~Wp							S			3,7,12 N = 19
	7.8	SANDY SILTY CLAY: Firm to stiff grey-brown sandy silty clay, with some gravel, M~Wp From 8.55m to 8.8m, soft to firm							pp pp S pp			30-50 kPa 30-50 kPa 1,0,4 N = 4 80-100 kPa

RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 5.5m

TYPE OF BORING: Solid flight auger (tc-bit) to 2.5m, then wash boring to 5.5m; then rotary with mud to 13.25m; then NMLC coring to 19.9m

WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling

REMARKS: Coordinates are MGA. 50mm diameter Class 18 PVC piezometer installed to 4m; screened from 1.0m to 4.0m; 5mm gravel filter from 0.4m to 4.0m; bentonite plug from surface to 0.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

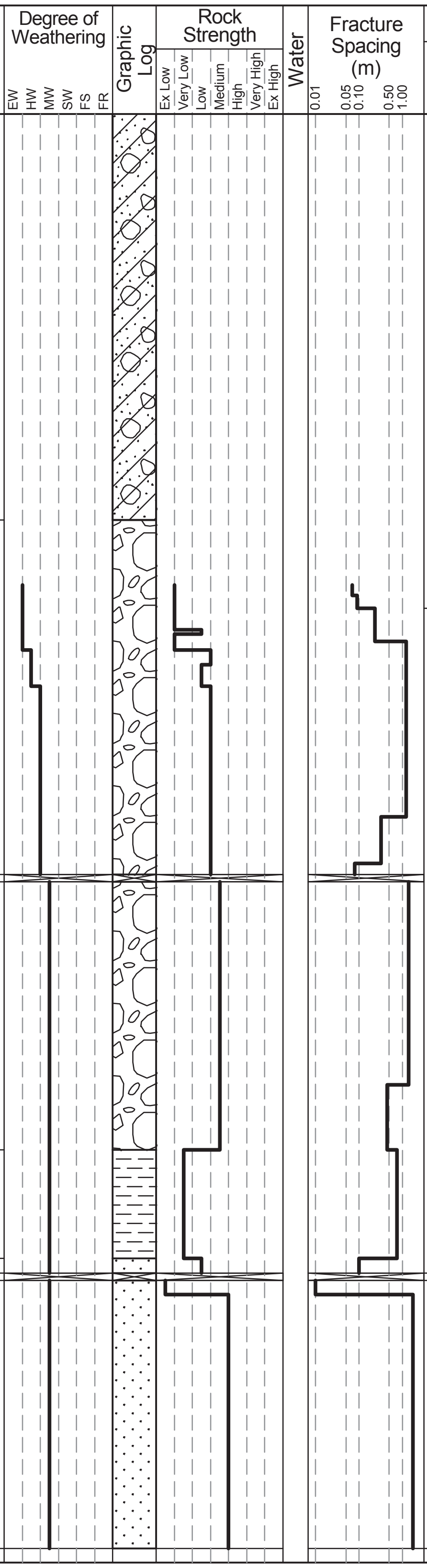
Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: 1.27 AHD
EASTING: 363834
NORTHING: 6334174
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 39823
DATE: 26/9/07
SHEET 2 OF 2



Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear D - Drill Break	Type	Core Rec. %	RQD %	Test Results & Comments
10.0	GRAVELLY SANDY CLAY: Stiff grey-brown gravelly sandy clay, M~Wp		S pp			120-140 kPa 5,4,6 N = 10
			S			7,4,11 N = 15
	From 11.9m, stiff to very stiff					
12.8	CONGLOMERATE: Extremely low strength, extremely weathered orange-brown and light grey conglomerate		S			23,25/80mm
	From 13.25m, extremely low to very low strength, extremely to highly weathered From 13.56m to 13.59, low strength From 13.7m, low to medium strength, highly to moderately weathered	13.32m: P, 5º, ro, un 13.41m: P, 5º, ro, un 13.64m: J, 10º, ro, un	C	100	73	PL(A) = 0.67MPa PL(D) = 0.26MPa
		14.85m: J, 45º, ro, un	C	100	94	
15.25	CORE LOSS:	15.25m: CORE LOSS: 50mm				
15.3	CONGLOMERATE: Medium strength, moderately weathered brown conglomerate	15.77m: J, 10º, sm, pl 16.7m: P, 5º, sm, pl, Fe	C	98	98	PL(A) = 0.7MPa PL(D) = 0.35MPa
17.15	CLAYSTONE: Very low strength, moderately weathered brown conglomerate	17.15m: P, 10º, ro, pl, Fe				PL(A) = 0.07MPa PL(D) = 0.05MPa
17.9	PEBBLY SANDSTONE: Low strength, moderately weathered light grey fine to coarse grained pebbly sandstone	17.9m: P, 5º, ro, pl	C	97	90	
18.0	CORE LOSS:	18m: CORE LOSS: 50mm				
18.05	PEBBLY SANDSTONE: Extremely low strength, moderately weathered light grey fine to coarse grained pebbly sandstone From 18.45m, medium to high strength	From 18.05m to18.15m, highly Fg (1mm to 10mm)	C	100	100	PL(A) = 1.57MPa PL(D) = 1.06MPa
19.9	Bore discontinued at 19.9m, limit of investigation					

RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 5.5m

TYPE OF BORING: Solid flight auger (tc-bit) to 2.5m, then wash boring to 5.5m; then rotary with mud to 13.25m; then NMLC coring to 19.9m

WATER OBSERVATIONS: Free groundwater observed at 1.0m during drilling

REMARKS: Coordinates are MGA. 50mm diameter Class 18 PVC piezometer installed to 4m; screened from 1.0m to 4.0m; 5mm gravel filter from 0.4m to 4.0m; bentonite plug from surface to 0.4m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ≚ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

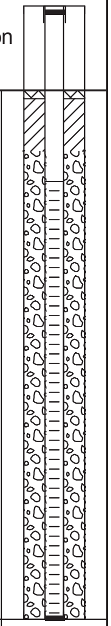
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 1.27
EASTING: 363834
NORTHING: 6334174
DIP/AZIMUTH: 90°/--

BORE No: 101A
PROJECT No: 39823
DATE: 16 Oct 07
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
0.3	FILLING: Generally comprising brown fine to medium grained gravelly silty sand, humid						From 0.05m to 0.4m, bentonite
1.7	GRAVELLY SAND: Very loose to loose grey-brown fine to coarse grained sand, some silt and clay, damp From 0.65m, wet to saturated					▼	
3.0	GRAVELLY CLAYEY SAND: Very loose to loose grey-brown fine to coarse grained gravelly sand, with some silt, saturated						From 0.4m to 3.5m, 5mm gravel filter From 0.6m to 3.5m, screen
3.5	GRAVEL: Loose grey-brown fine to coarse gravel, with some sand and trace silt, saturated						
	Bore discontinued at 3.5m, limit of investigation						



RIG: Truck mounted rig **DRILLER:** Atkins **LOGGED:** Karpiel **CASING:** -

TYPE OF BORING: 150mm hollow flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.15m below ground level during drilling

REMARKS: Endcap dislodged during removal of casing, screen backfilled inside well to 1.84m below ground level

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: 0.89 AHD
EASTING: 363828.6
NORTHING: 6334140.7
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 39823
DATE: 08 Oct 07
SHEET 1 OF 2

Depth (m)	Description of Strata	Water	Sampling Type	Test Results & Comments
0.0	TOPSOIL: Generally comprising dark brown-black clayey sandy silt, with trace rootlets to 0.2m, damp			
0.4	SILTY SAND: Dark brown fine to medium grained silty sand, damp		A	
0.7	SAND: Very loose brown fine to medium grained sand, with trace silt, clay and shell fragments, moist		A S	 1,0,0 N = 0
1.3	SILTY SAND: Very loose grey fine to medium grained silty sand, with trace clay and shell fragments, saturated	▼	S	0,0,0 N = 0 (weight of hammer)
			S	3,1,2 N = 3
4.2	CLAYEY SAND/SANDY CLAY: Very soft grey-brown medium grained clayey sand/sandy clay, saturated			
4.7	SILTY SANDY CLAY: Firm to stiff light brown sandy clay, with fine grained gravel, M>Wp			
5.3	SILTY CLAY: Firm to very stiff light brown silty clay, with some sand, M<Wp		pp pp S pp	80 kPa 150 kPa 3,3,6 N = 9 320 kPa
7.15	GRAVELLY SANDY CLAY: Very stiff to hard light brown gravelly sandy clay, M~Wp		S	3,8,25/130mm
8.0	SILTY CLAY: Stiff light brown silty clay, with some fine grained sand, M>Wp		S pp	3,4,5 N = 9 170 kPa
9.5	From 9.5m, very stiff to hard, slightly sandy			

RL: 0, -1, -2, -3, -4, -5, -6, -7, -8, -9
Degree of Weathering: EW HW MW SW FS FR
Rock Strength: Ex Low, Very Low, Low, Medium, High, Very High, Ex High
Fracture Spacing (m): 0.01 0.05 0.10 0.50 1.00
Discontinuities: B - Bedding J - Joint S - Shear D - Drill Break
Core Rec. % RQD %

RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 7.2m, HQ to 11.65m
TYPE OF BORING: 100mm diameter solid flight auger (tc-bit to 4.5m), then rotary wash boring to 11.65m, then NMLC coring to 17.75m
WATER OBSERVATIONS: Free groundwater observed at 1.3m during drilling
REMARKS: Coordinates are MGA. 50mm diameter Class 18 PVC piezometer installed to 4.0m depth on completion

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

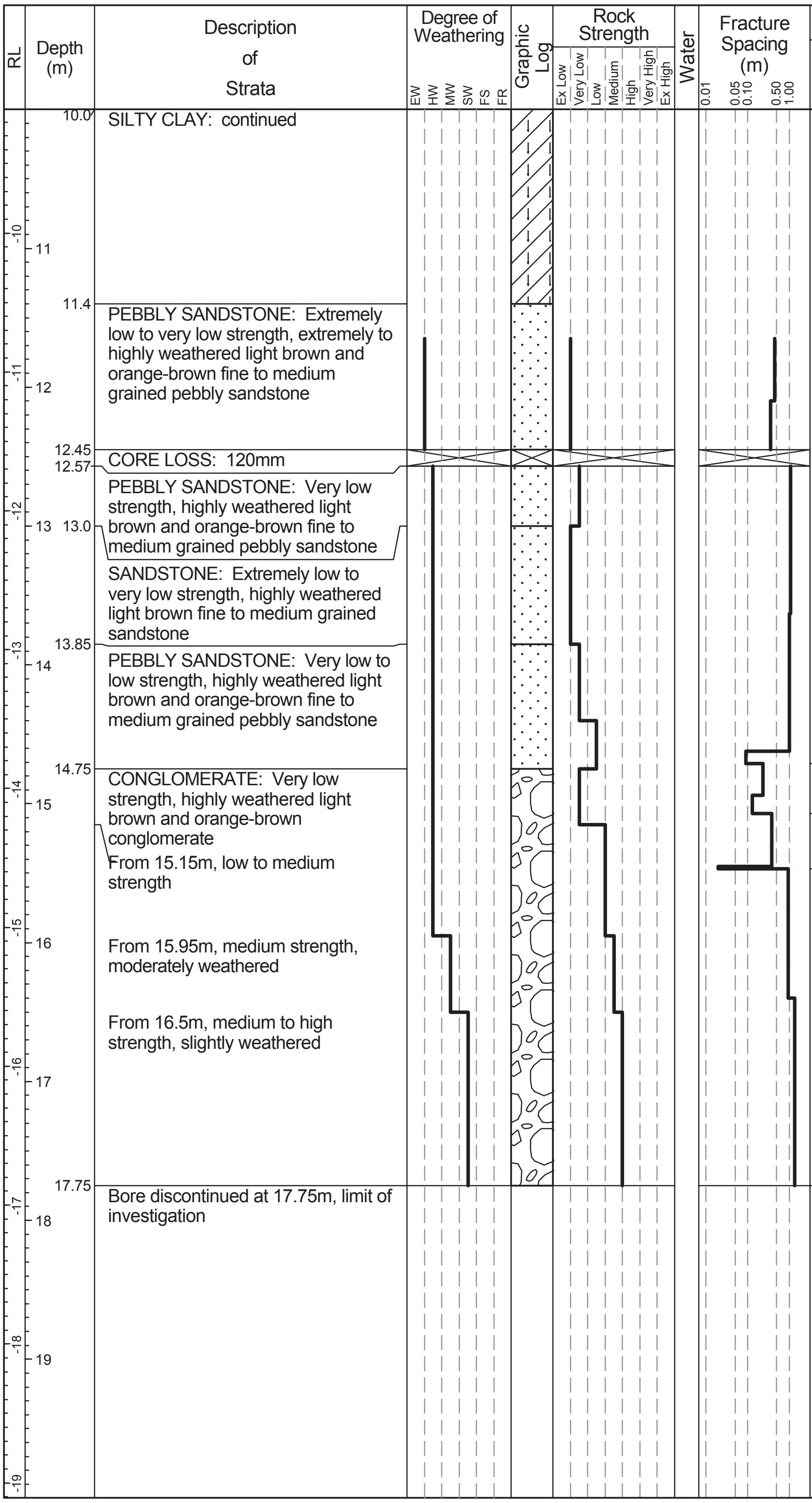
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: 0.89 AHD
EASTING: 363828.6
NORTHING: 6334140.7
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 39823
DATE: 08 Oct 07
SHEET 2 OF 2

Depth (m)	Description of Strata	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Type	Core Rec. %	RQD %	Test Results & Comments
10.0	SILTY CLAY: continued		S pp pp			340 kPa 5,9,13 N = 22 380-440 kPa
11.4	PEBBLY SANDSTONE: Extremely low to very low strength, extremely to highly weathered light brown and orange-brown fine to medium grained pebbly sandstone	12.1m: J, 70°, ro, un	S C	 100	 100	25/120mm PL(A) = 0.04MPa PL(D) = 0.05MPa
12.45	CORE LOSS: 120mm	12.45m: CORE LOSS: 120mm				
12.57	PEBBLY SANDSTONE: Very low strength, highly weathered light brown and orange-brown fine to medium grained pebbly sandstone		C	92	92	
13.0	SANDSTONE: Extremely low to very low strength, highly weathered light brown fine to medium grained sandstone	13.63m: J, 10°, ro, pl				PL(A) = 0.01MPa PL(D) = 0MPa
13.85	PEBBLY SANDSTONE: Very low to low strength, highly weathered light brown and orange-brown fine to medium grained pebbly sandstone	14.62m: P, 5°, ro, un	C	100	94	
14.75	CONGLOMERATE: Very low strength, highly weathered light brown and orange-brown conglomerate From 15.15m, low to medium strength	14.71m: P, 5°, ro, un 14.94m: P, 5°, ro, pl 15.07m: J, 40°, ro, pl 15.45m: P, 5°, ro, pl 15.47m: J, 20°, ro, un				PL(A) = 0.31MPa PL(D) = 0.22MPa
	From 15.95m, medium strength, moderately weathered From 16.5m, medium to high strength, slightly weathered	16.4m: J, 30°, ro, un	C	100	99	PL(A) = 0.57MPa PL(D) = 0.5MPa
17.75	Bore discontinued at 17.75m, limit of investigation					



RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 7.2m, HQ to 11.65m

TYPE OF BORING: 100mm diameter solid flight auger (tc-bit to 4.5m), then rotary wash boring to 11.65m, then NMLC coring to 17.75m

WATER OBSERVATIONS: Free groundwater observed at 1.3m during drilling

REMARKS: Coordinates are MGA. 50mm diameter Class 18 PVC piezometer installed to 4.0m depth on completion

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▽ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

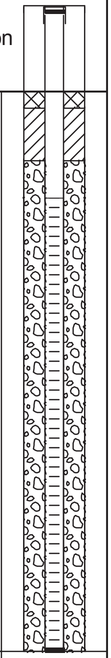
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 0.89
EASTING: 363829
NORTHING: 6334141
DIP/AZIMUTH: 90°/--

BORE No: 102A
PROJECT No: 39823
DATE: 16 Oct 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		TOPSOIL: Generally comprising black clayey sandy silt, with trace rootlets to 0.2m							End cap Stick up ~0.57m From 0.1m to 0.45m, bentonite
	0.4	SILTY SAND: Dark brown silty sand medium grained, damp							
	0.7	SAND: (Very loose) fine to medium grained sand with trace silt, clay and shell, wet						▼	
	1.3	SILTY SAND: (Very loose) grey fine to medium grained silty sand, with trace clay, saturated							From 0.45m to 3.7m, 5mm gravel filter From 0.7m to 3.7m, screen
	3.7	Bore discontinued at 3.7m, limit of investigation							



RIG: Truck mounted rig **DRILLER:** Atkins **LOGGED:** Karpiel **CASING:** -
TYPE OF BORING: 150mm hollow flight auger
WATER OBSERVATIONS: Free groundwater observed at 0.83m below ground level during drilling
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

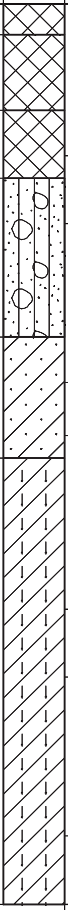
Douglas Partners
Geotechnics · Environment · Groundwater

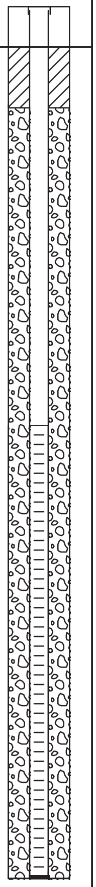
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 2.487
EASTING: 363872
NORTHING: 6334034
DIP/AZIMUTH: 90°/--

BORE No: 103
PROJECT No: 39823
DATE: 28 Sep 07
SHEET 1 OF 1





RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		FILLING - Generally comprising dark brown sandy silt with some organics, (bark, wood chips, rootlets), dry to moist						From surface to 0.4m, bentonite plug
2	0.2	FILLING - Generally comprising dark brown-black fine to medium grained silty sand with trace sand, damp	A	0.5				
	0.7	FILLING - Generally comprising light brown and dark brown gravelly sandy clay with some silt, M>Wp		1.0				
1	1.15	SILTY GRAVELLY SAND - Medium dense to dense, red and orange-brown silty gravelly sand, M~Wp	pp A,S	1.2 1.45		150-300 kPa 8,18,13 N = 31		
0	2.2	SANDY CLAY - Very stiff, light grey-brown sandy clay, M~Wp	U_{50} pp	2.5 2.85		350-390 kPa		
-1 -2 -3	3.0	SILTY CLAY - Very stiff, light grey-brown and red-brown silty clay with some gravel, M>Wp	S,pp S	4.0 4.45 5.5 5.95		4,7,12 N = 19 300 kPa 7,13,16 N = 29	▼ (4.0)	From 0.4m to 5.5m, 5mm gravel filter From 2.5m to 5.5m, 50mm diameter Class 18 PVC screen
-4	5.95	Bore discontinued at 5.95m, limit of investigation						

RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:**

TYPE OF BORING: 100mm diameter solid flight auger (tc-bit)

WATER OBSERVATIONS: Free groundwater observed at 4.0m during drilling

REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

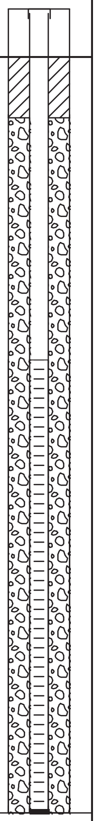
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 3.82
EASTING: 363899
NORTHING: 6333964
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 39823
DATE: 28 Sep 07
SHEET 1 OF 1

Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	FILLING -							
0.2	FILLING - Generally comprising brown sandy silt, dry to humid from 0.6m, some gravel		A	0.5				From surface to 0.4m, bentonite plug
1.05	SANDY SILTY CLAY - Very stiff, grey-brown, orange and red-brown sandy silty clay, M<Wp		A,S,pp	1.0 1.45		5,8,9 N = 17 400 kPa		
1.8	SILTY CLAY - Very stiff, light grey-brown silty clay with some gravel, M<Wp		S,pp	2.5 2.95		3,8,8 N = 16 320-360 kPa		From 0.4m to 5.0m, 5mm gravel filter
	from 3.6m, (stiff) to very stiff						▼	From 2.0m to 5.0m, 50mm diameter Class 18 PVC screen
4.2	PEBBLY SANDSTONE - Extremely low to very low strength, extremely to highly weathered, orange-brown fine to medium grained pebbly sandstone		S,pp	4.0 4.45		7,13,19 N = 32 150-250 kPa		
5.0	Bore discontinued at 5.0m, limit of investigation							



RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:**

TYPE OF BORING: 100mm diameter solid flight auger (tc-bit)

WATER OBSERVATIONS: Free groundwater observed at 3.6m during drilling

REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

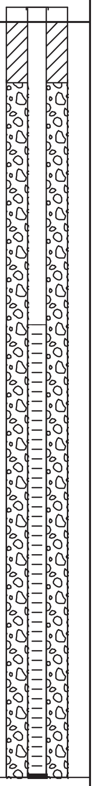
BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: Off Henry Street, Trinity Point

SURFACE LEVEL: 6.62
EASTING: 363918
NORTHING: 6333881
DIP/AZIMUTH: 90°/--

BORE No: 105
PROJECT No: 39823
DATE: 28 Sep 07
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details
				Type	Depth	Sample	Results & Comments		
		FILLING -							
	0.2	FILLING - Generally comprising dark brown fine to medium grained silty sand with some fine grained sand, humid		A	0.5				From surface to 0.4m, bentonite plug
	1.05	SILTY SANDY CLAY - Very stiff to hard, orange and red-brown silty sandy clay with some fine grained gravel		A,S,pp pp	1.0 1.4 1.45		4,5,10 N = 15 >450 kPa >450 kPa		
		from 2.1m, slightly gravelly		S,pp	2.5 2.95		6,10,13 N = 23 350->450 kPa		From 0.4m to 5.0m, 5mm gravel filter From 2.0m to 5.0m, 50mm diameter Class 18 PVC screen
		from 4m, hard, grading to extremely low strength conglomerate		S	4.0 4.45		4,14,18 N = 32		
	5.0	Bore discontinued at 5.0m, limit of investigation							



RIG: Scout 2 **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:**
TYPE OF BORING: 100mm diameter solid flight auger (tc-bit)
WATER OBSERVATIONS: No free groundwater observed during drilling
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

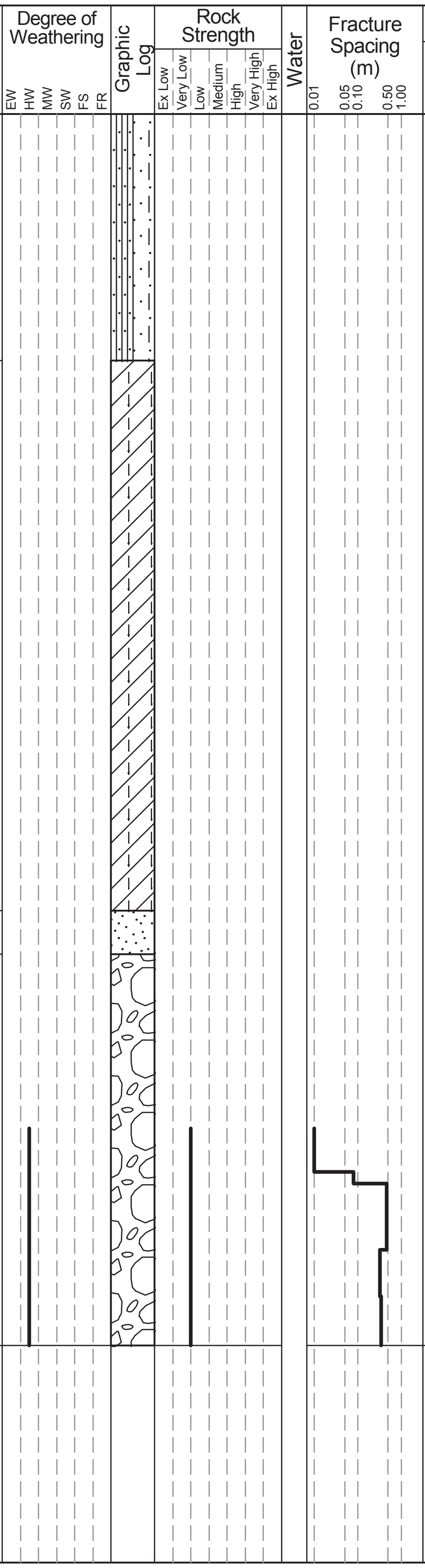
Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.86 AHD
EASTING: 363920.9
NORTHING: 6334291.7
DIP/AZIMUTH: 90°/--

BORE No: 201
PROJECT No: 39823B
DATE: 03 Oct 07
SHEET 1 OF 1



Depth (m)	Description of Strata	Discontinuities	Type	Core Rec. %	RQD %	Test Results & Comments
	SANDY SILT/SILTY SAND: Very loose/very soft grey-brown silty sand/sandy silt, with some shells, M>Wp		S			0,0,0 N = 0 (weight of rods)
			S			0,0,0 N = 0 (weight of rods)
1.7	SILTY CLAY: Stiff to very stiff light grey-brown and grey-brown silty clay, M>Wp		pp S			350-390 kPa 3,5,8 N = 13
	From 4.25m, soft to firm		pp S pp			140-220 kPa 3,5,4 N = 9 20-60 kPa
	From 5.3m, some sand and coal fragments					
5.5	SAND: Very loose to loose fine to coarse grained sand, with some silt and coal fragments, saturated		S			1,1,12 N = 13
5.8	CONGLOMERATE: Extremely low to very low strength, extremely to highly weathered light grey-brown conglomerate					
	From 6.4m, (very low to low strength) higher resistance to drilling, brown	From 7.0m to 7.3m, highly Fr	C	100	100	
	From 7.45m, very low to low strength	7.38m: J, 60º, ro, un 7.84m: J, 45º, ro, un 8.16m: J, 10º, ro, pl				PL(A) = 0.06MPa PL(D) = 0.05MPa PL(A) = 0.04MPa PL(D) = 0.04MPa
8.5	Bore discontinued at 8.5m, bore abandoned due to strong winds					

Discontinuities: B - Bedding J - Joint S - Shear D - Drill Break

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 2.2m
TYPE OF BORING: 100mm diameter rotary wash boring to 7.0m, then NMLC coring to 8.5m
WATER OBSERVATIONS: Depth of water 4.95m at start of bore
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.15 AHD
EASTING: 363870.5
NORTHING: 6334479.2
DIP/AZIMUTH: 90°/--

BORE No: 202
PROJECT No: 39823B
DATE: 04 Oct 07
SHEET 1 OF 2

Degree of Weathering: EW HW MW SW FS FR
Rock Strength: Ex Low, Very Low, Low, Medium, High, Very High, Ex High
Fracture Spacing (m): 0.01 0.05 0.10 0.50 1.00
Discontinuities: B - Bedding J - Joint S - Shear D - Drill Break

RL: -6 -7 -8 -9 -10 -11 -12 -13 -14 -15
Depth (m): 1 2 3 4 5 6 7 8 9

Depth (m)	Description of Strata	Discontinuities	Type	Core Rec. %	RQD %	Test Results & Comments
	SANDY SILTY CLAY: Very soft dark grey-brown sandy silty clay, with some shells, M>Wp		S			0,0,0 N = 0 (weight of rods)
			S			0,0,0 N = 0 (weight of rods)
2.2	GRAVELLY SILTY CLAY: Stiff light brown gravelly silty clay, with some sand, M>Wp		pp S pp			160 kPa 3,5,7 N = 12 160 kPa
2.8	CLAYEY SAND: Stiff to very stiff light brown slightly gravelly clayey sand, M>Wp		pp S pp			100-150 kPa 4,8,12 N = 20 >450 kPa
			S pp			4,8,12 N = 20 300-360 kPa
6.9	CONGLOMERATE: Extremely low strength, extremely weathered light brown and red-brown conglomerate		S			5,12,18 N = 30
7.55	CORE LOSS: 950mm	7.55m: CORE LOSS: 950mm	C	46	31	
8.5	CONGLOMERATE: Extremely low strength, extremely weathered light brown and red-brown conglomerate	From 8.5m to 8.72m, highly Fr				
8.75	CLAYSTONE: Very low to low strength, extremely weathered light brown and red-brown claystone					PL(A) = 0.1MPa PL(D) = 0.12MPa
9.3	CORE LOSS: 1700mm	9.3m: CORE LOSS: 700mm	C	33	33	

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 3.0m
TYPE OF BORING: 100mm diameter rotary wash boring to 7.5m, then NMLC coring to 14.55m
WATER OBSERVATIONS: Depth of water 5.25m at start of bore
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

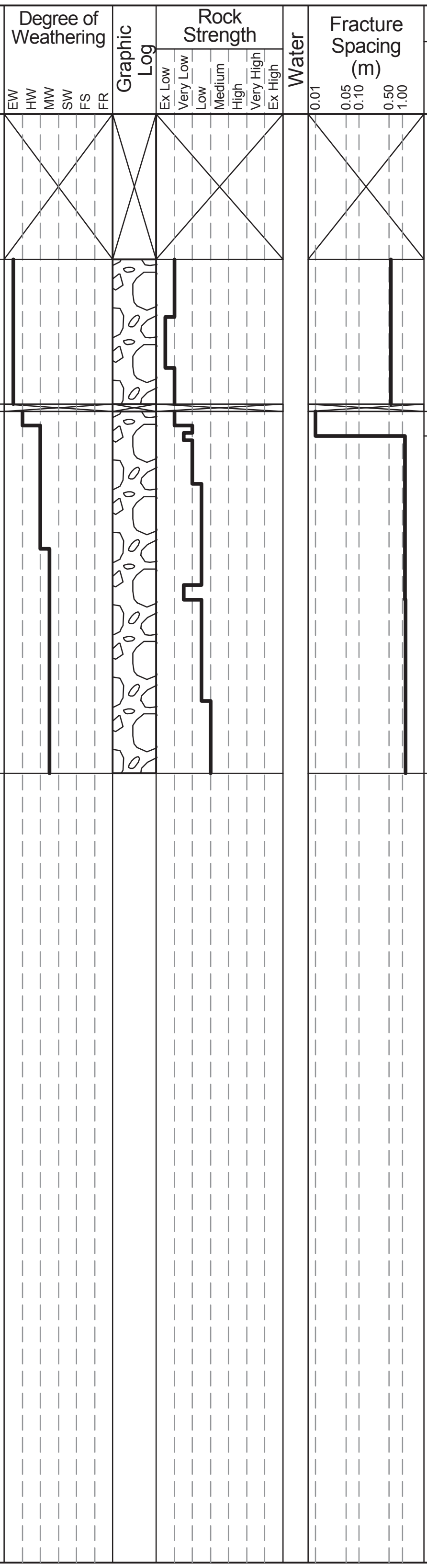
Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.15 AHD
EASTING: 363870.5
NORTHING: 6334479.2
DIP/AZIMUTH: 90°/--

BORE No: 202
PROJECT No: 39823B
DATE: 04 Oct 07
SHEET 2 OF 2



RL	Depth (m)	Description of Strata	Discontinuities B - Bedding J - Joint S - Shear D - Drill Break	Type	Core Rec. %	RQD %	Test Results & Comments
	10.0	CORE LOSS: continued	10m: CORE LOSS: 1000mm				
-16	11.0	CONGLOMERATE: Extremely low to very low strength, extremely weathered light orange-brown conglomerate	11.55m: P, sh, ro, un, cy filled (20mm)	C	33	33	PL(A) = 0.03MPa PL(D) = 0.04MPa
-17	12.0	CORE LOSS: 50mm	12m: CORE LOSS: 50mm				
	12.05	CONGLOMERATE: Extremely low to very low strength, extremely to highly weathered orange-brown conglomerate	From 12.05m to 12.55m, high Fr 12.22m: P, sh, ro, un, cy filled (15mm)	C	95	78	
-18		From 12.15m, very low to low strength, highly to moderately weathered					PL(A) = 0.04MPa PL(D) = 0.02MPa
	13	From 13.0m, moderately weathered light brown	13.35m: P, sh, ro, un	C	100	100	
-19	14	From 14.05m, low to medium strength					PL(A) = 0.11MPa PL(D) = 0.06MPa
-20	14.55	Bore discontinued at 14.55m, limit of investigation					
-21	15						
-22	16						
-23	17						
-24	18						
-25	19						

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 3.0m
TYPE OF BORING: 100mm diameter rotary wash boring to 7.5m, then NMLC coring to 14.55m
WATER OBSERVATIONS: Depth of water 5.25m at start of bore
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.35 AHD
EASTING: 364077.3
NORTHING: 633437.6
DIP/AZIMUTH: 90°/--

BORE No: 203
PROJECT No: 39823B
DATE: 05 Oct 07
SHEET 1 OF 2

Discontinuities: B - Bedding J - Joint S - Shear D - Drill Break

Depth (m)	Description of Strata	Type	Core Rec. %	RQD %	Test Results & Comments
	SANDY SILTY CLAY: Very soft dark grey-brown sandy silty clay, with some shell fragments, M>>Wp	S			0,0,0 N = 0 (weight of rods)
		S			0,0,0 N = 0 (weight of rods)
		S			0,0,0 N = 0 (weight of rods)
3.0	CLAY: Stiff light brown and brown clay, with some sand, and silt, M>Wp	pp S pp			180 kPa 2,4,7 N = 11 190-200 kPa
		pp S pp			140 kPa 3,5,7 N = 12 160-180 kPa
6.5	GRAVELLY CLAY: Very stiff light brown gravelly clay, with some sandy gravelly clay bands, M>Wp	pp S pp			200-220 kPa 7,9,11 N = 20 300-400 kPa
7.9	CONGLOMERATE: Extremely low strength, extremely weathered light brown and red-brown conglomerate, with soil like properties	S			5,8,10 N = 18
	From 9.5m, extremely low to very low strength, extremely to highly weathered	S			13,27,25/90mm

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 4.0m
TYPE OF BORING: 100mm diameter rotary wash boring to 11.0m, then NMLC coring to 13.45m
WATER OBSERVATIONS: Depth of water 5.5m at start of bore
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater

BOREHOLE LOG

CLIENT: Johnson Property Group
PROJECT: Trinity Point Marina & Tourist Development
LOCATION: 49 Lakeview Road, Morisset Park

SURFACE LEVEL: -5.35 AHD
EASTING: 364077.3
NORTHING: 633437.6
DIP/AZIMUTH: 90°/--

BORE No: 203
PROJECT No: 39823B
DATE: 05 Oct 07
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Type	Core Rec. %	RQD %	Test Results & Comments
	10.0	CONGLOMERATE: continued										
	11	From 11.0m, extremely low to very low strength, highly weathered red-brown and orange-brown						11.91m: J, 30º, sm, un 12.36m: P, 10º, sm, pl 12.53m: J, 15º, ro, pl 12.76m: J, 15º, sm ,un 12.93m: J, 15º, sm, un 13.24m: J, 10º, sm, pl	C	100	100	PL(A) = 0.03MPa PL(D) = 0.03MPa PL(A) = 0.01MPa PL(D) = 0.02MPa
	13.45	Bore discontinued at 13.45m, limit of investigation										

RL scale: -16, -17, -18, -19, -20, -21, -22, -23, -24, -25
Depth scale: 11, 12, 13, 14, 15, 16, 17, 18, 19

RIG: Scout 2 on Modular Barge **DRILLER:** Ground Test (Driver) **LOGGED:** Reid **CASING:** HW to 4.0m
TYPE OF BORING: 100mm diameter rotary wash boring to 11.0m, then NMLC coring to 13.45m
WATER OBSERVATIONS: Depth of water 5.5m at start of bore
REMARKS: Coordinates are MGA

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

Douglas Partners
Geotechnics · Environment · Groundwater