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REPORT

TO

HEALTH INFRASTRUCTURE NSW

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED ALTERATIONS & ADDITIONS

AT

ST GEORGE HOSPITAL
GRAY STREET, KOGARAH, NSW

2 November 2011

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1 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for the proposed alterations and additions at St George Hospital, Gray Street, Kogarah, NSW. The investigation was commissioned by Mr Jonathan Darwen of Sweett (Australia) Pty Ltd, on behalf of Health Infrastructure NSW, by email dated 30 September 2011. The commission is in the process of being formalised under Consultancy Agreement No HI 11358. This report confirms and amplifies our draft report dated 21 October 2011 to Sweett Australia.

We understand from the Sweett brief dated 7 September 2011, that the proposed alterations and additions will comprise a new Emergency Department Building, a new Sub-Acute Building, an Oxygen Tank Hardstand, a Waste Handling Area, and extensions to the Rose Cottage/Technical Skills Building. The extensions to the Rose Cottage/Technical Skills Building were subsequently omitted and a new Substation and an Engineering Building were proposed. Details of each of the proposed structures are presented in the relevant sections which follow.

For the purposes of this report, 'site north' has been assumed parallel to Gray Street, as indicated on attached Figure 1.

The purpose of the investigation was to obtain geotechnical information on subsurface conditions at each of the proposed structures, as a basis for comments and recommendations on earthworks, excavation conditions, excavation support, retaining walls, footings, and on-grade floor slabs.

Our Environmental Division, Environmental Investigation Services (EIS), was commissioned to carry out a Preliminary Stage 1 Environment Site Assessment and Waste Classification. The environmental report must be read in conjunction with this geotechnical report.

2 GENERAL INVESTIGATION PROCEDURE

The fieldwork for the investigation was carried out on 13, 14 and 21 October 2011, and comprised the drilling of 14 boreholes and the completion of one Dynamic Cone Penetration (DCP) test. Prior to drilling, the borehole locations were set out by taped measurements from existing surface features, and were electromagnetically scanned for buried services. The surface reduced levels (RLs) at the borehole locations were estimated by interpolation between spot heights shown on the provided survey plan (ref 33459D1, Sheet 1/14 to Sheet 13/14, all dated 18/10/2010) prepared by Lockley Land Title Solutions. The survey datum is the Australian Height Datum (AHD).

The nature and composition of the subsurface soils and rocks were assessed by logging the materials recovered during drilling. The relative density/strength of the subsoils was assessed from the Standard Penetrometer Tests (SPT) 'N' values, hand penetrometer readings on cohesive soil samples recovered in the SPT split tube sampler, and from the DCP test results. The DCP refusal can also provide an indicative depth to bedrock, though the DCP can also refuse on buried obstructions, roots, other hard layers, and not necessarily on bedrock. The strength of the augered rock was assessed by observation of drilling resistance when using a tungsten carbide (TC) bit, examination of the recovered rock chip samples and subsequent correlation with laboratory moisture content testing. The strength of the cored rock was assessed by examination of the recovered rock core and subsequent correlation with laboratory Point Load Strength Index test results. Groundwater observations were made during augering, on completion of augering, and on completion of coring individual boreholes. No longer term groundwater monitoring was carried out.

Our geotechnical engineers were present full time on site during the drilling and set out the borehole locations, directed electromagnetic scanning, nominated the sampling and testing, and logged the subsurface profile. The borehole logs and DCP test results are presented with this report together with the Report Explanation Notes, which describe the investigation techniques adopted, and define the logging terms and symbols used.

Selected soil samples were submitted to Soil Test Services Pty Ltd (STS), a NATA registered laboratory, for moisture contents, Atterberg Limits, linear shrinkage, Standard compaction, and four-day soaked CBR testing. The results are summarised in attached Tables A and B. The rock core was returned to STS where it was photographed and select sections of core subjected to Point Load Strength Index testing. The test results are summarised in Table C and have been plotted on the borehole logs. The core photographs are presented opposite the relevant borehole log. Selected soil samples were also submitted to EnviroLab Services Pty Ltd, a NATA registered laboratory, for soil pH, chloride and sulphate analysis. The test results are summarised in Table D and a Certificate of Analysis is presented in Appendix A.

3 PROPOSED NEW EMERGENCY DEPARTMENT BUILDING

3.1 Proposed Development

We understand from the Sweett brief dated 7 September 2011 that, following demolition of existing buildings and structures on site, a new five to six storey concrete framed building will be constructed. The building platform will be formed at reduced level (RL) 28.4m, which will require a maximum excavation depth of 2.2m over the northern portion of the site. Over the southern portion, up to 1.5m fill will be required or, alternatively, the ground floor slab will be suspended over the existing subgrade. A maximum column load of approximately 6,500kN is anticipated. The area will also include an Ambulance Hardstand.

3.2 Detailed Investigation Procedure

Six boreholes (BH2 to BH7) were auger drilled to depths between 0.2m and 6.1m below existing grade using our track mounted JK250 and JK300 drilling rigs, at the locations shown on attached Figure 1. Regular SPTs were carried out within the soil profile and the bedrock was proven using a 'TC' bit. BH3 and BH7 were then extended into the underlying bedrock using rotary core drilling techniques with water flush to final depths of 8.0m and 5.5m, respectively.

3.3 Results of Investigation

3.3.1 Site Description

The site for the proposed new Emergency Department Building is located over the western end of the Hospital complex adjacent to Gray Street. It covers an area of approximately 3,000m^2 and slopes down to the south at approximately 2°. At the time of the investigation, the site was occupied by a one and two storey brick services building and brick and metal sheds for waste disposal. A concrete paved area was located between the two buildings.

A three and five storey building was located beyond the northern end of the eastern site boundary, and an eight storey building was located beyond the southern end of the eastern site boundary. The latter building had a basement level which exposed sandstone bedrock. To the north was Griffith House, a one and two storey brick Heritage listed building. The site was bound along the south by an asphaltic concrete (AC) access road over a buried detention tank. A four storey carpark was located beyond the access road to the south. All buildings within and surrounding the site appeared to be in good external condition based on a cursory inspection. Between the site and Gray Street was a concrete footpath with a grassed garden area.

3.3.2 Subsurface Conditions

Based on the 1:100,000 geological map of Sydney, the site for the new Emergency Services Building is underlain by Hawkesbury Sandstone. The investigation has revealed a generalised subsurface profile comprising fill over residual clays with sandstone bedrock at relatively shallow depth. Reference should be made to the BH2 to BH7 logs for detailed subsurface conditions at specific locations. A graphical borehole summary is presented in Figure 2 and a summary of the subsurface conditions, as encountered, is presented below:

- Fill, generally comprising sands and clays was encountered in all boreholes and extended to depths between 0.2m (BH7) and 1.3m (BH6). BH4 refused on a buried obstruction at a depth of 0.2m within the fill profile. Several attempts were made in the vicinity to extend the borehole, but all refused at similar depths.

- Residual silty and sandy clays were encountered below the fill in all locations, except BH4. The clays were generally of medium plasticity and very stiff strength. A very dense residual clayey sand was encountered below the fill in BH6.

- Sandstone bedrock was encountered in all boreholes, except BH4, at depths between 0.55m (BH7) and 3.1m (BH2 and BH5). In general, the sandstone on first contact was of very low or low strength, and improved to medium and high strength with depth. In BH3, core loss zones, 90mm and 100mm thick, representing extremely weathered sandstone or clay seams were encountered at depths of 6.1m and 6.8m, respectively. Other defects encountered in BH3 and BH7 (the cored boreholes) included extremely weathered and clay seams up to 40mm thick, and bed partings.

- The following rock classification in terms of Pells *et al* (2007) should be adopted for design:

LOCATION	**Depth to Class of Rock (m)**		
	Class V	**Class IV**	**Class III**
BH2	3.1 – 4.0*	4.0 – 5.0*	5.0 – 6.1*
BH3	1.6 – 3.5* 4.5 – 6.9	3.5 – 4.5	6.9 – 8.0
BH5	3.1 – 3.6*	3.6 – 5.0*	5.0 – 6.0*
BH6	–	2.4 – 2.6*	2.6 – 3.9*
BH7	0.55 – 2.4*	–	2.4 – 5.5

* Estimated.

- Groundwater was not encountered during or on completion of augering any of the boreholes. We note that water is added to the borehole to facilitate the coring process, and the groundwater level measured in BH3 and BH7 on completion of coring probably does not represent the natural groundwater level. However, a full water recycle return was estimated, indicating that the rock mass had a relatively low mass permeability. Longer term groundwater monitoring was not carried out.

3.3.3 Laboratory Test Results

The laboratory moisture content and Atterberg Limits results confirmed our field assessment of the soil properties and augered rock strengths. A four-day soaked CBR value of 4.5% is indicated for the residual silty clay in BH2, when compacted to 98% Standard density ratio. The Point Load Strength Index test results correlated well with our field assessed rock strengths. The chemical test results generally indicated a slightly alkaline soil with relatively low chloride and sulphate contents.

3.4 Comments and Recommendations

3.4.1 Earthworks

The earthworks recommendations provided here should be complemented by reference to AS3798.

Based on the investigation results, excavations over the northern portion of the site to a maximum depth of about 2.2m will encounter the soil profile and can be completed using conventional earthworks equipment. If site levels need to be raised, engineered fill should be used. Engineered fill may comprise the excavated soils placed in maximum 200mm thick loose layers, and compacted to between 98% and 102% of Standard Maximum Dry Density (SMDD) within 2% of Standard Optimum

Moisture Content (SOMC). Engineered fill should be tested under Level 1 to the frequency detailed in AS3798.

Excavation and fill embankments should be temporarily battered to side slopes no steeper than 1 Vertical (V):1.5 Horizontal (H) in sand, and 1V:1H in clay. Permanent batters should have side slopes no steeper than 1V:3H, and be protected from erosion using a rapidly growing vegetation or by structural means (eg. shotcrete, stone pitching, etc).

The exposed subgrade within the cut areas should be proof-rolled using a 5 tonne maximum dead-weight, smooth drum vibratory roller. Proof-rolling should be carried out under the direction of an experienced earthworks superintendent or geotechnical engineer to assist in the detection of unstable areas which are not disclosed by this investigation. Any unstable areas identified during proof-rolling should be locally excavated down to a competent base and replaced with engineered fill.

The clay subgrade may soften with an increase in moisture content. Therefore, good and effective site drainage should be provided both during construction and for long term site maintenance. Earthworks platforms should be graded to maintain cross-falls during construction. The principal aim of the drainage is to promote runoff and reduce ponding. A poorly drained clay subgrade may become untrafficable when wet. We recommend that if soil softening occurs, the subgrade be over-excavated to below the depth of moisture softening, and that the excavated material be replaced with a clean, well graded fill, compacted as specified above.

We note that where a suspended ground floor slab is proposed, the recommended proof-rolling is not necessary.

Prior to excavation or shoring commencing, we recommend that a dilapidation survey of Griffith House to the north and that portion of the building beyond the northern end of the eastern boundary which is closest to the proposed excavation, be carried out. Excavation procedures, the shoring design, and the dilapidation report should be carefully reviewed prior to commencing, to confirm that the actual site conditions have been considered in shoring design and in piling and excavation equipment selection.

3.4.2 Retaining Walls

Where the required temporary batters can be accommodated, conventional retaining walls may be constructed and subsequently backfilled. Where the required batters cannot be accommodated or are not preferred, then a retention system will be required and should be installed prior to excavation commencing. A suitable retention system, given the subsoil conditions encountered, includes a soldier pile wall with shotcrete infill panels. Anchoring of the wall may be required in order to reduce deflections in critical areas.

Retaining walls, if required, should be designed using the following parameters:

- Conventional free-standing cantilever walls which support areas where movement is of little concern, should be designed using a triangular lateral earth pressure distribution and an 'active' earth pressure coefficient, K_a, of 0.3, for the soil profile and extremely weathered bedrock, assuming a horizontal retained surface.
- Cantilever walls, the tops of which will be restrained by the ground floor slab prior to backfill or which support movement sensitive elements, should be designed using a triangular lateral earth pressure distribution and an 'at rest' earth pressure coefficient, K_o, of 0.6, for the soil profile and extremely weathered bedrock, assuming a horizontal retained surface.

- A bulk unit weight of $20kN/m^3$ should be adopted for the soil profile and extremely weathered bedrock.
- For anchored or internally propped walls where minor movements can be tolerated, we recommend the use of a trapezoidal earth pressure distribution of 6H kPa for the soil profile and extremely weathered bedrock, where 'H' is the retained height in metres. These pressures should be assumed to be uniform over the central 50% of the support system.
- For anchored or propped walls which support areas which are highly sensitive to lateral movement (such as adjacent to existing buildings), we recommend the use of a trapezoidal earth pressure distribution of 8H kPa for the soil profile and extremely weathered bedrock, where 'H' is the retained height in metres. These pressures should be assumed to be uniform over the central 50% of the support system.
- Any surcharge affecting the walls (eg. traffic and construction loading, nearby high level footings, etc) should be allowed in the design using the appropriate earth pressure coefficient from above.
- The retaining walls should be designed as drained and measures taken to induce complete and permanent drainage of the ground behind the walls. The subsoil drains should incorporate a non-woven geotextile fabric (eg. Bidim A34), to act as a filter against subsoil erosion.
- Toe resistance may be achieved by socketing the piles into the underlying bedrock below bulk excavation level. An allowable lateral toe resistance of 300kPa for low or higher strength sandstone may be adopted. The upper 0.3m depth of the socket immediately below bulk excavation level, if applicable, should not be taken into account to allow for disturbance effects during excavation.

- Anchors bonded at least 3m into low or higher strength sandstone may be designed for an allowable bond stress of 300kPa. All anchors should be proof-tested to 1.3 times the working load under the direction of an experienced engineer, independent of the anchor contractor. We recommend that only experienced contractors be considered for the anchor installation.

3.4.3 Footings

Footings for minor structures may comprise conventional strip or pad footings founded in the natural soil at depths between 0.2m and 1.3m when an allowable bearing pressure of 150kPa is applicable. A site classification, 'Class P', applies in accordance with AS2870, due to the existing fill. However, footings as above will be subject to maximum shrink-swell movements associated with a 'Class M' site.

The main structure should be supported using pile footings founded in sandstone bedrock. Conventional bored piles founded at least 0.3m into sandstone bedrock below bulk excavation level may be designed for an allowable end bearing pressure of 1,000kPa, with an allowable shaft adhesion being applicable over that length of rock socket in excess of 0.3m. Conventional bored piles founded at least 0.3m into 'Class III' sandstone bedrock may be designed for an allowable end bearing pressure of 5,000kPa, with an additional allowable shaft adhesion of 500kPa being applicable to that length of rock socket in excess of 0.3m into 'Class III' sandstone. The table in Section 3.3.2 above may be used to estimate the depth to 'Class III' sandstone.

All footings must be inspected by a geotechnical engineer prior to pouring to confirm that the design assumptions have been met.

Based on the chemical test results from BH3 and BH5, a 'non-aggressive' exposure classification is applicable to concrete piles, in accordance with AS2159.

3.4.4 On-Grade Floor Slabs

Slab-on-grade construction is feasible, provided the earthworks, as indicated in Section 3.4.1 above, are completed, and that some minor differential movements between the floor slab and main structure are acceptable. Careful attention to the architectural detailing will go a long way to reducing any adverse impacts of differential movements.

The concrete on-grade floor slab should be separated from all walls, columns, footings, etc, to allow relatively movement. Joints in the on-grade floor slab should be designed to accommodate shear forces but not bending moments by using dowels or keys.

3.4.5 Hardstand Areas

Hardstand areas and pavements should be designed based on a soaked CBR value of 4% or a short term Young's Modulus value of 30MPa.

Concrete pavements should be supported on a subbase layer of RTA 305 Specification unbound or equivalent good quality crushed rock, compacted to a density of at least 100% SMDD. The subbase material would provide more uniform slab support and would reduce 'pumping' of subgrade 'fines' at joints. Concrete pavements should be provided with effective shear connection at joints by using dowels or keys.

Subsoil drains should be provided along the perimeter of pavements, with inverts not less than 0.2m below clay subgrade level. The drainage trench should be excavated with a longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. The pavement subgrade should be graded to promote water flow or infiltration towards subsoil drains.

4 PROPOSED SUB-ACUTE BUILDING

4.1 Proposed Development

Based on the Sweett brief dated 7 September 2011, the proposed Sub-Acute Building will be either a single or a two storey concrete framed structure with a structural steel framed roof. The building platform will be at approximately RL25.39m and will require a maximum excavation depth of 2.5m adjacent to the western corner, with filling up to 0.7m required along the east. Maximum working column loads of approximately 2,000kN are anticipated.

4.2 Detailed Investigation Procedure

Three boreholes (BH8, BH10 and BH11) were auger drilled to depths between 0.8m and 3.2m using our JK250 drilling rig. Due to premature refusal, BH10 was relocated and drilled as BH10a to a final depth of 2.5m. Due to its shallow depth, SPTs were not carried out within the soil profile. However, the bedrock was proven using a 'TC' bit.

4.3 Results of Investigation

4.3.1 Site Description

The site of the proposed Sub-Acute Building is located on the western side of the Hospital complex adjacent to the Belgrave Street and South Street intersection. At the time of the fieldwork, two single storey brick and rendered buildings were located on the site. An on-grade AC carpark was located to the north-west, South Street was located to the north-east, and a one to five storey brick building was located to the south-east. To the south-west was a grass and paved area which graded down to the south-east at approximately 3°. The buildings appeared to be in good external condition based on a cursory inspection from within the subject site, with no basements evident.

4.3.2 Subsurface Conditions

The 1:100,000 geological map of Sydney indicates that the site of the proposed Sub-Acute Building is underlain by Hawkesbury Sandstone. The investigation has revealed a generalised subsurface profile comprising surficial fill directly over sandstone bedrock. Groundwater was not encountered. Reference should be made to the BH8, BH10, BH10a and BH11 logs for detailed subsurface conditions at specific locations. A graphical borehole summary is presented as Figure 3 and a summary of the subsurface conditions as encountered, is presented below:

- AC, 40mm thick, was encountered at the surface of BH8. Reinforced concrete 120mm thick was encountered at the surface of BH10a.
- Fill comprising sand, gravelly sand, silty sand and clayey sand was encountered in all boreholes and included gravel inclusions. BH10 refused on an obstruction in the fill at a depth of 0.8m. Several attempts to redrill the borehole within the immediate vicinity refused at similar depths.
- Sandstone bedrock was encountered at a depth of 0.6m (BH8 and BH10a), and 0.9m (BH11). The sandstone was generally of medium or higher strength to the borehole termination depths between 2.5m and 3.2m.
- Groundwater was not encountered and all boreholes were 'dry' during and shortly after completion of drilling. We note that groundwater levels may not have stabilised during the limited observation period. Long term groundwater monitoring was not carried out.

4.3.3 Laboratory Test Results

The laboratory moisture content results on rock chip samples correlated reasonably well with our field assessed rock strengths.

A four-day soaked CBR value of 4.5% is indicated for the sand and clayey sand fill in BH11 when compacted to 98% of Standard density ratio.

The chemical test results indicated that the fill in BH10 was alkaline with relatively low chloride and sulphate contents.

4.4 Comments and Recommendations

4.4.1 Earthworks

Based on the investigation results, the proposed excavation to 2.5m will encounter the fill and extend into sandstone bedrock.

The soil cover should be readily excavatable using conventional earthworks equipment. Some of the underlying weathered sandstone of extremely or very low strength, if encountered, may also be excavated by a large bucket excavator, possibly with some ripping. However, we expect excavation of low to medium and higher strength sandstone would be most effectively excavated using a hydraulic impact rock hammer. This equipment would also be required for breaking up boulders or blocks, for trimming rock excavation side slopes, and for detailed rock excavation (such as for footings or buried services).

We recommend that considerable caution be taken during rock excavation on this site, as there will likely be direct transmission of ground vibrations to adjoining buildings and structures. Prior to excavation commencing, a detailed dilapidation report should be compiled on that portion of the building to the south-east which is closest to the proposed excavation. Excavation procedures and the dilapidation report should be carefully reviewed prior to excavation commencing, so that appropriate equipment is used. The dilapidation report can also be used as a benchmark against which to assess possible future claims for damage as a result of the works.

We recommend that continuous vibration monitoring be carried out during rock excavations. The excavation with hydraulic rock hammers, if used, should commence away from likely critical areas (ie. commence over the north and north-west) using a moderately sized excavator fitted with a relatively low energy hydraulic hammer, no larger than a Krupp 600 size or equivalent. Vibrations, measured as Peak Particle Velocity (PPV) on the neighbouring buildings and structures, should be limited to no higher than 5mm/sec. We note that this limit is based on structural considerations. Stricter limits may be applicable for operational requirements. If it is found that transmitted vibrations are excessive, then it would be necessary to change to a considerably smaller rock hammer or to use alternative excavation techniques. Alternative excavation techniques which will significantly reduce vibrations include a rotary grinder or grid sawing in conjunction with ripping and/or hammering. The vibrations during excavation may be further dampened by providing a vertical saw cut slot along the perimeter of the excavation and maintaining the base of the slot at a lower level than the adjoining rock excavation at all times. When using a rock saw or rotary grinder, the resulting dust must be suppressed by spraying with water.

The following procedures are recommended to reduce vibrations if rock hammers are used:

- Maintain rock hammer orientated towards the face and enlarge excavation by breaking small wedges off the face.
- Operate hammer in short bursts only to reduce amplification of vibrations.

- Use excavation contractors with experience in confined work with a competent supervisor who is aware of vibration damage risks, possible rock face instability issues, etc. The contractor should be provided with a copy of this report and have all appropriate statutory and public liability insurances.

We would expect some groundwater seepage flows will occur at the soil-rock interface and through joints and bedding planes within the completed cut faces, particularly after periods of heavy rain. Seepage, if any, during excavation is expected to be satisfactorily controlled by conventional sump pumping or gravity drainage systems.

4.4.2 Excavation Support

Where space permits, excavations through the soil profile should be temporarily battered to a side slope no steeper than 1V:1.5H. However, possible seepage at the soil-rock interface may cause localised instability at the toe of soil batters and allowance should be made for sand bagging. Where temporary batters cannot be accommodated or where not preferred, a retention system would be required and should be installed prior to excavation commencing.

Given its relatively shallow depth, we anticipate that battering of the soil profile will be feasible.

We expect that good quality sandstone of low or higher strength may be cut vertically. However, localised stabilisation measures may be necessary if adverse defects (such as inclined joints or bedding) are found. Treatment for zones requiring stabilisation may include rock bolting, shotcreting, underpinning, etc. Clay seams occurring in permanently exposed sandstone slopes may also require 'dental' treatment. We therefore recommend that the rock face be progressively inspected by a geotechnical engineer as excavation proceeds, to identify adverse defects and propose appropriate stabilisation measures.

4.4.3 Engineered Fill

Engineered fill, if required, should be as for Section 3.4.1 above.

4.4.4 Retaining Walls

Retaining walls should be designed using the following parameters:

- For conventional free-standing cantilever walls where movement is of little concern (ie. where only garden or open areas are being retained), adopt a triangular lateral earth pressure distribution and an 'active' earth pressure coefficient, K_a, of 0.33, for the soil profile and extremely weathered bedrock, assuming a horizontal retained surface.
- For cantilever walls, the tops of which will be restrained by the ground floor slab prior to backfill, or which support movement sensitive elements, adopt a triangular lateral earth pressure distribution and an 'at rest' earth pressure coefficient, K_o, of 0.6, for the soil profile and extremely weathered bedrock, assuming a horizontal retained surface.
- A bulk unit weight of 20kN/m^3 should be adopted for the soil profile and extremely weathered bedrock.
- Any surcharge affecting the walls (eg. traffic and construction loading, adjacent high level footings, etc) should be allowed in the design using the appropriate earth pressure coefficient from above.

- The retaining walls should be designed as drained and measures taken to induce complete and permanent drainage of the ground behind the walls. The subsoil drains should incorporate a non-woven geotextile fabric (eg. Bidim A34) to act as a filter against subsoil erosion.
- For lateral toe restraint, the wall footings should be keyed into the underlying bedrock below excavation level. An allowable lateral toe resistance of 300kPa is applicable for low or higher strength sandstone. The upper 0.3m below bulk excavation level should be ignored in the analysis to take excavation tolerances and disturbance into account.

4.4.5 Footings

The site has a 'Class P' classification in accordance with AS2870 due to the existing fill. However, given that the proposed bulk excavation will expose bedrock over the north-west, we recommend that the entire building be supported on bedrock. Conventional pad or strip footings founded in sandstone bedrock of low or higher strength, may be designed for an allowable bearing pressure of 1,000kPa.

All footing excavations should be inspected by a geotechnical engineer prior to pouring to confirm that adequate founding material has been exposed.

Based on the chemical test results from BH10, a 'non-aggressive' exposure classification is applicable to buried concrete, in accordance with AS2159.

4.4.6 On-Grade Floor Slabs

We recommend that the entire floor slab be supported on sandstone bedrock, so as avoid differential settlements. However, underfloor drainage should be provided over the bedrock within the cut areas. The underfloor drainage should comprise a strong, durable, single sized washed aggregate (such as 'blue metal' gravel) and should connect with the wall drains and lead groundwater seepage to a sump for pumped or gravity drainage to the stormwater system.

4.4.7 Hardstand Areas and Pavements

Hardstand areas and pavements should be designed based on a soaked CBR value of 4% or a short term Young's Modulus value of 30MPa.

Concrete pavements should be supported on a subbase layer of RTA 305 Specification unbound or equivalent good quality crushed rock, compacted to a density of at least 100% SMDD. The subbase material would provide more uniform slab support and would reduce 'pumping' of subgrade 'fines' at joints. Concrete pavements should be provided with effective shear connection at joints by using dowels or keys.

Subsoil drains should be provided along the perimeter of pavements, with inverts not less than 0.2m below clay subgrade level. The drainage trench should be excavated with a longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. The pavement subgrade should be graded to promote water flow or infiltration towards subsoil drains.

5 OXYGEN TANK HARDSTAND

5.1 Proposed Development

Based on discussions with Mr Tom Krapeshlis of Cardno, the structural engineers, the proposed finished level of the Oxygen Tank Hardstand will be constructed at between RL27.35m and RL28.0m.

5.2 Detailed Investigation Procedure

The fieldwork for the investigation comprised the auger drilling of one borehole (BH9) using our track mounted JK250 drilling rig. Due to its shallow depth, SPTs were not carried out within the soil profile. However, the bedrock was proven using a 'TC' bit.

5.3 Results of Investigation

5.3.1 Site Description

The proposed Oxygen Tank Hardstand area will be located over the northern portion of the open on-grade AC carpark at the western end of the Hospital complex. A demountable building was located to the north and a covered walkway was located to the west. AC pavements continued to the south and east.

5.3.2 Subsurface Conditions

The 1:100,000 geological map of Sydney indicates that the site for the proposed Oxygen Tank Hardstand is underlain by Hawkesbury Sandstone. The investigation has revealed a subsurface profile below the paving comprising sandy fill over competent sandstone bedrock. Groundwater was not encountered. Reference should be made to the BH9 log for detailed subsurface conditions. A summary of the subsurface conditions is presented below:

- An AC pavement, 40mm thick, was encountered at the surface of BH9. The AC was underlain by a sandy fill bedding to a depth of 0.1m.
- Fill comprising sand was encountered to a depth of 0.5m.
- The fill was immediately underlain by sandstone bedrock. The sandstone bedrock was of medium to high strength on first contact and extended to a depth of 2.2m where refusal to further borehole penetration was encountered.
- Groundwater was not encountered and the borehole was 'dry' during and on completion of drilling. We note that the groundwater level may not have stabilised during the limited observation period. Long term groundwater monitoring was not carried out.

5.3.3 Laboratory Test Results

The laboratory moisture content testing on rock chip samples correlated reasonably well with our field assessed rock strengths.

5.4 Comments and Recommendations

Based on the investigation results, the proposed Oxygen Tank Hardstand will be constructed between RL27.35m and RL28.0m and will therefore be supported on bedrock which was encountered in BH9 at 27.8m.

The soil profile may be excavated using conventional equipment with any minor excavations into sandstone bedrock probably requiring ripping and/or the use of hydraulic impact rock hammers. The excavation through the soil profile should be temporary battered to a side slope no steeper than 1V:1H. Over the longer term, the batter slope should be flattened to no steeper than 1V:3H or shored. We further recommend that underfloor drainage be provided, using a strong, durable, single sized aggregate, to direct groundwater seepage to a sump for pumped or gravity drainage to the stormwater system.

6 WASTE HANDLING AREA

6.1 Proposed Development

The proposed Waste Handling Area will be constructed over a building platform at RL31.0m. It is envisaged that the roof of the existing Waste Handling Area will be reused after it is removed from the area of the proposed new Emergency Department Building.

6.2 Detailed Investigation Procedure

A borehole (BH1) was auger drilled to a depth of 7.5m using our track mounted JK250 drilling rig. Regular SPTs were carried out in the soil profile and the bedrock was proven using a 'TC' bit. BH3 to the south-west, which was drilled for the proposed new Emergency Department Building, is also relevant.

6.3 Results of Investigation

6.3.1 Site Description

The site of the proposed new Waste Handling Area is located to the east and south-east of existing Griffith House and the Fire Station, respectively. Griffith House is a one and two storey brick building and is Heritage listed. The area comprises an AC surfaced open on-grade parking.

6.3.2 Subsurface Conditions

The 1:100,000 geological map of Sydney indicates that the site for the proposed Waste Handling Area is underlain by Hawkesbury Sandstone with Ashfield Shale of the Wianamatta Group indicated a short distance to the north. The investigation has revealed a subsurface profile comprising fill over residual silty and sandy clay with shale and sandstone bedrock at relatively shallow depth. Groundwater was not encountered. This indicates that the site probably overlies the interface between the Ashfield Shales and the underlying Hawkesbury Sandstone. Reference should be made to the BH1 and BH3 logs for detailed subsurface conditions at specific locations. A summary of the encountered subsurface conditions follows:

- AC surfacing, 30mm thick, was encountered at the surface of BH1.
- Fill comprising silty sand, gravelly sand, and sandy clay with gravel and brick fragment inclusions, was encountered to depths of 0.8m and 0.7m in BH1 and BH3, respectively.
- Residual silty or silty sandy clay was encountered below the fill in both boreholes. The clays generally had a variable plasticity and a very stiff strength.
- Shale bedrock was encountered at a depth of 1.65m in BH1 and extended to a depth of 3.7m. The shale was of extremely low or low strength, and was underlain by a 0.5m thick band of interbedded shale and sandstone of very low to low strength.
- Sandstone bedrock was encountered at a depth of 4m below the interbedded shale and sandstone in BH1 and at 1.6m below the residual sandy clay in BH3. The sandstone in BH1 was of very low strength, improving to medium and high strength with depth. In BH3, the sandstone was of extremely low strength improving to very low and low strength with depth.

- Groundwater was not encountered and the boreholes were 'dry' during and shortly after completion of drilling. We note that groundwater levels may not have stabilised during the observation period. Long term groundwater monitoring was not carried out.

6.4 Comments and Recommendations

The columns to the roof of the proposed Waste Handling Area may be supported using pad footings founded in the residual silty or silty sandy clay below depths of 0.7m to 0.8m, where an allowable bearing pressure of 150kPa is applicable. The site classifies as 'Class P' in accordance with AS2870, due to the existing fill. However, footings founded as above will be subject to maximum shrink-swell movements, associated with a 'Class M' site.

Alternatively, the use of conventional pile footings may be considered. We note that the upper soil horizons comprise sands which may require the use of temporary liners to avoid side wall collapse. Piles will extend through the fill and residual soil into shale or sandstone bedrock. For rationalisation of the footing design, we recommend that piles founded at least 0.3m into shale or sandstone of at least low or very low strength, respectively, be designed for an allowable end bearing pressure of 700kPa. In addition, an allowable shaft adhesion value of 70kPa may be applied to that length of rock socket in excess of 0.3m in compression, and 35kPa when uplift is being resisted.

All footing excavations should be inspected by a geotechnical engineer prior to pouring to confirm that adequate founding material has been exposed.

7 SUBSTATION BUILDING

7.1 Proposed Development

No details on the proposed Substation Building were provided. We have therefore assumed a typical one storey building which is constructed at grade.

7.2 Detailed Investigation Procedure

One borehole (BH14) was drilled to a refusal depth of 0.3m using a hand auger. In addition, a Dynamic Cone Penetration (DCP) test was carried out to a refusal depth of 3.7m.

7.3 Results of Investigation

7.3.1 Site Description

The site of the proposed Substation Building is located over a grassed area between Gray Street and the adjacent four storey carpark.

7.3.2 Subsurface Conditions

The 1:100,000 geological map of Sydney indicates that the proposed Substation Building site is underlain by Hawkesbury Sandstone. The investigation has revealed a subsurface profile comprising surficial sandy fill over residual silty clay. The DCP14 results indicates that the soil profile extends to moderate depth. It is possible that blow counts in excess of, say, 15 blows per 100mm, represent gravel or iron indurated inclusions over the upper horizons and extremely weathered bands or iron indurated zones within the lower horizons. Refusal of DCP14 occurred at a depth of 3.65m on inferred sandstone bedrock.

7.4 Comments and Recommendations

A 'Class HI' site classification probably applies in accordance with AS2870.

We recommend that the proposed Substation Building be supported using conventional pad, strip or stiffened raft slab footings founded in natural soils, where an allowable bearing pressure of 150kPa may be adopted. Alternatively, the building may be supported using conventional bored piles founded in the underlying weathered sandstone, where an allowable end bearing pressure of 1,000kPa is applicable. We note that as a result of the investigation techniques adopted, the nature and composition of the subsurface materials in BH/DCP14 have been inferred.

We therefore recommend that at the commencement of construction, at least two test pits be excavated and inspected by a geotechnical engineer, to confirm the subsurface profile and the footing recommendations.

8 PROPOSED ENGINEERING BUILDING

8.1 Proposed Development

Based on discussions with Mr Tom Krapeshlis of Cardno, the structural engineers, the proposed Engineering Building will comprise a two storey modular structure supported by a steel chassis suspended between stub columns approximately 0.6m above ground level.

8.2 Detailed Investigation Procedure

One borehole (BH12) was auger drilled to a depth of 3.0m using our track mounted JK250 drilling rig. Regular SPT tests were carried out within the soil profile and the bedrock was proven using a 'TC' bit.

8.3 Results of Investigation

8.3.1 Site Description

The site of the proposed Engineering Building is located at the south-western end of the site adjacent to the St George Private Hospital. AC pavements were located along the north-west, north-east and south-west and a single storey St George Private Hospital building was located along the south-east. A two storey brick building was located across the AC pavements to the north.

8.3.2 Subsurface Conditions

The 1:100,000 geological map of Sydney indicates that the proposed Engineering Building site is underlain by Hawkesbury Sandstone. The investigation has revealed a subsurface profile comprising sandy fill over residual sandy clay with competent sandstone bedrock encountered at relatively shallow depth. Groundwater was not encountered. A summary of the subsurface profile as encountered, is presented below:

- AC paving, 40mm thick, was encountered at the surface of BH12 and was underlain by a sand subbase 160mm thick.
- Fill comprising clayey sand with igneous gravel and ash inclusions was encountered below the pavement and extended to a depth of 1.2m. The fill appeared moderately compacted.
- Residual sandy clay of medium plasticity and hard strength was encountered below the fill.
- Sandstone bedrock was encountered at a depth of 2.2m. The sandstone was slightly weathered and of high strength to the borehole termination depth at 3.0m.

- Groundwater was not encountered and BH12 was 'dry' during and on completion of drilling. We note that the groundwater level may not have stabilised during the limited observation period. Long term groundwater monitoring was not carried out.

8.4 Comments and Recommendations

The site of the proposed Engineering Building classifies as 'Class P' in accordance with AS2870, due to the existing fill. However, we recommend that the proposed stub columns be supported using conventional bored pile footings which are founded in sandstone bedrock, where an allowable end bearing pressure of 1,000kPa may be adopted. In addition, an allowable shaft adhesion value of 100kPa may be applied over the rock socket in compression, and 50kPa where the socket is being designed to resist uplift.

All footings should be inspected by a geotechnical engineer prior to pouring to confirm that adequate founding material has been exposed.

9 FURTHER GEOTECHNICAL INPUT

The following summarises the further geotechnical input which is required and which has been detailed in the preceding sections of this report:

- Dilapidation survey of Griffith Building and of the existing buildings adjacent to the proposed Emergency Department and Sub-Acute Buildings.
- Inspection of test pits which have been excavated in the area of the proposed Substation Building to confirm the subsoil conditions and the recommendations.
- Quantitative vibration monitoring during rock excavations for the proposed Sub-Acute Building.
- Geotechnical inspection of all cut rock faces.

- Density testing of all engineered fill.
- Direction of all proof-rolling.
- Geotechnical inspection of all footing excavations.
- Proof-testing of all anchors, if appropriate.

10 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and Jeffery and Katauskas Pty Ltd accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

The long term successful performance of floor slabs and pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, we recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and potential difficulties. This meeting should clearly define the lines of communication and responsibility.

Occasionally, the subsurface conditions between the completed boreholes may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

A waste classification will need to be assigned to any soil excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), General Solid, Restricted Solid or Hazardous Waste. If the natural soil has been stockpiled, classification of this soil as Excavated Natural Material (ENM) can also be undertaken, if requested. However, the criteria for ENM are more stringent and the cost associated with attempting to meet these criteria may be significant. Analysis takes seven to 10 working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of Jeffery and Katauskas Pty Ltd. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

Should you have any queries regarding this report, please do not hesitate to contact the undersigned.

A ZENON
Senior Associate
For and on behalf of
JEFFERY AND KATAUSKAS PTY LTD.

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SOIL TEST SERVICES

ABN 43 002 145 173

Ref No: 25264Z

TABLE A
SUMMARY OF LABORATORY TEST RESULTS

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
1	2.00-2.40	9.5				
1	2.70-3.00	9.9				
1	4.10-4.50	10.6				
2	1.50-1.95	17.5	34	15	19	7.5
2	3.50-3.70	6.9				
2	4.10-4.50	5.8				
2	4.70-5.00	6.6				
3	2.50-3.00	13.9				
3	4.00-4.50	8.9				
5	1.50-1.95	19.0	25	12	13	4.0
5	3.20-3.50	8.5				
5	4.00-4.50	6.0				
5	4.80-5.00	5.5				
6	2.60-2.90	4.9				
6	3.10-3.40	3.8				
6	3.60-3.90	4.2				
7	1.00-1.50	8.9				
7	2.20-2.53	5.7				
8	0.80-1.00	2.9				
8	1.20-1.50	4.7				
8	1.80-2.00	8.6				
8	2.50-2.70	2.6				
9	0.60-0.80	4.9				
9	0.90-1.20	5.6				
9	1.30-1.50	5.1				
9	1.80-2.20	2.9				
10a	1.00-1.50	4.7				
10a	1.80-2.20	5.5				
10a	2.30-2.50	5.0				
11	1.40-1.50	4.0				
11	1.70-2.00	4.8				
11	2.30-2.50	4.9				
11	2.80-3.00	4.7				
11	3.00-3.20	3.1				
12	2.50-3.00	4.6				
13	1.10-1.50	7.9				
13	1.80-2.30	8.8				
13	2.60-3.00	5.1				

Notes:
- The test sample for liquid and plastic limit was air-dried & dry-sieved
- The linear shrinkage mould was 125mm
- Refer to appropriate notes for soil descriptions

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SOIL TEST SERVICES
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Ref No: 25264Z
Table B: Page 1 of 1

TABLE B
SUMMARY OF FOUR DAY SOAKED C.B.R.TEST RESULTS

BOREHOLE NUMBER	2	11
DEPTH (m)	0.60 - 1.50	0.00 - 0.30
Surcharge (kg)	9.0	9.0
Maximum Dry Density (t/m^3)	1.736 STD	1.566 STD
Optimum Moisture Content (%)	17.0	19.0
Moulded Dry Density (t/m^3)	1.70	1.54
Sample Density Ratio (%)	98	98
Sample Moisture Ratio (%)	109	77
Moisture Contents		
Insitu (%)	18.0	14.6
Moulded (%)	18.6	14.7
After soaking and		
After Test, Top 30mm(%)	20.4	24.9
Remaining Depth (%)	18.8	24.0
Material Retained on 19mm Sieve (%)	0	0
Swell (%)	0.0	0.0
C.B.R. value: @5.0mm penetration	4.5	4.5

NOTES:

- Refer to appropriate Borehole logs for soil descriptions
- Test Methods :
  - (a) Soaked C.B.R. : AS 1289 6.1.1
  - (b) Standard Compaction : AS 1289 5.1.1
  - (c) Moisture Content : AS 1289 2.1.1

Approved Signatory
(A.Tatikonda)

Date: 1/11/11

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SOIL TEST SERVICES

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Ref No: 25264Z

TABLE C
SUMMARY OF POINT LOAD STRENGTH INDEX TEST RESULTS

BOREHOLE NUMBER	DEPTH m	$I_{S\,(50)}$ MPa	ESTIMATED UNCONFINED COMPRESSIVE STRENGTH (MPa)
3	4.60-4.66	0.3	6
	4.97-5.01	0.1	2
	5.36-5.41	0.4	8
	5.86-5.93	0.3	6
	6.41-6.46	0.05	<1
	7.14-7.19	0.9	18
	7.52-7.57	0.7	14
	7.97-8.02	0.7	14
7	2.48-5.53	2.0	40
	3.16-3.21	1.5	30
	3.65-3.70	1.6	32
	4.33-4.37	1.1	22
	4.97-5.02	1.5	30
	5.32-5.37	1.0	20

NOTES:

1. In the above table testing was completed in the Axial direction.
2. The above strength tests were completed at the 'as received' moisture content.
3. Test Method: RTA T223.
4. The Estimated Unconfined Compressive Strength was calculated from the point load Strength Index by the following approximate relationship and rounded off to the nearest whole number :
   U.C.S. = 20 $I_{S\,(50)}$

TABLE D
Summary of Chemical Test Results

Location (BH)	Depth (m)	pH	Sulphate (mg/kg)	Chloride (mg/kg)
3	0.9 – 1.15	7.5	31	22
5	0.5 – 0.95	9.0	120	13
10	0.5 – 0.8	9.3	1,700	120

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
1
1/2

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED WASTE HANDLING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 13-10-11
Method: SPIRAL AUGER JK250
Logged/Checked by: H.W./ [signature]
R.L. Surface: ≈ 31.8m
Datum: AHD

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		0	-	ASPHALTIC CONCRETE: 30mm.t	D	-	-	
	N = 8 6,4,4			FILL: Gravelly sand, fine to medium grained, grey, with fine to medium grained sandstone and igneous gravel.				APPEARS MODERATELY COMPACTED
		1	CH	SILTY CLAY: high plasticity, orange brown and light grey, with fine to medium grained ironstone gravel.	MC<PL	VSt	400 400 400	TOO FRIABLE FOR HP TESTING
	N > 30 12,30/ 100mm REFUSAL			as above, but light grey.	MC<PL	H	>600	
			-	SHALE: light grey.	XW	EL		LOW 'TC' BIT RESISTANCE
		2		SHALE: dark grey.	DW	L		LOW TO MODERATE RESISTANCE
		3		as above, but with iron indurated bands.				
			-	INTERBEDDED SHALE AND SANDSTONE: fine to medium grained, dark grey and grey, with iron indurated bands.		VL-L		VERY LOW RESISTANCE
ON COMPLETION		4		SANDSTONE: fine to medium grained, light grey, with iron indurated bands.		VL		LOW RESISTANCE
AFTER 2 HRS		5		SANDSTONE: fine to coarse grained, light grey and yellow brown.	SW-FR	M		MODERATE RESISTANCE WITH HIGH BANDS
						H		HIGH RESISTANCE
		6		as above, but with iron indurated bands.				
		7						

SAMPLES: ES, U50, DB, DS

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Borehole No.
1
2/2

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED WASTE HANDLING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 13-10-11
Method: SPIRAL AUGER JK250
R.L. Surface: ≈ 31.8m
Datum: AHD
Logged/Checked by: H.W./

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
									SANDSTONE: fine to medium grained, light grey and yellow brown, with iron indurated bands.	SW-FR	H		
											M-H		MODERATE RESISTANCE
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No. 2

1/1

Client: HEALTH INFRASTRUCTURE NSW

Project: PROPOSED EMERGENCY DEPARTMENT BUILDING

Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z

Date: 13-10-11

Method: SPIRAL AUGER JK250

R.L. Surface: ≈ 30.3m

Datum: AHD

Logged/Checked by: H.W./

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		FILL: Silty sand, fine to medium grained, dark brown, with root fibres.	D			GRASS COVER
				FILL: Clayey sand, fine to medium grained, dark brown.				APPEARS MODERATELY COMPACTED
	N = 6 3,3,3		SC	CLAYEY SAND: fine to medium grained, light grey.		L		
		1	CL	SILTY CLAY: medium plasticity, orange brown and light grey, with fine grained sand.	MC>PL	VSt	330 370 290	
	N = 16 4,7,9	2	CL	SANDY CLAY: medium plasticity, light grey, fine grained sand, with fine grained ironstone gravel.			290 330 340	
	SPT 15/100mm REFUSAL	3	SC	CLAYEY SAND: fine to medium grained, light grey.				
			-	SANDSTONE: fine to coarse grained, light grey and yellow brown, with iron indurated bands.	DW	L	-	LOW 'TC' BIT RESISTANCE
								LOW TO MODERATE RESISTANCE
		4			SW	M		MODERATE RESISTANCE WITH LOW BANDS
		5			FR	M-H		MODERATE TO HIGH RESISTANCE
		6		END OF BOREHOLE AT 6.1m				'TC' BIT REFUSAL ON INFERRED SANDSTONE
		7						

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BOREHOLE LOG

Borehole No. 3
1/2

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED EMERGENCY DEPARTMENT BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 14-10-11
Method: SPIRAL AUGER JK300
Logged/Checked by: M.L.T./
R.L. Surface: ≈ 30.4m
Datum: AHD

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION OF AUGERING		0		FILL: Mulch 50mm.t	M			
				FILL: Silty sand, fine to medium grained, dark brown, with fine to medium grained igneous gravel.	- / MC≈PL			
				FILL: Concrete boulders 200mm.				
	N = 7 2,3,4	1	CL	FILL: Silty sandy clay, low plasticity, dark grey and dark brown, fine grained sand, trace of fine grained igneous gravel and brick fragments.	MC≈PL	VSt	350 350 350	RESIDUAL
				SILTY SANDY CLAY: low plasticity, fine grained sand, light grey, orange brown and red brown.		H	450	
	N > 25 7,11, 14/50mm REFUSAL	2	-	SANDSTONE: fine grained, light grey stained orange brown and red brown.	XW	EL		VERY LOW 'TC' BIT RESISTANCE
ON COMPLETION OF CORING				as above, but with trace of clay bands.	DW	VL		VERY LOW RESISTANCE WITH LOW BANDS
		3						
				as above, but fine to medium grained, without clay bands		L		LOW TO MODERATE RESISTANCE
		4						
		5						
		6		REFER TO CORED BOREHOLE LOG				
		7						


JEFFERY & KATAUSKAS PTY LTD
JOB NO.252642 BH3 START CORING AT 4.45m
4.45
5
6
C.L 0.09m
C.L 0.1m
7
END OF BH AT 8.00m

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CORED BOREHOLE LOG

Borehole No. **3** 2/2

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED EMERGENCY DEPARTMENT BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z | **Core Size:** NMLC | **R.L. Surface:** ≈ 30.4m
Date: 14-10-11 | **Inclination:** VERTICAL | **Datum:** AHD
Drill Type: JK300 | **Bearing:** - | **Logged/Checked by:** M.L.T./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (EL VL L M H VH EH)	DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
		4		START CORING AT 4.45m						
FULL RET-URN				SANDSTONE: fine to medium grained, light grey, bedded at 0-5°.	DW	L	×			
						VL	×		- XWS, 0°, 10mm.t	
		5			FR	M	×			
				as above, but with shale clasts and flecks.			×		- XWS, 0°, 40mm.t	
		6		as above, but light grey and orange brown.	DW	L-M			- Be, 0°, P	
				CORE LOSS 0.09m						
				SANDSTONE: fine to medium grained, light grey, bedded at 0-5°.	XW	EL	×			
				CORE LOSS 0.1m						
		7		SANDSTONE: fine to medium grained, light grey, bedded at 0°.	FR	M	× × ×			
		8		END OF BOREHOLE AT 8.00m						
		9								
		10								

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 4
1/1

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED EMERGENCY DEPARTMENT BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 14-10-11
Method: SPIRAL AUGER JK300
Logged/Checked by: M.L.T./ PR
R.L. Surface: ≈ 28.5m
Datum: AHD

Groundwater Record	SAMPLES ES	SAMPLES U50	SAMPLES DB	SAMPLES DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■					0			FILL: Silty sand, fine grained, dark brown, with roots.	D			
									END OF BOREHOLE AT 0.2m				BOREHOLE ATTEMPTED AT THREE LOCATIONS AND ALL REFUSED AT SIMILAR DEPTHS ON AN OBSTRUCTION IN THE FILL. (POSSIBLE BURIED CONCRETE OBSTRUCTION)
						1							
						2							
						3							
						4							
						5							
						6							
						7							

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CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. **5**
1/1

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED EMERGENCY DEPARTMENT BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 13-10-11
Method: SPIRAL AUGER JK250
Logged/Checked by: H.W./PR
R.L. Surface: ≈ 28.4m
Datum: AHD

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		BRICK PAVERS: 80mm.t				
			-	FILL: Sandy gravel, fine to medium grained igneous and shale gravel, dark grey, fine to coarse grained sand, with silt.	D	-	-	APPEARS MODERATELY COMPACTED
	N = 8 5,5,3			FILL: Gravelly sand, fine to medium grained, grey brown, with fine to medium grained ironstone, igneous and shale gravel.				
		1	CH	SILTY CLAY: high plasticity, light grey and yellow brown.	MC<PL	VSt		TOO FRIABLE FOR HP TESTING
	N = 9 5,4,5		CL	SANDY CLAY: medium plasticity, light grey.	MC>PL		230 200 210	
		2		as above, but with ironstone gravel.				BANDS OF VERY LOW 'TC' BIT RESISTANCE
								VERY LOW RESISTANCE
	SPT 25/100mm REFUSAL	3	-	SANDSTONE: fine to medium grained, light grey.	DW	VL-L	-	
					SW	M		MODERATE RESISTANCE WITH LOW BANDS
		4						
		5		as above, but with iron indurated bands.		M-H		HIGH RESISTANCE
		6		END OF BOREHOLE AT 6.0m				
		7						

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BOREHOLE LOG

Borehole No. **6**
1/1

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED EMERGENCY DEPARTMENT BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 13-10-11
Method: SPIRAL AUGER JK250
Logged/Checked by: H.W./
R.L. Surface: ≈ 27.5m
Datum: AHD

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			BRICK PAVERS: 80mm.t				
					-	FILL: Gravelly sand, fine to medium grained, with fine to coarse grained sandstone gravel, fine grained igneous gravel.	D	-	-	APPEARS MODERATELY COMPACTED
		N = 14 8,7,7	1			FILL: Gravelly clayey sand, fine to coarse grained sandstone, ironstone and igneous gravel.				
		SPT 20/150mm REFUSAL			SC	CLAYEY SAND: fine grained, light grey, with fine to medium grained ironstone gravel.	D	VD	-	
			2							
					-	SANDSTONE: fine to coarse grained, light grey, with iron indurated bands.	SW	M	-	MODERATE 'TC' BIT RESISTANCE
								H		HIGH RESISTANCE
			3				FR			
			4			END OF BOREHOLE AT 3.9m				'TC' BIT REFUSAL ON INFERRED SANDSTONE
			5							
			6							
			7							

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BOREHOLE LOG

Borehole No. **7**
1/2

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED EMERGENCY DEPARTMENT BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 14-10-11
Method: SPIRAL AUGER JK300
Logged/Checked by: M.L.T./
R.L. Surface: ≈ 27.5m
Datum: AHD

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION OF AUGERING			0			CONCRETE: 100mm.t				7mm DIA. REINFORCEMENT, 70mm TOP COVER
					-	FILL: Sand, fine to medium grained, brown.	M	-	-	
					CL	SILTY CLAY: medium plasticity, light grey mottled orange brown and red brown.	MC<PL	H	-	
		N > 9 9,9/60mm REFUSAL			-	SANDSTONE: fine grained, light grey stained orange brown and red brown.	XW	EL	420	VERY LOW 'TC' BIT RESISTANCE
			1				DW	VL		
▼			2							
						SANDSTONE: fine to medium grained, light grey and orange brown.		L-M		LOW TO MODERATE RESISTANCE
						REFER TO CORED BOREHOLE LOG				
			3							
			4							
			5							
			6							
			7							


JEFFERY & KATAUSKAS PTY LTD
JOB NO. 25264Z BH7 START CORING AT 2.39m
2.39m
3
4
5
END 5.50m

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CORED BOREHOLE LOG

Borehole No. **7**

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED EMERGENCY DEPARTMENT BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z | **Core Size:** NMLC | **R.L. Surface:** ≈ 27.5m
Date: 14-10-11 | **Inclination:** VERTICAL | **Datum:** AHD
Drill Type: JK300 | **Bearing:** - | **Logged/Checked by:** M.L.T./

Water Loss/Level	Barrel Lift	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, structure, minor components.)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (EL VL L M H VH EH)	DEFECT SPACING (mm) (500 300 100 50 30 10)	DEFECT DETAILS DESCRIPTION (Type, inclination, thickness, planarity, roughness, coating.) Specific	General
		2		START CORING AT 2.39m						
FULL RETURN				SANDSTONE: fine to medium grained, light grey stained orange brown, bedded at 0-10°	SW	H	×			
		3					×			
				as above, but coarse grained, red brown.	DW		×		- Be, 5°, P, S, IS	
		4					×			
									- CS, 0°, 7mm.t	
		5					×			
							×			
				as above, but light grey stained orange brown.	SW					
				END OF BOREHOLE AT 5.5m						
		6								
		7								
		8								
		9								

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BOREHOLE LOG

Borehole No. **8**

1/1

Client: HEALTH INFRASTRUCTURE NSW

Project: PROPOSED SUB-ACUTE BUILDING

Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z

Date: 14-10-11

Method: SPIRAL AUGER JK250

Logged/Checked by: H.W./

R.L. Surface: ≈ 26.9m

Datum: AHD

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0		-	ASPHALTIC CONCRETE: 40mm.t	D			
						FILL: Gravelly sand, fine to coarse grained, grey brown, fine to medium grained ironstone, sandstone and igneous gravel.				
		SPT 10/30mm REFUSAL			-	FILL: Gravelly sand, fine to coarse grained, orange brown, fine to coarse grained ironstone gravel.	SW	M	-	MODERATE TO HIGH 'TC' BIT RESISTANCE
			1			SANDSTONE: fine to coarse grained, light grey and yellow brown.				
						as above, but light grey.	FR	H		HIGH RESISTANCE WITH MODERATE BANDS
			2							HIGH RESISTANCE
						as above, but with iron indurated bands.				
			3			END OF BOREHOLE AT 3.0m				
			4							
			5							
			6							
			7							

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Borehole No. 9
1/1

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED OXYGEN TANK HARDSTAND
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 14-10-11
Method: SPIRAL AUGER JK250
Logged/Checked by: H.W./
R.L. Surface: ≈ 28.3m
Datum: AHD

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0		-	ASPHALTIC CONCRETE: 40mm.t				
						FILL: Sand, fine to coarse grained, grey brown, fine to medium grained igneous gravel.	D			
		SPT 10/0mm REFUSAL			-	FILL: Sand, fine to medium grained yellow brown.				
						SANDSTONE: fine to coarse grained, light grey, with iron indurated bands.	SW	M-H	-	MODERATE TO HIGH 'TC' BIT RESISTANCE
			1							MODERATE RESISTANCE
										MODERATE TO HIGH RESISTANCE WITH LOW BANDS
			2							HIGH RESISTANCE
			3			END OF BOREHOLE AT 2.2m				'TC' BIT REFUSAL ON SANDSTONE BEDROCK
			4							
			5							
			6							
			7							

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Borehole No. **10**
1/1

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED SUB-ACUTE BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z | **Method:** SPIRAL AUGER JK250 | **R.L. Surface:** ≈ 25.8m
Date: 14-10-11 | **Datum:** AHD
Logged/Checked by: H.W./

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	ES		0			FILL: Silty sand, fine to medium grained, dark brown, with fine to medium grained ironstone and sandstone gravel and root fibres.				GRASS COVER
	ES, DS	N > 30 12,20/ 150mm REFUSAL				FILL: Sand, fine to coarse grained, red brown, with fine to medium grained ironstone gravel.				
			1			FILL: Sand, fine to coarse grained, grey and brown, with fine to medium grained ironstone, sandstone and igneous gravel and concrete fragments.				'TC' BIT REFUSAL ON CONCRETE. INFERRED SERVICE TRENCH
						END OF BOREHOLE AT 0.8m				
			2							
			3							
			4							
			5							
			6							
			7							

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Borehole No.
10a
1/1

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED SUB-ACUTE BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 14-10-11
Method: SPIRAL AUGER JK250
R.L. Surface: ≈ 25.4m
Datum: AHD
Logged/Checked by: H.W./ [signature]

Groundwater Record	Samples (ES / U50 / DB / DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0		-	CONCRETE: 120mm.t	W	-	-	7mm DIA. REINFORCEMENT, 80mm TOP COVER
						FILL: Gravel, fine to coarse grained igneous and ironstone gravel.				
		SPT 10/100mm REFUSAL			SC	FILL: Sand, fine to medium grained, grey brown, with fine to coarse grained ironstone and igneous gravel.	M	-	-	
					-	CLAYEY SAND: fine to medium grained, yellow brown.	SW	M	-	MODERATE 'TC' BIT RESISTANCE
			1			SANDSTONE: fine to coarse grained, yellow brown.		M-H		HIGH RESISTANCE
						SANDSTONE: fine to medium grained, light grey and yellow brown, with iron indurated bands.		M		MODERATE RESISTANCE WITH VERY LOW BANDS
			2				FR	M-H		MODERATE TO HIGH RESISTANCE
						END OF BOREHOLE AT 2.5m				
			3							
			4							
			5							
			6							
			7							

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Borehole No. **11**

1/1

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE NSW

Project: PROPOSED SUB-ACUTE BUILDING

Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z **Method:** SPIRAL AUGER JK250 **R.L. Surface:** ≈ 27.8m

Date: 14-10-11 **Datum:** AHD

Logged/Checked by: H.W./

Groundwater Record	Samples (ES / U50 / DB / DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			FILL: Sand, fine to medium grained, dark brown, with fine to medium grained sandstone, ironstone and slag gravel, root fibres, trace of silt.	D			GRASS COVER APPEARS MODERATELY COMPACTED
		N = 13 5,4,9				FILL: Clayey sand, fine to coarse grained, dark brown and orange brown.	M			
			1			SANDSTONE: fine to coarse grained, orange brown, with iron indurated bands.	XW DW	EL M		LOW TO MODERATE 'TC' BIT RESISTANCE
						SANDSTONE: fine to coarse grained, light grey, with iron indurated bands.				
			2				FR	H		MODERATE TO HIGH RESISTANCE
			3							HIGH RESISTANCE
						END OF BOREHOLE AT 3.2m				'TC' BIT REFUSAL ON INFERRED SANDSTONE BEDROCK
			4							
			5							
			6							
			7							

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BOREHOLE LOG

Borehole No. **12**
1/1

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED ENGINEERING BUILDING
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 14-10-11
Method: SPIRAL AUGER JK250
Logged/Checked by: H.W./
R.L. Surface: ≈ 24.3m
Datum: AHD

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0		-	ASPHALTIC CONCRETE: 40mm.t	D	-		APPEARS MODERATELY COMPACTED
						FILL: Sand, fine to coarse grained, grey brown, with silt, fine to medium grained igneous and sandstone gravel.				
		N = 10 3,4,6				FILL: Clayey sand, fine grained, with fine to coarse grained sandstone, ironstone and igneous gravel, trace of ash.	M			
		N = 19 4,8,11	1		CL	SANDY CLAY: medium plasticity, light grey.	MC<PL	H	- >600 >600 >600	
			2		-	SANDSTONE: fine to coarse grained, light grey.	SW	H	-	HIGH 'TC' BIT RESISTANCE
			3			END OF BOREHOLE AT 3.0m				
			4							
			5							
			6							
			7							

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BOREHOLE LOG

Borehole No. **13**
1/1

Client: HEALTH INFRASTRUCTURE NSW
Project: PROPOSED ROSE COTTAGE EXTENSION
Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z
Date: 14-10-11
Method: SPIRAL AUGER JK250
Logged/Checked by: H.W./ [signature]
R.L. Surface: ≈ 25.8m
Datum: AHD

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0	-	ASPHALTIC CONCRETE: 40mm.t	D	-	-	
				FILL: Gravelly sand, fine to coarse grained, grey, fine to medium grained igneous and slag gravel.				
	N = 16 3,3,13		CH	SANDY SILTY CLAY: high plasticity, orange brown and light grey, with ironstone gravel.	MC<PL	St	- 190 170 150	
		1	-	SANDSTONE: fine to coarse grained, light grey and yellow brown, with iron indurated bands.	DW	L	-	MODERATE 'TC' BIT RESISTANCE WITH LOW BANDS
				as above, but with clay bands.		M		LOW TO MODERATE RESISTANCE WITH VERY LOW BANDS
		2						
		3		END OF BOREHOLE AT 3.0m				
		4						
		5						
		6						
		7						

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Borehole No. 14

1/1

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE NSW

Project: PROPOSED SUBSTATION

Location: ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW

Job No. 25264Z | **Method:** HAND AUGER | **R.L. Surface:** ≈ 25.8m

Date: 21-10-11 | **Datum:** AHD

Logged/Checked by: H.W./ [signature]

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■		0			FILL: Sand, fine grained, dark brown, with silt and fine to medium grained sandstone and shale gravel.	D			APPEARS MODERATELY COMPACTED
								CH	SILTY CLAY: high plasticity, light grey.	MC<PL	-	-	HAND AUGER REFUSAL ON STIFF CLAY
									END OF BOREHOLE AT 0.3m				
						1							
						2							
						3							
						4							
						5							
						6							
						7							

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DYNAMIC CONE PENETRATION TEST RESULTS

Client:	HEALTH INFRASTRUCTURE NSW
Project:	PROPOSED SUBSTATION
Location:	ST GEORGE HOSPITAL, GRAY STREET, KOGARAH, NSW
Job No.	25264Z
Date:	21-10-11
Tested By:	H.W.

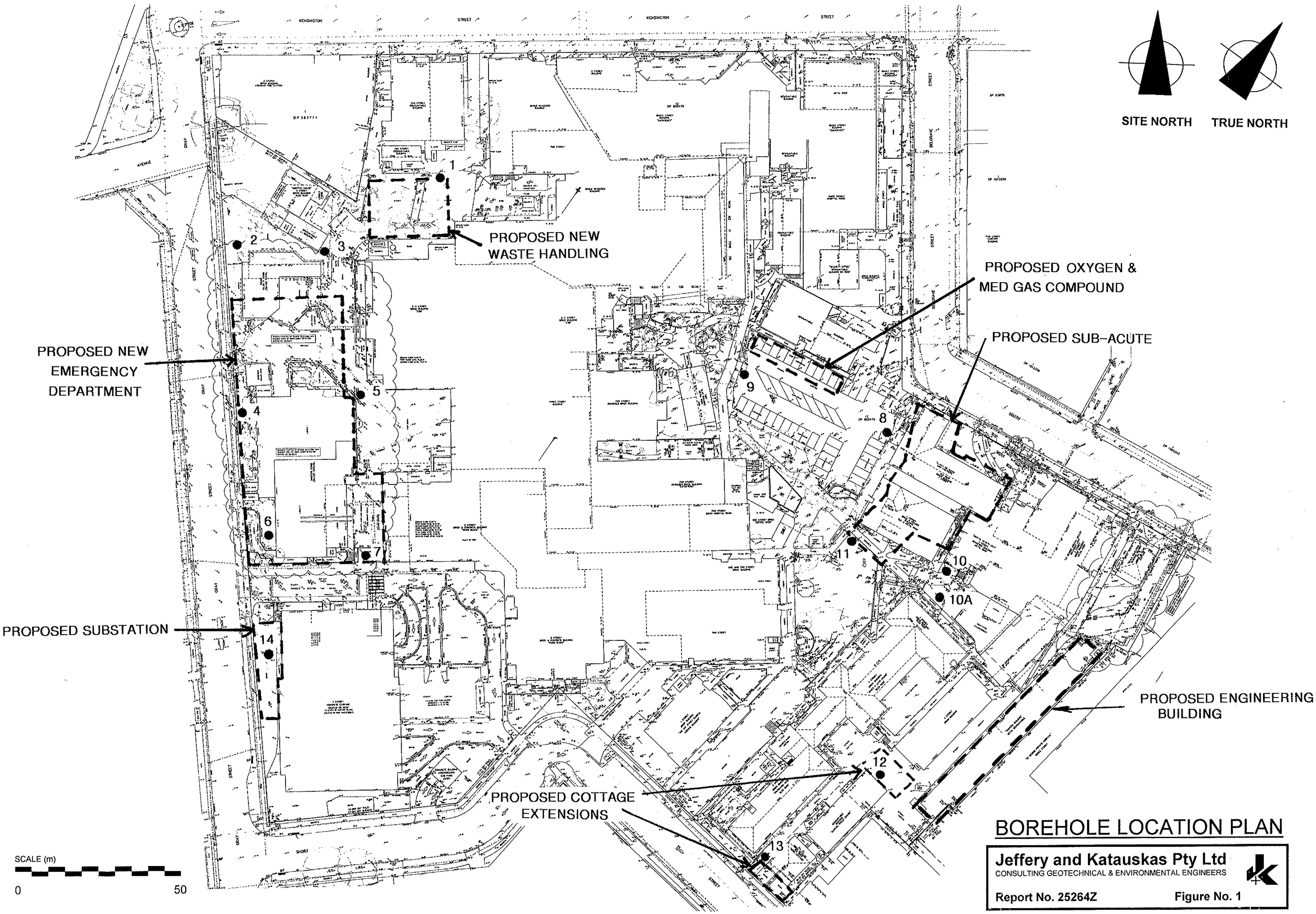
Hammer Weight & Drop: 9kg/510mm
Rod Diameter: 16mm
Point Diameter: 20mm

Number of Blows per 100mm Penetration

Test Location	RL ~25.8m			Test Location			
Depth (mm)	**14**			Depth (mm)	**14**		
0 - 100	6			3000-3100	22		
100 - 200	12			3100-3200	7		
200 - 300	16			3200-3300	8		
300 - 400	11			3300-3400	6		
400 - 500	16			3400-3500	8		
500 - 600	22			3500-3600	25		
600 - 700	13			3600-3700	40/50mm		
700 - 800	20			3700-3800	REFUSAL		
800 - 900	32			3800-3900			
900 - 1000	12			3900-4000			
1000 - 1100	12			4000-4100			
1100 - 1200	11			4100-4200			
1200 - 1300	10			4200-4300			
1300 - 1400	9			4300-4400			
1400 - 1500	7			4400-4500			
1500 - 1600	4			4500-4600			
1600 - 1700	6			4600-4700			
1700 - 1800	8			4700-4800			
1800 - 1900	12			4800-4900			
1900 - 2000	7			4900-5000			
2000 - 2100	6			5000-5100			
2100 - 2200	6			5100-5200			
2200 - 2300	5			5200-5300			
2300 - 2400	4			5300-5400			
2400 - 2500	3			5400-5500			
2500 - 2600	5			5500-5600			
2600 - 2700	12			5600-5700			
2700 - 2800	14			5700-5800			
2800 - 2900	36			5800-5900			
2900 - 3000	20			5900-6000			

Remarks:
1. The procedure used for this test is similar to that described in AS1289.6.3.2-1997, Method 6.3.2.
2. Usually 8 blows per 20mm is taken as refusal
3. Survey datum is AHD.

Ref: Scala6.xls April 99



BOREHOLE LOCATION PLAN

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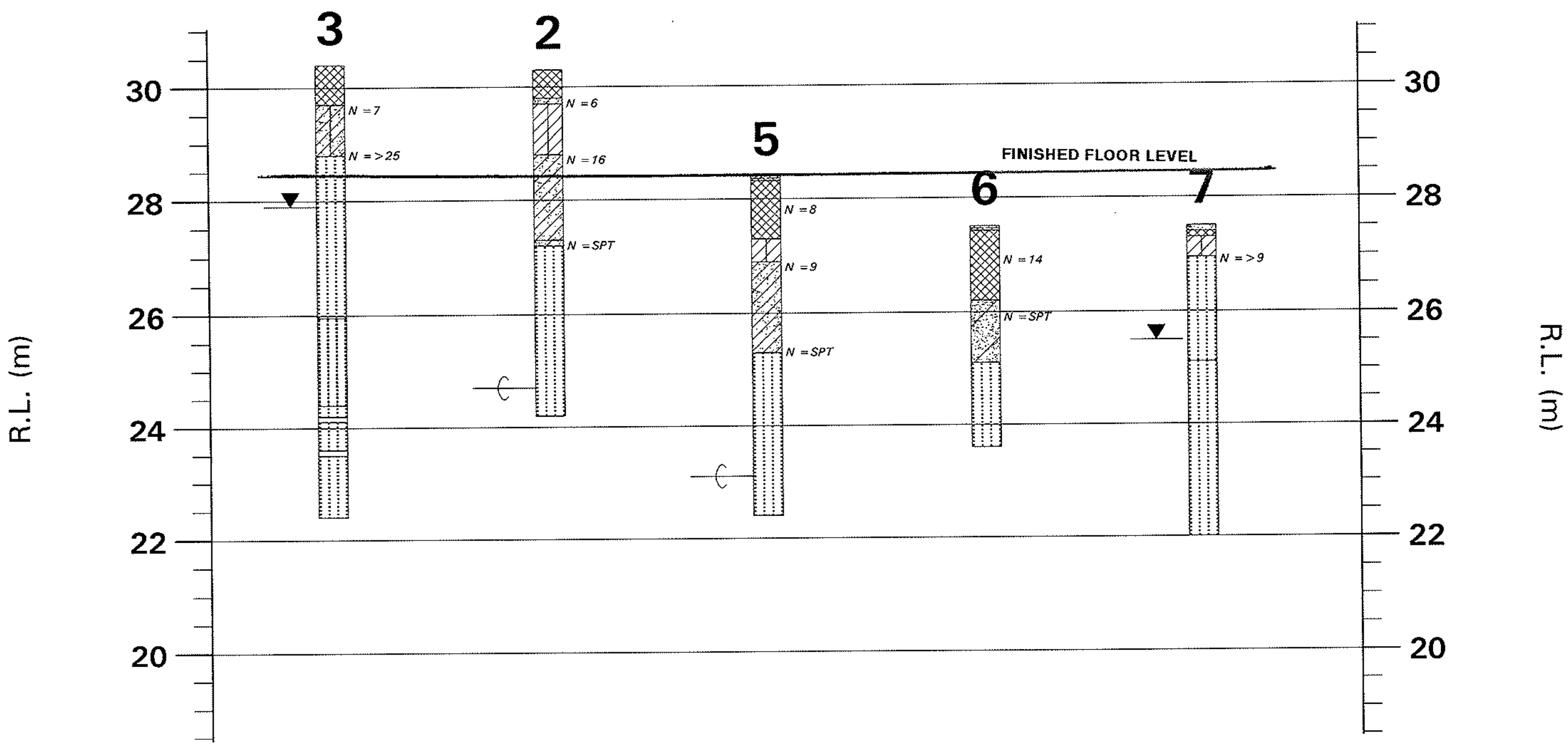
Report No. 25264Z **Figure No. 1**

GRAPHICAL BOREHOLE SUMMARY

NEW EMERGENCY DEPARTMENT BUILDING



Fill	Core Loss/ Empty	Sandy Clay	Observed water level	Nc	SOLID CONE BLOW COUNTS PER 150mm
Silty Sandy Clay	Clayey Sand	Brick	Borehole Collapse Depth		
Sandstone/ Greywacke	Silty Clay	Concrete		N	SPT "N" VALUE

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 100 (vert) ; NTS (horiz)

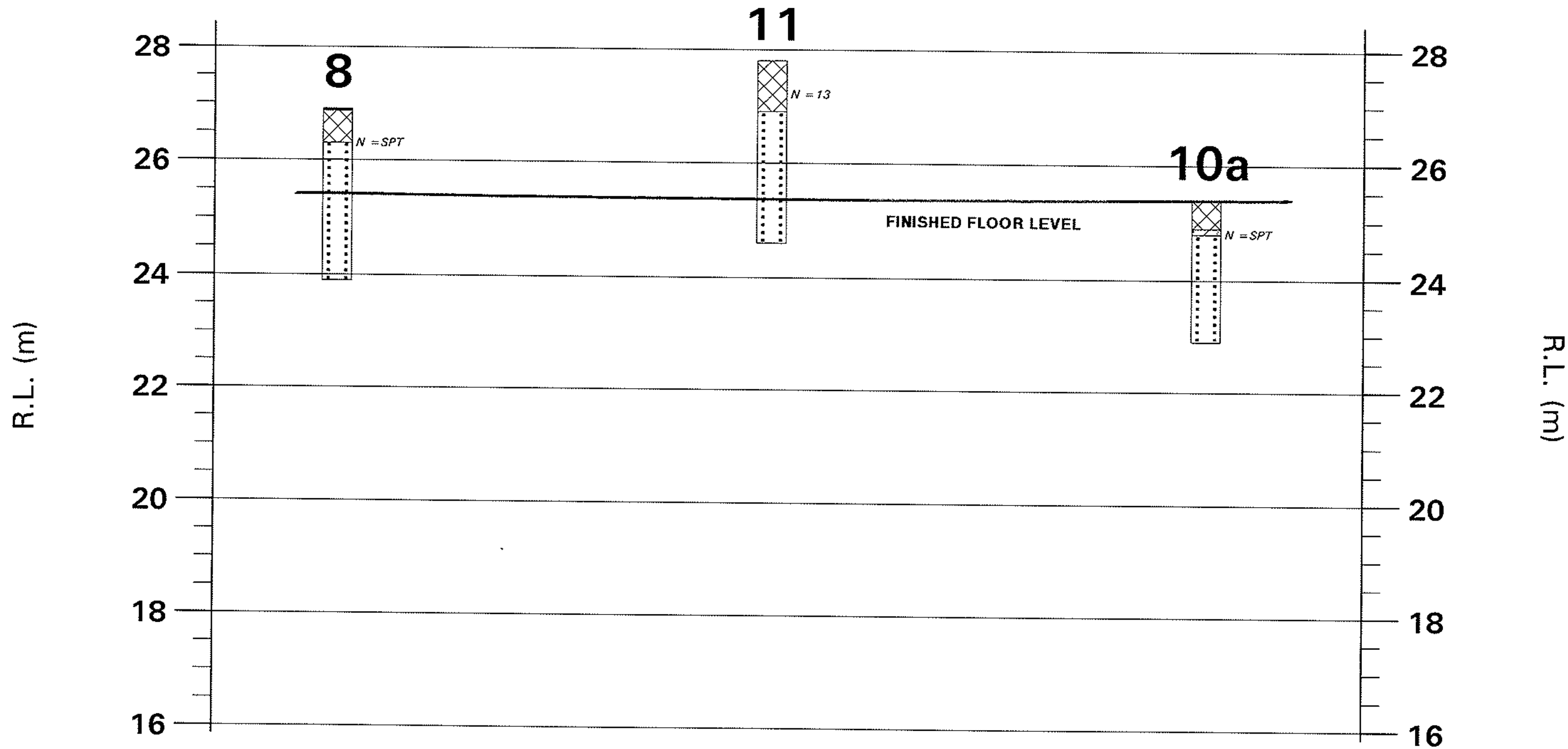
Jeffery and Katauskas Pty Ltd

Job No.: 25264Z

Figure No.: 2

GRAPHICAL BOREHOLE SUMMARY

NEW SUB–ACUTE BUILDING



Asphaltic/ Bituminous Paving or Coal	Sandstone/ Greywacke	N	SPT "N" VALUE
Fill	Concrete	Nc	SOLID CONE BLOW COUNTS PER 150mm
	Clayey Sand		

NOTE: REFER TO BOREHOLE LOGS

Scale: 1 : 100 (vert) ; NTS (horiz)

Jeffery and Katauskas Pty Ltd

Job No.: 25264Z

Figure No.: 3

REPORT EXPLANATION NOTES

INTRODUCTION

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

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

DESCRIPTION AND CLASSIFICATION METHODS

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

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (eg sandy clay) as set out below:

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2mm
Gravel	2 to 60mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	Strength not attainable – soil crumbles

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'Shale' is used to describe thinly bedded to laminated siltstone.

SAMPLING

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

Disturbed samples taken during drilling provide information on plasticity, grain size, colour, moisture content, minor constituents and, depending upon the degree of disturbance, some information on strength and structure. Bulk samples are similar but of greater volume required for some test procedures.

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

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

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All except test pits, hand auger drilling and portable dynamic cone penetrometers require the use of a mechanical drilling rig which is commonly mounted on a truck chassis.

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

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

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock fragments. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually 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.

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

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as CORE LOSS. The location of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils as a means of indicating density or strength 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 F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm 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 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

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

  N>30
  15, 30/40mm

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

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

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

Static Cone Penetrometer Testing and Interpretation: Cone penetrometer testing (sometimes referred to as a Dutch Cone) described in this report has been carried out using an Electronic Friction Cone Penetrometer (EFCP). The test is described in Australian Standard 1289, Test F5.1.

In the tests, a 35mm diameter rod with a conical tip 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 frictional resistance on a separate 134mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are electrically connected by 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 20mm per second) the information is output as incremental digital records every 10mm. The results given in this report have been plotted from the digital data.

The information provided on the charts comprise:

- 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 as a percentage.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and occasionally very soft clays, rising to 4% to 10% in stiff clays and peats. Soil descriptions based on cone resistance and friction ratios are only inferred and must not be considered as exact.

Correlations between EFCP and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of EFCP values can be made to empirically derive modulus or compressibility values to allow calculation of foundation settlements.

Stratification can be inferred from the cone and friction traces and from experience and information from nearby boreholes etc. Where shown, this information is presented for general guidance, but must be regarded as interpretive. The test method provides a continuous profile of engineering properties but, where precise information on soil classification is required, direct drilling and sampling may be preferable.

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

Two relatively similar tests are used:

- Cone penetrometer (commonly known as the Scala Penetrometer) – a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS1289, Test F3.2). The test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various Road Authorities.
- Perth sand penetrometer – a 16mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS1289, Test F3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.

LOGS

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

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

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

GROUNDWATER

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

- Although groundwater may be present, in low permeability soils it 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 and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if water observations are to be made.

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

FILL

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

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

LABORATORY TESTING

Laboratory testing is normally carried out in accordance with Australian Standard 1289 *'Methods of Testing Soil for Engineering Purposes'*. Details of the test procedure used are given on the individual report forms.

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 conditions, 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 be partially dependent on borehole spacing and sampling frequency as well as investigation technique.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of persons or contractors responding to commercial pressures.

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

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those 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 that 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.

Copyright in all documents (such as drawings, borehole or test pit logs, reports and specifications) provided by the Company shall remain the property of Jeffery and Katauskas Pty Ltd. Subject to the payment of all fees due, the Client alone shall have a licence to use the documents provided for the sole purpose of completing the project to which they relate. License to use the documents may be revoked without notice if the Client is in breach of any objection to make a payment to us.

REVIEW OF DESIGN

Where major civil or structural developments are proposed or where only a limited investigation has been completed or where the geotechnical conditions/ constraints are quite complex, it is prudent to have a joint design review which involves a senior geotechnical engineer.

SITE INSPECTION

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

Requirements could range from:

i) a site visit to confirm that conditions exposed are no worse than those interpreted, to
ii) a visit to assist the contractor or other site personnel in identifying various soil/rock types such as appropriate footing or pier founding depths, or
iii) full time engineering presence on site.

GRAPHIC LOG SYMBOLS FOR SOILS AND ROCKS

SOIL

- FILL
- TOPSOIL
- CLAY (CL, CH)
- SILT (ML, MH)
- SAND (SP, SW)
- GRAVEL (GP, GW)
- SANDY CLAY (CL, CH)
- SILTY CLAY (CL, CH)
- CLAYEY SAND (SC)
- SILTY SAND (SM)
- GRAVELLY CLAY (CL, CH)
- CLAYEY GRAVEL (GC)
- SANDY SILT (ML)
- PEAT AND ORGANIC SOILS

ROCK

- CONGLOMERATE
- SANDSTONE
- SHALE
- SILTSTONE, MUDSTONE, CLAYSTONE
- LIMESTONE
- PHYLLITE, SCHIST
- TUFF
- GRANITE, GABBRO
- DOLERITE, DIORITE
- BASALT, ANDESITE
- QUARTZITE

DEFECTS AND INCLUSIONS

- CLAY SEAM
- SHEARED OR CRUSHED SEAM
- BRECCIATED OR SHATTERED SEAM/ZONE
- IRONSTONE GRAVEL
- ORGANIC MATERIAL

OTHER MATERIALS

- CONCRETE
- BITUMINOUS CONCRETE, COAL
- COLLUVIUM

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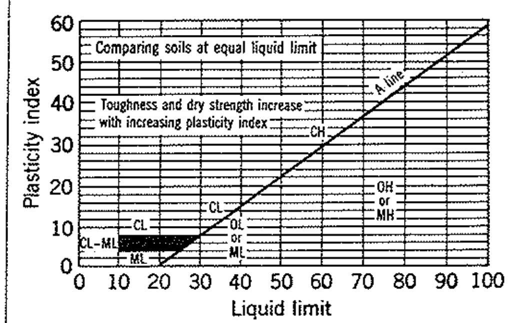
CONSULTING GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

UNIFIED SOIL CLASSIFICATION TABLE

Major division	Subdivision	Fines	Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)	Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils More than half of material is *larger* than 75 μm sieve size[b] (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	Use grain size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols. $C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics	Not meeting all gradation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures	Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, with *PI* greater than 7
	Sands More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7

Major division	Subdivision	Identification Procedures on Fraction Smaller than 380 μm Sieve Size: Dry Strength (crushing character-istics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols	Typical Names	Information Required for Describing Soils
Fine-grained soils More than half of material is *smaller* than 75 μm sieve size	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity chart for laboratory classification of fine grained soils

NOTE: 1) Soils possessing characteristics of two groups are designated by combinations of group symbols (e.g. GW-GC, well graded gravel-sand mixture with clay fines).

2) Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

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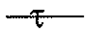
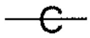
ABN 17 003 550 801

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown.
		Extent of borehole collapse shortly after drilling.
		Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES	Soil sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos screening.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of Undrained Shear Strength.
	PID = 100	Photoionisation detector reading in ppm (Soil sample headspace test).
Moisture Condition (Cohesive Soils)	MC>PL	Moisture content estimated to be greater than plastic limit.
	MC≈PL	Moisture content estimated to be approximately equal to plastic limit.
	MC<PL	Moisture content estimated to be less than plastic limit.
(Cohesionless Soils)	D	DRY - runs freely through fingers.
	M	MOIST - does not run freely but no free water visible on soil surface.
	W	WET - free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT - Unconfined compressive strength less than 25kPa
	S	SOFT - Unconfined compressive strength 25-50kPa
	F	FIRM - Unconfined compressive strength 50-100kPa
	St	STIFF - Unconfined compressive strength 100-200kPa
	VSt	VERY STIFF - Unconfined compressive strength 200-400kPa
	H	HARD - Unconfined compressive strength greater than 400kPa
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** **SPT 'N' Value Range (Blows/300mm)**
	VL	Very Loose <15 0-4
	L	Loose 15-35 4-10
	MD	Medium Dense 35-65 10-30
	D	Dense 65-85 30-50
	VD	Very Dense >85 >50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten carbide wing bit.
	T 60	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

Ref: Standard Sheets/Log Symbols
November 2007

Jeffery and Katauskas Pty Ltd

CONSULTING GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
ABN 17 003 550 801

LOG SYMBOLS

ROCK MATERIAL WEATHERING CLASSIFICATION

TERM	SYMBOL	DEFINITION
Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered rock	XW	Rock is weathered to such an extent that it has "soil" properties, ie it either disintegrates or can be remoulded, in water.
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh rock	FR	Rock shows no sign of decomposition or staining.

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 Journal of Rock Mechanics, Mining, Science and Geomechanics. Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL		Easily remoulded by hand to a material with soil properties.
		0.03	
Very Low:	VL		May be crumbled in the hand. Sandstone is "sugary" and friable.
		0.1	
Low:	L		A piece of core 150mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
		0.3	
Medium Strength:	M		A piece of core 150mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
		1	
High:	H		A piece of core 150mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
		3	
Very High:	VH		A piece of core 150mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
		10	
Extremely High:	EH		A piece of core 150mm long x 50mm dia. is very difficult to break with hand-held hammer. Rings when struck with a hammer.

ABBREVIATIONS USED IN DEFECT DESCRIPTION

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to the long core axis (ie relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Ironstained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	

APPENDIX A

EnviroLab Services Pty Ltd
'Certificate of Analysis'
(Ref: 63627)

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

CERTIFICATE OF ANALYSIS **63627**

Client:
Environmental Investigation Services
PO Box 976
North Ryde BC
NSW 1670

Attention: Heather Walker

Sample log in details:

Your Reference:	**25264Z**		
No. of samples:	3 Soils		
Date samples received / completed instructions received	19/10/11	/	19/10/11

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	26/10/11	/	26/10/11
Date of Preliminary Report:	Not issued		

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Nick Sarlamis
Inorganics Supervisor

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Miscellaneous Inorg - soil				
Our Reference:	UNITS	63627-1	63627-2	63627-3
Your Reference	-------------	BH5	BH3	BH10
Depth	------------	0.5-0.95	0.9-1.15	0.5-0.8
Date Sampled		13/10/2011	14/10/2011	14/10/2011
Type of sample		Soil	Soil	Soil
Date prepared	-	21/10/2011	21/10/2011	21/10/2011
Date analysed	-	21/10/2011	21/10/2011	21/10/2011
pH 1:5 soil:water	pH Units	9.0	7.5	9.3
Chloride, Cl 1:5 soil:water	mg/kg	13	22	120
Sulphate, SO4 1:5 soil:water	mg/kg	120	31	1,700

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 21st ED, 4500-H+.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 21st ED, 4110 -B.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			21/10/2011	[NT]	[NT]	LCS-1	21/10/2011
Date analysed	-			21/10/2011	[NT]	[NT]	LCS-1	21/10/2011
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	LCS-1	101%
Chloride, Cl 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	104%
Sulphate, SO4 1:5 soil:water	mg/kg	2	Inorg-081	<2	[NT]	[NT]	LCS-1	111%

Report Comments:

Asbestos ID was analysed by Approved Identifier: Not applicable for this job
Asbestos ID was authorised by Approved Signatory: Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

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

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable.