REPORT TO

HEALTH INFRASTRUCTURE

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED STAGE 2 REDEVELOPMENT

AT

NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Date: 23 December 2020

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1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed Stage 2 Redevelopment at Nepean Hospital, Derby Street, Kingswood, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by Health Infrastructure and was carried out in accordance with the Health Infrastructure Consultancy Agreement (Contract No. HI16465, dated 1 October 2020), our fee proposal (Ref: P52660LT) dated 21 September 2016, and our variation for non-destructive digging dated 16 November 2020.

We have been supplied with the following drawings and information:

- Eleven schematic architectural general arrangement drawings by BVN Architecture (Project No. 1903020.000, Drawing No's. TB2-11B-0000001 to 11B- 1000001, all Revision C dated 28 November 2020).
- Preliminary column loadings and column plan by Meinhardt Bonacci dated 14 September 2020.

From the above information we understand that the Stage 2 Tower will comprise an eight-storey structure with an additional two-levels of lift shaft above the southern corner of the building. The Stage 2 Tower will be located in the area of the existing North Block and Hope Cottage, and immediately west of the currently 'under-construction' Stage 1 building. Ultimate column loads up to about 30,000kN have been indicated. The lowest Level 00 floor will have a finished floor level at RL49.02m to match in with the adjoining Stage 1 development. Level 00 will extend over an area as shown approximately on the attached Figure 2. Excavation to achieve this Level 00 will be to maximum depths of about 6.0m in the area of North Block reducing to about 1m along at the northern end of the new building. Locally deeper excavations for the proposed kitchen dock and lift pits will be required. In the southern portion, relatively minor excavation of only about 1.5m or so will be required to achieve the Level 01 finished floor level which has been indicated to be at RL53.52m.

The purpose of the investigation was to obtain geotechnical information on subsurface conditions as a basis for comments and recommendations on excavation conditions, retention, bearing pressures for footings, and potential settlements.

2 PREVIOUS INVESTIGATIONS

We have previously completed a number of geotechnical investigations at Nepean Hospital for the current Stage 1 works. These included;

- Geotechnical Investigation Report 29845L1rpt MWCDB dated 24 February 2017. This report was for the main Stage 1 building.
- Geotechnical Investigation Report 29845L3rpt dated 7 September 2018. This report was prepared to provide a more detailed assessment of the subsurface conditions within the main Stage 1 building area.

Relevant boreholes have been extracted from these reports to supplement our current investigation. The borehole logs from these previous investigations have been attached as Appendix A, and the borehole locations are shown on the attached Figure 2.

3 CURRENT INVESTIGATION PROCEDURE

The fieldwork for the current investigation comprised the drilling of five boreholes (BH501 to BH505) to depths ranging from 18.0m to 24.12m below existing surface levels, using our track-mounted drilling rig. All boreholes were initially advanced through the soils and upper weathered bedrock using spiral auger drilling techniques and a Tungsten Carbide (TC) bit. The boreholes were then extended to the final depths by rotary diamond coring techniques, using an NMLC triple tube core barrel and water flush.

Prior to commencement of the fieldwork, the investigation locations were electromagnetically scanned by a specialist subcontractor so that borehole locations could be located clear of buried services. The services scan was also completed by referencing the 'Dial Before You Dig' plans. Safe work measures and procedures were implemented during the course of the fieldwork. At two locations (BH504 and BH505), non-destructive digging with vacuum excavation was completed to a depth of about 1.1m to visually assess whether any services were present at the borehole locations. We note that due to the nature of vacuum excavation assessment of the soils in this portion of the subsurface profile was made based on visual assessment only.

The borehole locations are shown on the attached Figure 2, and were set out by taped measurements from existing surface features shown on the survey plan. The approximate Reduced Level (RL) at each borehole location, as shown on the borehole logs, was interpolated from spot heights and contours from the supplied survey plan prepared by Cardno (Drawing No. 118117502, Revision 05, dated 2 March 2018). The height datum is Australian Height Datum.

The apparent compaction of the fill and strength of the cohesive soils were assessed from Standard Penetration Test (SPT) 'N' values, augmented by hand penetrometer tests carried out on cohesive samples recovered by the SPT split tube sampler. The strength of the bedrock in the augered portion was assessed from observation of drilling resistance using the TC drill bit attached to the augers, tactile examination of rock cuttings, and correlation with the results of subsequent laboratory moisture content tests. It should be noted that strengths assessed in this way are approximate and variances of at least one strength order should not be unexpected.

For the cored portion of the bedrock, the recovered core was returned for photographing and Point Load Strength Index (Is_{50}) testing. Using established correlations, the Unconfined Compressive Strength (UCS) of the bedrock was then calculated from the Is_{50} results. These Point Load Strength test results are summarised in the attached Table C and on the borehole logs.

Selected soil samples were also returned to Soil Test Services Pty Ltd (STS) and Envirolab Services Pty Ltd, both NATA accredited laboratories. STS completed moisture content, Atterberg limits and CBR testing and the results of these tests are provided in the attached STS Tables A and B. Soil aggression testing was completed by Envirolab Services Pty Ltd and the results are provided in the attached Certificate of Analysis No. 256866.

Groundwater observations were recorded in all boreholes during and on completion of auger drilling. Standpipe piezometers was installed in BH502 and BH505 to allow for longer-term groundwater monitoring. No further groundwater monitoring has been carried out since the fieldwork was completed.

Our geotechnical engineers were present on a full-time basis during the fieldwork, to nominate testing and sampling and prepare the borehole logs. The borehole logs, which include field test results and groundwater observations, are attached, together with a set of explanatory notes which describe the investigation techniques, and their limitations and define the logging terms and symbols used.

4 RESULTS OF INVESTIGATION

4.1 Site Description

The site is located within gently undulating topography defined by slopes of 5° or less and is located near the crest of a low-height ridgeline orientated north-south and roughly followed by Parker Street/The Northern Road. Surface levels across the site slope down to the north-east at approximately 2°.

The site comprises an area, shown on Figure 1, within Nepean Hospital which encompasses the northern portion of the existing North Block of the main hospital building, Hope Cottage and the Nepean Redevelopment demountable buildings. Surface levels across the site have been altered by the existing developments through retaining walls and batters to create relatively level areas in and around the buildings. North Block comprises a two-storey brick and concrete building which appears to be in good condition based upon our cursory visual observations. Hope Cottage is a single-storey unit complex of brick construction which also appears to be in good condition. The buildings are linked by a network of concrete footpaths. Scattered throughout the site are trees generally ranging in height from 6m to 12m. Garden beds are situated adjacent to some external walls of North Block and Hope Cottage.

The site is generally surrounded by adjacent areas within Nepean Hospital including Total Asset Management and Tresillian. However, east of the site is the Nepean Hospital Redevelopment Stage 1 construction site and surface levels across this boundary slope down through a shotcrete faced batter adjacent to Hope Cottage and then a soldier pile shoring wall adjacent to the eastern wing of North Block. The shoring wall is set back a minimum 3.3m from the eastern wing of North Block. The bulk excavation level for the Stage 1 site appears to range from about RL48.5m to RL47.5m with surface levels within the subject site being higher by a maximum height of about 6m at the southern end of the shoring wall and similar to the Stage 1 site at the northern end. Surface levels within the Stage 1 construction site adjacent to the south-eastern corner of the site are generally 0.5m lower due to recent excavation to remove pavements.

4.2 Subsurface Conditions

The Penrith 1:100,000 Geological Series Sheet 9030 indicates that the site is underlain by Bringelly Shale of the Wianamatta Group consisting of *"shale, carbonaceous claystone, claystone, laminite, fine- to medium-grained lithic sandstone, rare coal and tuff".* This profile does not take into account in-situ weathering or any earthworks that have taken place on the site.

The investigation encountered a generalised profile comprising relatively shallow fill overlying residual silty clay which transitioned to weathered siltstone and claystone bedrock at depths ranging from 3.5m to 5.4m. The bedrock is generally deeply weathered, though in some of the boreholes there was an upper capping layer of sandstone bedrock of up to high strength. Some of the more pertinent subsurface observations are discussed below, however for specific details reference should be made to the attached borehole logs and graphical borehole summaries (Figures 3 and 4).

Pavements and Fill

A 140mm thick concrete pavement was encountered at the surface in BH505. Pavements were not encountered at the surface within the other current boreholes. Asphaltic concrete pavements ranging from 20mm to 50mm thick, were encountered from the surface in our previous boreholes within the old on-grade car park, although these pavements have largely been removed during construction of Stage 1.

Underlying the pavements and from the surface in BH501 to BH504, fill was encountered and it extended to depths ranging from 0.1m (BH502) to 2.3m (BH503 and BH504). The fill within the current boreholes generally comprised silty clay, whilst the fill in our previous boreholes was generally granular. The fill contained inclusions of igneous, ironstone and sandstone gravel and slag. The fill, where assessed, appeared to be moderately to well compacted. The clays within the fill were assessed to range from low to high plasticity.

Residual Silty Clay

Silty clay, assessed as residual in origin, was encountered below the fill in all boreholes. The clay was assessed as medium to high plasticity and of very stiff to hard strength. The residual clay generally contained inclusions of ironstone gravel with the proportion of gravel generally appearing to increase with depth.

Weathered Bedrock

Weathered bedrock, predominantly comprising claystone, was encountered at depths ranging from 3.5m (BH505) to 5.4m (BH503). The level of the bedrock ranged from approximately RL50.7m (BH505) to RL46.5m (BH501). The surface of the bedrock generally appears to dip down to the north. Although the bedrock predominantly comprised claystone, bands of fine-grained sandstone or laminite was encountered within each of the boreholes, except BH505, and generally above a depth of 10m. Towards the base of the boreholes fine-grained sandstone laminae were present within the claystone and some interbedded siltstone was encountered within BH501 and BH502.

The following table provides our rock classification assessment for BH501 to BH505 inclusive, BH304, BH308 and BH10. The classification was completed in general accordance with Pells et al (2019). The rock classes presented in the table below are also shown schematically on the attached Figures 3 and 4. The rock classes are approximate only and will be dependent on footing/pile sizes. The delineation between the various classes of rock shown on Figures 3 and 4 are also approximate and have been determined by linear interpolation and some judgement between the known locations. Some variability should be expected.

Borehole Number	Depths (Reduced Levels) Class V Rock	Depths (reduced Levels) Class IV Rock	Depths (Reduced Levels) Class III Rock	Depths (Reduced Levels) Class II or Better Rock
501	3.8m to 7.2m (RL46.5 to RL43.1) Claystone	7.2m to 10.8m (RL46.5 to RL39.5) Claystone	10.8m to 14.4m (RL39.5 to RL35.9) Claystone 15.1m to 18.0m (RL35.2 to RL32.3) Claystone	14.4m to 15.1m (RL35.9 to RL35.2) Sandstone
502	4.4m to 9.6m (RL46.6 to RL41.4) Sandstone 11.8m to 13.0m (RL39.2 to RL38.0) Claystone 16.6m to 20.9m (RL34.4 to RL30.1) Siltstone + Claystone	9.6m to 11.8m (RL41.4 to RL39.2) Claystone 13.0m to 16.6m (RL38.0 to RL34.4) Claystone	20.9m to 24.1m (RL30.1 to RL26.9) Siltstone + Claystone	Not encountered
503	5.4m to 7.8m (RL48.5 to RL46.1) Claystone 12.8m to 18.4m (RL41.1 to RL35.5) Claystone	7.8m to 12.8m (RL46.1 to RL41.1) Claystone+ Sandstone	18.4m to 21.5m (RL35.5 to RL32.4) Claystone	Not encountered
504	4.1m to 5.8m (RL49.3 to RL48.3) Claystone 12.0m to 13.5m (RL42.1 to RL40.6) Claystone 16.2m to 17.1m (RL37.9 to RL37.0) Claystone	5.8m to 9.2m (RL48.3 to RL44.9) Laminite + Claystone 13.5m to 16.2m (RL40.6 to RL37.9) Claystone	9.2m to 12.0m (RL44.9 to RL42.1) Laminite + Claystone 17.1m to 21.0m (RL37.0 to RL33.1) Claystone	Not encountered
505	3.5m to 8.5m (RL50.7 to RL45.7) Claystone 11.3m to 13.0m (RL42.9 to RL41.2) Claystone	15.3m to 16.7m (RL38.9 to RL37.5) Claystone	8.5m to 11.3m (RL45.7 to RL42.9) Claystone 13.0m to 15.3m (RL41.2 to RL38.9) Claystone 16.7m to 19.9m (RL37.5 to RL34.3)	Not encountered

304	4.1m to 5.5m (RL47.2 to RL45.8) Shale 6.5m to 7.5m (RL44.8 to RL43.8) Shale	Not encountered	5.5m to 6.5m (RL45.8 to RL44.8) Shale + Sandstone 7.5m to 18.9m (RL43.8 to RL32.4) Shale	18.9m to 20.4m (RL32.4 to RL30.9) Shale
308	2.0m to 6.8m (RL51.1 to RL46.3) Shale	6.8m to 7.7m (RL46.3 to 45.4) Shale	7.7m to 20.0m (RL45.4 to RL33.1) Shale	Not Encountered
10	3.3m to 5.5m (RL47.8 to RL45.6) Shale + Sandstone 10.85m to 12.7m (RL40.25 to RL38.4) Shale	12.7m to 15.5m (RL38.4 to RL35.6) Shale	7.15m to 10.85m (RL43.95 to RL40.25) Shale 15.5m to 16.25m (RL35.6 to RL34.85) Shale	5.5m to 7.15m (RL45.6 to RL43.95) Sandstone

NOTE:

1. Logging descriptions for rock have been amended in the current borehole descriptions to align with the latest version AS1726.

Groundwater

All boreholes were dry on completion of auger drilling except BH503 in which groundwater was measured at a depth of 6.35m (RL47.55m). We note that during the coring process, water is introduced into the borehole and therefore water levels immediately after completion of coring have not been recorded as they would be artificially high. Piezometer standpipes installed within BH502 and BH505 were measured on 10 December 2020 at depths of 2.44m and 4.11m (correlating with levels of RL48.6m and RL50.1m) respectively.

4.3 Laboratory Test Results

The Atterberg Limits testing completed on the residual silty clay and silty clay fill indicate they are of high plasticity. The linear shrinkage results indicate a high potential for shrink-swell movements with changes in moisture content, with the residual clays being more reactive than the clay fill. The moisture contents of the clay were all below their respective plastic limits.

The four-day soaked CBR tests on the residual clay returned a value of 2.5%. The clays are 2.3% and 2.2% ‘dry’ of their respective optimum moisture contents. During soaking, the samples swelled by 1.0% and 1.5% indicating the clays are reactive with respect to variations in moisture content.

The following table summarises the soil aggression tests.

Borehole	Depth (m)	Sample Type	pH	Sulphates SO_4 (ppm)	Chlorides Cl (ppm)	Resistivity (ohm.cm)
BH501	4.2-4.65	XW Claystone	6.5	1,000	200	1,300
BH503	1.5-1.95	Silty Clay FILL	5.3	140	170	4,900
BH505	2.7-3.15	Silty Clay RESIDUAL	4.6	820	350	1,400

Based on these results, the soils would be classified as having a 'Mild' exposure classification for concrete and steel piles in accordance with Table 6.4.2(C) and 6.5.2(C) of AS2159-2009 'Piling – Design and Installation.

5 COMMENTS AND RECOMMENDATIONS

5.1 Site Classification

Due to the depth of the fill and the likely abnormal moisture conditions as a result of buildings, pavements and trees, we consider that the proposed building area will classify as Class 'P' in accordance with AS2870-2011 'Residential Slabs and Footings'. Therefore, all footings will need to be designed by engineering principles.

The use of AS2870-2011 will only be relevant to lightly-loaded structures within the scope defined by the code. For such structures, the laboratory testing of the residual silty clay soils indicates that they will likely have characteristic surface movements in the range equivalent to that of a Class 'H1' site under 'normal' conditions. Where footings are designed on the basis of AS2870-2011, consideration will also need to be given to the adverse effect on shrink-swell movements from trees which are scattered around the proposed development area.

If the residual silty clay soils are used as an engineered fill, or if excavations into the residual silty clays are carried out, then it is possible that characteristic surface movements will be greater, and may be closer to Class 'H2' type movements. As such further advice from the geotechnical engineers is recommended when design details and levels are known.

Reference should also be made to Appendix B of AS2870-2011, for guidance on appropriate site maintenance, including site drainage and planting of trees and shrubs.

5.2 Excavation Conditions

The following recommendations should be read in conjunction with the latest version of *'Excavation Work – Code of Practice'* prepared by SafeWork NSW.

The proposed Level 00 is at RL49.02m which will require excavation to depths ranging from about 6m along the southern end of Level 00, reducing to about 1.0m at the northern end. Locally deeper excavations will be required to the main bulk level in the area of the proposed kitchen dock and lift pit.

Based on the investigation results, excavation to these depths will encounter the fill, residual soils, extremely weathered claystone and some very low or low strength claystone bedrock towards the southern end of the site. Excavation of the soils and extremely weathered claystone should be readily achievable using the buckets of large hydraulic excavators. Where very low or low strength claystone is encountered it will be able to be ripped using a dozer (say D6 or D7 size) with ripping tyne or by using a ripping tyne fitted to a large hydraulic excavator.

Locally deeper excavations e.g. for lift overruns, may encounter higher strength claystone or bands of medium to high strength sandstone. Where encountered, these materials (particularly the medium to high strength sandstone) will require excavation using specialised 'hard rock' excavation equipment such as hydraulic impact hammers.

During the use of hydraulic impact hammers, precautions must be made to reduce the risk of vibrational damage to adjoining structures. At the commencement of the use of hydraulic impact hammers we recommend that some quantitative vibration monitoring be carried out on any adjoining structures, or at the boundaries by an experienced vibration consultant or geotechnical engineer to check that vibrations are within acceptable limits. Particular consideration must be given to any vibration sensitive medical equipment that may be located in proximity to excavations requiring the use of impact hammers.

If during excavation with the hydraulic impact hammers, vibrations are found to be excessive or there is concern, then alternative lower vibration emitting equipment, such as rock saws, rock grinders or smaller hammers may need to be used. The use of a rotary grinder or rock sawing in conjunction with ripping presents an alternative low vibration excavation technique, however, productivity is likely to be slower. When using a rock saw or rotary grinder, the resulting dust must be suppressed by spraying with water.

We recommend that only excavation contractors with appropriate insurances and experience on similar projects be used. Excavation contractors should be provided with a copy of this geotechnical report, including the borehole logs and point load strength test results, so that they can make their own assessment of suitable excavation equipment.

Groundwater was only encountered during auger drilling in BH503 at a depth of 6.35m (RL47.55), all other boreholes were dry during auger drilling. However groundwater was measured within the standpipe piezometers at depths of 2.44m and 4.11m which correlate with levels about 0.5m and 1.0m above the Level 00 floor level. We note that the groundwater in these boreholes is unlikely to have stabilised in the short period after drilling, and as such these groundwater levels may be artificially high. Further groundwater monitoring in the existing piezometers is recommended. Notwithstanding, the silty clay and claystone bedrock are anticipated to be of low permeability and we do not expect that seepage volumes into the excavation will be significant. As such, during construction, such flows will likely be controllable by conventional sump and pump techniques. Higher flows should be expected along the soil-rock interface particularly following periods of wet weather. Seepage may need to be treated prior to disposal into stormwater systems and any requirements should be checked with the environmental and hydraulic consultants.

Material to be disposed of offsite will need to be suitably classified for waste disposal.

5.3 Excavation Batters

The excavation of temporary batter slopes should be feasible provided there is suitable space around the perimeter of the excavation. Where excavation extends towards the Stage 1 site this will result in removal of the existing batter slopes and shoring walls around the perimeter of the Stage 1 tower. We anticipate that bulk levels for Stage 2 will be about 0.5m below the existing ground surface around the new Stage 1 building.

Temporary batter slopes may be excavated as per the recommendations below and are contingent on the batter slopes being not greater than 6m high and the batter slopes being inspected by a geotechnical engineer at not greater than 1.5m depth intervals. Higher batter slopes would require more specific geotechnical appraisal and advice.

- Temporary batter slopes through any clay fill material should be battered at not steeper than 1 Vertical (V) in 1.5 Horizontal (H). If sandy fill is exposed temporary batter slopes will need to be flatter at probably 1V in 2H subject to inspection by the geotechnical engineers.
- Temporary batters through the residual clays and all bedrock up to and including very low strength should be battered at not steeper than 1 Vertical (V) in 1 Horizontal (H). Seepage may occur at the soil/rock interface, from defects within the cut face or at the toe of the batter. Where the geotechnical engineers consider that the seepage is causing a higher risk of instability, it may be necessary to flatten batters or to provide some other local support.
- Where low or low to medium strength bedrock is encountered it may be temporarily battered at not steeper than 1V in 0.5H. Where adverse defects are encountered within temporary batter slopes, they would need to be stabilised with rock bolts, shotcrete or other measures approved by the geotechnical engineers.
- Surcharge loads, including adjoining buildings, construction loads etc must be kept well clear of the crest of temporary batters (at least 2H from the crest, where H is the vertical height of the batter slope in metres).
- Bringelly Shale bedrock is particularly susceptible to erosion. The upper residual soils are also likely to be quite dispersive. Therefore, we expect that temporary batter slopes will begin to show some signs of weathering if they are left exposed for extended periods of time. As such, even after temporary batter slopes are fully formed, we recommend ongoing monitoring and inspections by the geotechnical engineers to check for any adverse weathering that may affect stability. Additional stabilisation may be required if adverse weathering occurs. We suggest some allowance in the construction budget be made for some rectification or stabilisation of temporary batter slopes with time. As a minimum surface drainage should not be allowed to flow over the crest of temporary batters, and should be directed and discharged in a manner which avoids concentrated flows and erosion.

Where temporary batters are formed, consideration needs to be given to the type of backfill to be used against the permanent basement walls. Uncompacted backfill placed up against basement walls will result in large settlements which can have adverse effects on structures, paving or landscaping supported above. The backfill placed against the permanent basement retaining walls should preferably comprise a uniform sized durable granular material which is surrounded in a geotextile fabric. A capping layer of at least 0.5m thickness of clayey site won material should be placed above the geofabric, to reduce water infiltration. A subsoil ‘agg’ drain surrounded by a geofabric filter sock should also be placed at the base and rear of the basement wall to collect seepage and discharge it to the stormwater system. This type of backfill has the advantage that only nominal compaction is required (such as by the use of a plate attached to the excavator). The alternative (although less preferred) is to use the site won material as backfill, however it will require careful control of moisture content, placement and compaction of material in thin layers, and density testing of each layer to ensure it is placed in a controlled manner as an engineered fill material. Placement and compaction of site won material at the rear of basement walls is difficult and time consuming due to the space limitations. Care should also be taken when compacting fill behind retaining walls, to ensure that compaction stresses do not exceed the design earth pressures. Advice during construction is recommended when the type of equipment proposed is known.

There are cost implications of excavating and disposing of the additional soil from the batters, and importing large amounts of drainage material to backfill the permanent basement walls. The space required to form the temporary batters may also be problematic in that this will limit storage and construction space. In this regard, it may be preferable to install a shoring system to avoid the excavation of the material in the batters and replacement with high quality material.

Where permanent batter slopes are being proposed, the formation will be dependent on the height of the cut and the materials exposed. As a guide we suggest the following general recommendations;

- Permanent batters through the residual clays and all bedrock up to and including very low strength should be battered at not steeper than 1V in 2H.
- Permanent batters through low or low to medium strength bedrock should be battered at not steeper than 1V in 1H.
- Any permanent batters will need to be fully protected from erosion in the long term, by a suitable and approved erosion protection measure. Suitable measures would include revegetation or shotcrete. Where revegetation is being proposed, consideration should be given to flattening the permanent batters even further than recommended above to assist with initial vegetation and topsoil establishment and provide for ease of maintenance.

5.4 Retaining Walls

Where temporary batter slopes are not preferred or cannot be accommodated within the site boundary constraints, particularly adjacent to portions of building that may remain (such as North Block), we recommend that engineered in-situ shoring systems be constructed and installed prior to commencement of excavation. Such a shoring system may also be used as a permanent basement wall if required.

Given the subsurface conditions encountered, we consider that anchored/propped soldier pile walls with shotcrete infill panels are suitable for this site, provided some wall movements can be tolerated and any movement sensitive footings or services are at least 3m from the rear of the shoring wall. Where excavations are close to movement sensitive structures or services, we recommend stiffer anchored/propped contiguous piled shoring systems be constructed.

Bored piles will be suitable for the shoring piles, however some seepage may occur into bored piles if they are left open for any extended periods of time. Any seepage will require pumping of water and thorough cleaning of the base (including removal of any softened material) prior to pouring or possibly the need to pour using tremie techniques.

Piles for the shoring system should be socketed at least 1.0m below bulk excavation level, including allowances for nearby lift pits, footing and services excavations. Greater embedment may be required for lateral stability of the shoring system. Deeper shoring systems may need to penetrate high strength sandstone bedrock which will require the use of large capacity piling rigs. Even with large capacity piling rigs, productivity may be very slow. We recommend that further advice from piling contractors be obtained on the suitability of their equipment to cost effectively penetrate through the required strength of rock.

Temporary lateral support of the shoring system will need to be provided by anchors or internal propping. During excavation, reinforced shotcrete panels should be sprayed progressively with the excavation to support the soil and weathered rock between the piles, such that there is no more than 1.5m of vertical face of material exposed at any one time. It will be necessary to install strip drains with a non-woven geotextile filter fabric behind each panel of shotcrete to dissipate the pore pressures behind the shotcrete. We recommend strip drains be placed at minimum 1.5m centres. Where contiguous piled walls are adopted, weep holes comprising 40mm diameter PVC pipes with a geofabric filter on the back end should be used to provide drainage. The weep holes should also be spaced at not greater than 1.5m centres vertically and horizontally, the lowest row just above bulk excavation level. We have assumed that the permanent support of the shoring system will be provided by bracing or propping from the floor slabs.

Where temporary batter slopes are adopted, conventional concrete block retaining walls can be constructed.

An alternative shoring option may be the use of soil nailed walls. While further specific design and construction staging would need to be provided once details are known, soil nail walls are likely to include soil nails drilled at 1.5m horizontal and vertical spacings, with the soil nails installed to a similar length to the height of the excavation.

5.4.1 In-situ Shoring Systems – Design Parameters

The following characteristic parameters may be adopted for shoring wall design. The parameters outlined below are on the assumption that a soldier pile wall is constructed and that inspection of the rock face between soldier piles is completed by a geotechnical engineer at not greater than 1.5m depth intervals to check for significant adverse defects.

- Where minor movements of the shoring wall are tolerable, we recommend a rectangular lateral earth pressure distribution of 5H (where H is the depth of excavation in metres).

- Where adjoining structures or movement sensitive services are within a horizontal distance of 2H from the shoring wall we recommend that the magnitude of the rectangular lateral earth pressure be increased to 8H to reduce the risk of adverse deflections.
- Within shales (claystone and siltstones) there is always a risk that large continuous defects will be encountered. Therefore, although geotechnical inspections at 1.5m depth intervals are recommended, in addition, we also recommend that the structural shoring design be checked for the presence of a 45° sliding wedge of rock with a friction angle of 20° and with soil surcharge above. If such defects are encountered during geotechnical inspections, then additional and or higher capacity anchors may need to be installed.
- Measures should be taken to provide permanent and effective drainage of the ground immediately behind the shoring walls. As discussed above, strip drain protected by non-woven geotextile fabric should be used behind the shotcrete panels of soldier pile walls and weep holes should be adopted through contiguous piled walls. This drainage should be connected into the basement drainage system. Although the shoring walls will be provided with rear wall drainage in the form of strip drains or weep holes, this drainage will essentially only be effective in reducing water pressures from immediately behind the shoring wall facing. Hydrostatic pressures can build up behind wedges of rock some distance back from the wall. Therefore, we recommend that hydrostatic pressures based on the design groundwater level should still be assumed to apply to the shoring wall design. These hydrostatic pressures are additional to the earth pressure recommendations above. Out of balance hydrostatic pressures will occur during construction and these need to be considered as part of the shoring wall design. As discussed above, further groundwater monitoring in the standpipe piezometers is recommended.
- All surcharge loads affecting the walls (e.g. nearby buildings, construction loads and traffic etc) are additional to the earth pressure recommendations above and should be included in the design.
- Anchors should be bonded a minimum of 3m into bedrock of at least very low strength for which we consider that a maximum allowable bond stress of 100kPa may be adopted respectively. The anchor bond length should commence beyond a line drawn up at 45° from the bulk excavation level.
- All anchors should be proof loaded to 1.3 times their design working load and then locked off at about 85% of the working load under the direction of an experienced engineer or construction superintendent, independent of the anchor contractor. Lift off tests should be completed on all anchors about 4 days after lock off to confirm that anchors are holding their load.
- Piles embedded below bulk excavation level into weathered claystone of very low strength or low strength may be designed for a uniform passive resistance of 150kPa and 200kPa respectively. The upper 0.5m of the rock socket should be ignored in the passive resistance calculations to account for some disturbance and jointing within the upper shale from the excavation processes.

Shoring wall designs should include an assessment of wall movements during all stages of the excavation and anchoring construction stages. The wall designer should review the wall movements and assess whether such movements will adversely affect any nearby adjoining structures and services.

5.4.2 Permanent Basement Walls and Landscaping Walls

Where temporary batter slopes are adopted and permanent basement walls constructed within the excavation, we recommend that the following characteristic parameters may be adopted for shoring wall design. The following parameters are on the basis of either a properly placed and compacted engineered backfill or backfill comprising a uniform sized durable granular material which is surrounded in a geotextile fabric as discussed in Section 5.3 above.

- For cantilever walls where some movement can be tolerated, we recommend a triangular lateral earth pressure distribution using an 'active' earth pressure coefficient (Ka) of 0.35.
- For cantilever walls which will be propped by floor slabs or where movements are to be reduced, we recommend a triangular lateral earth pressure distribution using an 'at rest' earth pressure coefficient (K_0) of 0.6.
- A bulk unit weight of 20kN/m^3 may be used for the backfill.
- All surcharge loads affecting the walls (e.g. nearby footings, construction loads and traffic etc) are additional to the earth pressure recommendations above and should be included in the design.

Measures must be taken to provide permanent and effective drainage of the ground immediately behind the basement walls. We recommend the use of a free draining durable aggregate (such as 20mm size blue metal) with 'agg' pipe surrounded by a geotextile at the base and connected to the stormwater drainage system.

5.5 Earthworks

Around the edge of the proposed building new pavements are proposed and therefore in these areas and wherever slabs on-grade are proposed, we recommend the following subgrade preparation is completed.

- Strip off the existing grass, topsoil, root affected material, concrete pavements and any obvious deleterious fill materials. The root balls of any trees or shrubs should also be fully removed. Stripped materials will not be suitable for re-use as engineered fill and should be stockpiled separately. Such materials may be suitable for re-use within landscaped areas.
- The exposed subgrade should be proof rolled with 8 passes of a minimum 10 tonne smooth drum roller to detect any soft or heaving areas. The proof rolling should be carried out in the presence of a geotechnical engineer or experienced earthworks technician. Smaller rollers may be applicable for lightly loaded pavements and advice should eb sought from the geotechnical engineers in that regard at the time of proof rolling. The boreholes have generally indicated that the residual silty clays are of very stiff or hard strength and we do not expect significant areas of heaving subgrade within those areas, unless they are allowed to wet up. However, should poorly/moderately compacted clayey fill or stiff clays be encountered, we expect these areas to require some subgrade stabilisation; such as localised removal and replacement with engineered fill or the use of bridging layers and geogrid reinforcement. The subgrade should be well graded to promote runoff and reduce the risk of water ponding on the surface. If the subgrade becomes wet it may be untrafficable.

- Any areas of heaving subgrade should be locally removed to a competent base and replaced with engineered fill. As discussed above, where poorly compacted clayey fill is encountered as the subgrade, further more specific subgrade improvement may be required and this is best determined in consultation with the geotechnical engineers at the time of construction.
- Engineered fill should comprise a good quality granular material, such as crushed sandstone or the existing granular road-base material, and should be compacted in horizontal layers with a maximum 200mm loose thickness to at least 98% of Standard Maximum Dry Density (SMDD).
- While not preferred, the existing residual soils may also be used as engineered fill, provided they are compacted to between 98% and 102% of Standard Maximum Dry Density (SMDD) and to within ±2% of Standard Optimum Moisture Content (SOMC). If the residual silty clay soils are to be adopted for use as an engineered fill the following needs to be carefully considered.

  (i) Some of the clays may have moisture contents greater than the plastic limit and therefore they may require drying out prior to their use as engineered fill, and

  (ii) Where reactive silty clays are used as an engineered fill, they will undergo greater shrink swell movements with changes in moisture content than the in-situ reactive clays. Therefore, consideration needs to be given to the affect that greater shrink-swell movements will have on the performance of structures founded above.
- Density testing should be regularly carried out on any engineered fill. Regular density testing in accordance with Level 1 requirements of AS3798-2007 *'Guidelines on Earthworks for Commercial and Residential Developments'* are recommended.
- Any of the existing weathered bedrock excavated from the site would be suitable for use as an engineered fill. However, the weathered claystone will likely degrade quickly and may well become closer to a silty clay when placed and compacted. Therefore, these materials would also then have a relatively low soaked CBR value for pavement and slab design purposes.

Soil may need to be removed from site during earthworks operations or pile drilling which will require a waste classification prior to disposal.

5.6 Footings

Given the high column loads, deep piled footings into the claystone bedrock will be required to support the Stage 2 tower.

We consider that bored piles will be feasible, however groundwater seepage will occur into pile holes during drilling and therefore allowance will need to be made for pumping of seepage from the pier holes or pouring concrete by tremie methods. If this is not preferred then consideration could be given to using grout injected piles.

The bedrock generally ranges from extremely low to medium strength, although there are some high and even strength bands within the rock profile. Therefore, considering the bedrock profile and the likely large diameter piles required to carry the column loads, this will necessitate the use of moderate to large drilling rigs with rock drilling equipment. We recommend that any potential piling contractors be provided with a copy of this geotechnical report and they should be requested to confirm that their equipment is suitable to penetrate the rock and achieve the required depths.

The table in Section 4.2 provides our assessment of the depth and reduced levels for the various rock classes encountered within the boreholes. Based on the rock classification, the following table presents our recommendations on maximum allowable end bearing pressures, ultimate end bearing pressures, maximum allowable skin friction values and ultimate skin friction values for the various classes of rock.

Summary Table of Maximum Allowable and Ultimate End Bearing Pressures and Skin Friction Values

Rock Class	Maximum Allowable End Bearing Pressure (kPa)	Ultimate End Bearing Pressure (kPa)	Maximum Allowable Skin Friction (kPa)	Ultimate Skin Friction (kPa)
Class V Claystone (Shale)	700	1,500	50	70
Class IV Claystone (Shale)	1,000	3,000	100	150
Class III Claystone (Shale)	3,000	20,000	250	500
Class V Sandstone	1,000	3,000	100	150
Class IV Sandstone	1,500	4,000	150	300
Class III Sandstone	3,500	30,000	350	800

Class III bedrock was encountered in each of the boreholes, but at variable depths ranging from 5.5m to 20.9m. Bands of Class IV and Class V rock were also encountered within the Class III strata. Due to the variability in the quality of the rock and the magnitude of the proposed loads we recommend that unless further investigation is completed, piles be designed to found within Class IV material. Should footings be designed to found within Class III or II bedrock then additional cored boreholes must be completed following demolition of the existing structures on site.

We recommend that all piles be founded on and with a minimum embedment of 0.3m into the appropriate quality of rock. In addition to the maximum allowable and ultimate end bearing pressures, piles can also be designed for skin friction. The boreholes indicate bands of poorer quality rock within some of the better-quality rock. For founding purposes, a single pile must have a thickness of at least 1.5B (where B is the pile diameter) below the toe of the pile and within the required rock class, in order to adopt such a rock class for the founding material. Where pile groups are necessary, a similar 1.5 factor would apply, however this would apply to the minimum width of the pile group. Pile groups would need to be further assessed on a case by case basis.

Where ultimate end bearing and skin friction values are adopted, then the ultimate values recommended in the table above must be reduced by an appropriate geotechnical reduction factor. The geotechnical reduction factor should be based on the risk assessment procedure set out in Table 4.3.2 (A) of AS2159-2009, but should not be greater than 0.5, unless the risk factors producing a higher geotechnical reduction factor can be fully justified. Consideration should also be given to the pile testing requirements when determining a suitable geotechnical strength reduction factor.

In order to achieve the recommended skin friction values nominated in the table above, it is essential that the rock sockets be cleaned of any clay smear and suitably roughened using a side wall grooving tool, and that they be at least as rough as Roughness Class R2. We note that an R2 roughness is equivalent to grooves 1mm to 4mm deep and grooves 2mm wide, which are spaced at 50mm to 200mm down the socket length. It will be the responsibility of the piling contractor to ensure that he has the appropriate equipment and methodology to satisfy this roughness criteria.

Where allowable bearing pressures and skin friction values are adopted, settlement of piles will typically be less than 1% of the pile diameter at the toe of the pile. However where ultimate end bearing and skin friction values are adopted, settlements will be greater and therefore once column loads are known, some detailed settlement analysis of piles is recommended to check that predicted settlements are within acceptable limits.

We recommend that the geotechnical engineers inspect piles during drilling to confirm the above recommended bearing pressures and skin frictions are being achieved. Where the lower quality rock (equivalent to Class IV Claystone) is adopted as the founding material, we consider that only a selection of piles will need to be inspected by the geotechnical engineers. However, if further investigation allows the use of the higher quality rock (equivalent to Class III or better) for a founding material then all piles should be inspected by the geotechnical engineers. Inspection of piles will require the geotechnical engineer to be on site during the drilling process so that they can inspect both the material being drilled and check the pile's consistency with nearby borehole logs. It is important to note that the geotechnical engineers can only 'sign off' on piles which they have inspected.

Prior to pouring concrete, piles will need to be dewatered, cleaned of all loose debris from the base, inspected and approved by the geotechnical engineers. We recommend the base of piles are cleaned with a cleaning bucket. Piles will need to be poured as soon as possible after drilling, but at least on the day of drilling. If piles are left open overnight, they must be redrilled prior to pouring concrete to remove any softened or other debris from the base of the pile.

If the structure is to be designed as a fully suspended slab on piles, then any portions of the suspended slab where the subgrade, after bulk excavation, exposes residual clays or extremely weathered bedrock would need to be underlain by a void former. Further advice should be obtained from the geotechnical engineers when details are known more fully.

5.7 Pavements and Slabs On-Grade

Following subgrade preparation in accordance with the recommendations in Section 5.5, new pavements will need to be designed on the basis of the specific subgrade material. Where the subgrade comprises the residual silty clay a design CBR of 2.5% may be adopted. Where pavements overlie areas of engineered fill, CBR testing of the engineered fill subgrade will be required to confirm design assumptions.

Flexible pavements should be underlain by a good quality base-course layer comprising crushed rock to RTA QA specification 3051 (2010) unbound base material, or equivalent good quality and durable fine crushed rock compacted to at least 100% of Standard Maximum Dry Density (SMDD).

Concrete pavements should also be underlain by a subbase layer of at least 100mm thickness comprising DGB20 compacted to at least 100% of SMDD. This will reduce the risk of pumping of fines where clayey subgrades are encountered. Concrete pavements at ground floor level of the car parking structure, should be isolated from the structural columns to allow relative movement. Slab joints should be designed to resist shear forces but not bending moments by providing dowelled or keyed joints.

We recommend that subsoil drains be placed around the perimeter of the new pavements. The subsoil drains should extend to a depth of at least 0.3m below the subgrade level and the drains should have adequate falls to reduce ponding in the drains.

5.8 Earthquake Design Parameters

The following parameters can be adopted for earthquake design in accordance with AS1170.4-2007 'Structural Design Actions, Part 4: Earthquake Actions in Australia':

- Hazard factor (Z) = 0.08
- Site Subsoil Class = Class Ce

6 SALINITY

With reference to the Department of Natural Resource's 1:100,000 Map of Salinity Potential in Western Sydney the site is located in an area where there is a moderate potential for soil and groundwater salinity to occur. Salinity can affect the longevity and appearance of structures as well as causing adverse horticultural and hydrogeological effects. The local council has guidelines relating to salinity issues which should be checked for relevance to this project.

7 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. As an example, special treatment of soft spots may be required as a result of their discovery during proof-rolling, etc. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics 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, the quality assurance program should not be limited to routine compaction density testing only. Other critical factors associated with the earthworks may include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience. In order to identify potential problems, 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 is required for any soil and/or bedrock excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM), Excavated Natural Material (ENM), General Solid, Restricted Solid or Hazardous Waste. Analysis can take up to seven to ten 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) could be expected. We strongly recommend that this requirement 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 JK Geotechnics. 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.

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SOIL TEST SERVICES
ABN 43 002 145 173

TABLE A

MOISTURE CONTENT, ATTERBERG LIMIT AND LINEAR SHRINKAGE TEST REPORT

Client: JK Geotechnics
Project: Proposed Stage 2 Nepean Hospital Redevelopment
Location: Derby Street, Kingswood, NSW

Ref No: 33570LT
Report: A
Report Date: 9/12/2020
Page 1 of 1

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 %**
501	1.50 - 1.90	12.6	52	19	33	11.5
502	0.50 - 0.85	16.3	61	18	43	13.0
503	0.50 - 0.95	17	51	19	32	9.0

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
- Date of receipt of sample: 30/11/2020.
- Sampled and supplied by client. Samples tested as received.

NATA Accredited Laboratory Number:1327

Accredited for compliance with ISO/IEC 17025 - Testing.
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the items tested or sampled.

09/12/2020
Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES

ABN 43 002 145 173

TABLE B
FOUR DAY SOAKED CALIFORNIA BEARING RATIO TEST REPORT

Client:	JK Geotechnics	**Ref No:**	33570LT
Project:	Proposed Stage 2 Nepean Hospital Redevelopment	**Report:**	B
		Report Date:	19/11/2020
Location:	Derby Street, Kingswood, NSW	**Page 1 of 1**	

BOREHOLE NUMBER		BH 1	BH 2
DEPTH (m)		0.50 - 1.50	0.10 - 0.75
Surcharge (kg)		9.0	9.0
Maximum Dry Density (t/m^3)		1.87 STD	1.73 STD
Optimum Moisture Content (%)		15.2	19.1
Moulded Dry Density (t/m^3)		1.83	1.70
Sample Density Ratio (%)		98	98
Sample Moisture Ratio (%)		98	100
Moisture Contents			
Insitu (%)		12.9	16.9
Moulded (%)		14.9	19.2
After soaking and			
After Test, Top 30mm(%)		24.9	30.2
	Remaining Depth (%)	18.7	21.7
Material Retained on 19mm Sieve (%)		0	0
Swell (%)		1.0	1.5
C.B.R. value:	@2.5mm penetration		2.5
	@5.0mm penetration	2.5	

NOTES: Sampled and supplied by client. Samples tested as received.
- Refer to appropriate Borehole logs for soil descriptions
- Test Methods : AS 1289 6.1.1, 5.1.1 & 2.1.1.
- Date of receipt of sample: 05/11/2020.

NATA
NATA Accredited Laboratory Number:1327

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19/11/2020
Authorised Signature / Date
(D. Treweek)

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CERTIFICATE OF ANALYSIS 256866

Client Details

Client	JK Geotechnics
Attention	Arthur Kourtesis
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**33570LT, Kingswood**
Number of Samples	3 Soil
Date samples received	27/11/2020
Date completed instructions received	27/11/2020

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	04/12/2020
Date of Issue	01/12/2020

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Results Approved By
Priya Samarawickrama, Senior Chemist

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil				
Our Reference		256866-1	256866-2	256866-3
Your Reference	UNITS	BH501	BH503	BH505
Depth		4.2-4.45	1.5-1.95	2.7-3.15
Date Sampled		02/11/2020	04/11/2020	19/11/2020
Type of sample		Soil	Soil	Soil
Date prepared	-	30/11/2020	30/11/2020	30/11/2020
Date analysed	-	30/11/2020	30/11/2020	30/11/2020
pH 1:5 soil:water	pH Units	6.5	5.3	4.6
Chloride, Cl 1:5 soil:water	mg/kg	1,000	140	820
Sulphate, SO4 1:5 soil:water	mg/kg	200	170	350
Resistivity in soil*	ohm m	13	49	14

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	256866-2
Date prepared	-			30/11/2020	1	30/11/2020	30/11/2020		30/11/2020	30/11/2020
Date analysed	-			30/11/2020	1	30/11/2020	30/11/2020		30/11/2020	30/11/2020
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	6.5	6.5	0	101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	1000	1000	0	112	119
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	200	200	0	112	126
Resistivity in soil*	ohm m	1	Inorg-002	<1	1	13	13	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

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.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

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 batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

pH/EC

Samples were out of the recommended holding time for this analysis.

JKGeotechnics

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Method:** SPIRAL AUGER **R.L. Surface:** ~50.3 m
Date: 2/11/20 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.C.K./A.B.

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: Sandy silty clay, medium plasticity, dark brown, with fine to medium grained sandstone gravel and cobbles, trace of slag.	w~PL			
		~0.3	CI	Silty CLAY: medium plasticity, dark brown, trace of ash and root fibres.	w<PL	Hd		RESIDUAL
	N = 16 10,8,8	~0.5	CH	Silty CLAY: high plasticity, light grey brown and orange brown, trace of fine to medium grained sand and fine grained ironstone gravel.			>600 >600 >600	
	N = 17 7,7,10						500 470 >600	
		~1.9	CI	Sandy silty CLAY: medium plasticity, light grey and orange brown, with fine to medium grained ironstone gravel.	w~PL	VSt	350	
	N = 18 4,7,11	~2.2	CI-CH	Silty CLAY: medium to high plasticity, light grey mottled orange brown, with fine to medium grained ironstone gravel.	w<PL	Hd	>600 >600 530	
	N > 11 3,11/ 100mm REFUSAL	~3.8	-	Extremely Weathered claystone: silty CLAY, high plasticity, grey brown, with clay seams and iron indurated bands.	XW	Hd	>600	BRINGELLY SHALE
		~4.4						LOW RESISTANCE WITH VERY LOW BANDS

RL (m AHD) scale: 50, 49, 48, 47, 46, 45, 44. Depth (m) scale: 1, 2, 3, 4, 5, 6. SAMPLES columns: ES, U50, DB, DS.

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BOREHOLE LOG

Borehole No.
501

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Method:** SPIRAL AUGER **R.L. Surface:** ~50.3 m
Date: 2/11/20 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.C.K./A.B.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
									-		XW	Hd		
						43				CLAYSTONE: dark grey.	DW SW	L - M		LOW RESISTANCE
						42	8							
							9							
						41				REFER TO CORED BOREHOLE LOG				
						40	10							
						39	11							
						38	12							
						37	13							

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT	**Core Size:** NMLC	**R.L. Surface:** ~50.3 m
Date: 2/11/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK308	**Bearing:** N/A	**Logged/Checked By:** A.C.K./A.B.

Column headings: Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH) | DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20); DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness) Specific / General | Formation

START CORING AT 9.20m

Water Loss\Level: 100% RETURN

Formation: Bringelly Shale

RL (m AHD): 41, 40, 39, 38, 37, 36, 35
Depth (m): 10, 11, 12, 13, 14, 15

Core Description	Weathering	Strength	Point Load $I_s(50)$
CLAYSTONE: grey, bedded sub-horizontally.	MW, SW, MW, SW	M, L, M	0.60, 0.50, 0.30, 0.50, 0.50, 0.90, 0.50, 0.40, 0.40, 0.60, 0.40
SANDSTONE: fine grained, light grey, with grey claystone laminae, bedded sub-horizontally.	FR	H - VH	3.2
CLAYSTONE: grey, with fine grained light grey sandstone laminae, bedded sub-horizontally.	SW	M	0.40, 0.90

Defect Details (Specific):
- (9.23m) XWS, 0°, 5 mm.t
- (9.34m) XWS, 0°, 100 mm.t
- (9.45m) XWS, 5°, 20 mm.t
- (9.49m) XWS, 5°, 15 mm.t
- (9.60m) XWS, 15°, 50 mm.t
- (9.86m) XWS, 5°, 40 mm.t
- (10.06m) Fractured, 35°, 50 mm.t
- (10.24m) XWS, 5°, 30 mm.t
- (10.27m) CS, 5°, 40 mm.t
- (10.30m) XWS, 0°, 20 mm.t
- (10.34m) XWS, 0°, 20 mm.t
- (10.55m) XWS, 0°, 5 mm.t
- (10.82m) J, 20°, P, R, Cn
- (11.15m) Fractured, 5°, 20 mm.t
- (11.60m) XWS, 10°, 5 mm.t
- (11.74m) CS, 0°, 60 mm.t
- (11.90m) XWS, 0°, 15 mm.t
- (12.51m) Cr, 0°, 70 mm.t
- (13.62m) XWS, 5°, 2 mm.t
- (13.93m) XWS, 5°, 20 mm.t
- (13.98m) CS, 5°, 50 mm.t
- (14.78m) Ji, 70°, Cn
- (14.87m) J, 70°, Un, R, Cn
- (15.14m) J, 30°, P, S, Cn
- (15.64m) CS, 0°, 70 mm.t

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
501

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Core Size:** NMLC **R.L. Surface:** ~50.3 m
Date: 2/11/20 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.C.K./A.B.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION – Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness (Specific / General)	Formation
100% RETURN		34			CLAYSTONE: dark grey, with light grey laminae, bedded sub-horizontally.	SW	M	0.50, 1.5		(15.99m) CS, 0°, 10 mm.t (16.29m) XWS, 10°, 2 mm.t (16.88m) XWS, 0°, 20 mm.t (16.95m) XWS, 0°, 35 mm.t	Bringelly Shale
		33	17		interbedded SILTSTONE: dark grey and CLAYSTONE: grey, with fine grained light grey sandstone laminae.			0.60, 0.70			
		32, 31, 30, 29, 28	18, 19, 20, 21, 22		END OF BOREHOLE AT 18.00 m						

Point load scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH
Spacing scale: 600, 200, 60, 20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 33570LT
Borehole No: BH501
Depth: 9.2 m - 18 m
KODAK Gray Scale
KODAK Color Control Patches
33570LT BH501 START CORING AT 9.20m
9
10
11
12
13
14
15
16
17
END OF BOREHOLE AT 18.00m

JKGeotechnics

BOREHOLE LOG

Borehole No.
502

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Method:** SPIRAL AUGER **R.L. Surface:** ~51.0 m
Date: 3/11/20 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.C.K./A.B.

Groundwater Record	Field Tests	RL (m AHD)	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING					FILL: Silty clay, medium plasticity, dark grey brown, trace of fine to medium grained sand, fine to medium grained igneous and ironstone gravel and root fibres.	w~PL			
	N = 6 4,4,2	50	1	CH	Silty CLAY: high plasticity, light grey and orange brown, trace of fine grained ironstone gravel.	w<PL w>PL	Hd VSt	580 520 250 200	RESIDUAL GROUNDWATER MONITORING WELL INSTALLED TO 14.0m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 8.0m TO 14.0m. CASING 0m TO 8.0m. 2mm SAND FILTER PACK 6.2m TO 14.0m. BENTONITE SEAL 5.7m TO 6.2m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER. BACKFILLED FROM 24.12m TO 14.0m WITH SAND, THEN 0.5m BENTONITE PLUG.
	N = 15 3,5,10	49	2	CI	Silty CLAY: medium plasticity, light grey and light brown, trace of fine grained sand.	w~PL	VSt - Hd	470 370 340	
ON 10/12/20	N = 17 7,8,9	48	3		Silty CLAY: medium plasticity, light grey.	w<PL	Hd	600 430 600	
	N=SPT 9,4/ 150mm REFUSAL	47	4	CI-CH	Silty CLAY: medium to high plasticity, light grey and red brown, trace of fine to medium grained ironstone gravel.			>600 >600	
		46	5	-	Extremely Weathered claystone: silty CLAY, high plasticity, grey brown and red brown.	XW	Hd		BRINGELLY SHALE
		45	6	-	SANDSTONE: fine to medium grained, grey brown, with iron indurated bands and extremely weathered seams.	DW	VL - L M - H		VERY LOW TO LOW 'TC' BIT RESISTANCE MODERATE RESISTANCE
					REFER TO CORED BOREHOLE LOG				

JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
502

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT	**Core Size:** NMLC	**R.L. Surface:** ~51.0 m
Date: 3/11/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK308	**Bearing:** N/A	**Logged/Checked By:** A.C.K./A.B.

Column headings: Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH) | DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20) | DEFECT DETAILS: DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness) Specific / General | Formation

START CORING AT 6.20m

Water Loss\Level: 100% RETURN

RL / Depth: 44 – 7; 43 – 8; 42 – 9; 41 – 10; 40 – 11; 39 – 12

Core Description	Weathering	Strength
SANDSTONE: fine grained, light grey and light brown, bedded sub-horizontally.	MW	M
	HW	L
SANDSTONE: fine grained, light grey, with grey laminae and light grey brown bands, bedded sub-horizontally.	MW	L - M
		M
	XW	Hd
	MW	M
	HW	VL
CLAYSTONE: grey, bedded sub-horizontally.		
Extremely Weathered claystone: silty CLAY, high plasticity, grey.	XW	Hd

Point Load Strength Index $I_s(50)$: 0.20, 0.20, 0.40, 0.20, 0.90, 0.090, 0.040, 0.070, 0.070, 0.10, 0.20, 0.030, 0.030

Defect Details – Specific:
- (6.38m) XWS, 0°, 50 mm.t
- (6.44m) XWS, 0°, 40 mm.t
- (7.21m) Fragmented Zone, 10°, 20 mm.t
- (7.26m) J, 75°, C, R, Cn
- (7.28m) J, 70°, C, R, Cn
- (7.40m) J, 70°, P, R, Cn
- (7.58m) XWS, 0°, 40 mm.t
- (7.85m) XWS, 0°, 10 mm.t
- (7.95m) XWS, 0°, 100 mm.t
- (8.43m) XWS, 5°, 2 mm.t
- (8.84m) XWS, 10°, 25 mm.t
- (9.31m) XWS, 0°, 250 mm.t
- (9.56m) XWS, 0°, 40 mm.t
- (9.67m) XWS, 0°, 190 mm.t
- (10.13m) XWS, 0°, 25 mm.t
- (10.63m) XWS, 0°, 75 mm.t

Formation: Bringelly Shale

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Core Size:** NMLC **R.L. Surface:** ~51.0 m
Date: 3/11/20 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.C.K./A.B.

Water Loss\Level	Depth (m)	RL (m AHD)	Core Description	Weathering	Strength	Point Load Strength Index $I_s(50)$	Defect Details (Specific)	Formation
100% RETURN	to ~16.6		CLAYSTONE: grey and dark grey, bedded sub-horizontally. *(continued)*	HW	VL	0.10, 0.080, 0.080, 0.060, 0.040, 0.060, 0.30	(15.15m) XWS, 0°, 60 mm.t (15.29m) XWS, 0°, 80 mm.t (15.96m) XWS, 0°, 60 mm.t (16.23m) XWS, 0°, 70 mm.t	Bringelly Shale
	~16.6–16.9			MW	L			
	~16.9–18.45		Extremely Weathered claystone: silty CLAY, high plasticity, grey and dark grey, with occasional very low strength bands.	XW	Hd	0.10, 0.030, 0.040		
	~18.45–19.0		CLAYSTONE: dark grey, bedded sub-horizontally.	MW	L	0.20, 0.20	(18.47m) XWS, 5°, 10 mm.t (18.50m) XWS, 10°, 5 mm.t (18.58m) XWS, 5°, 5 mm.t (18.62m) CS, 0°, 35 mm.t (18.76m) XWS, 0°, 60 mm.t (18.85m) CS, 0°, 20 mm.t (18.90m) XWS, 10°, 5 mm.t	
	~19.0–19.3		Extremely Weathered claystone, silty CLAY, medium plasticity, dark grey.	XW	Hd			
	~19.3–20.0		Interbedded SILTSTONE: grey and dark grey, and CLAYSTONE: grey, bedded sub-horizontally.	SW	M	0.70, 0.50	(19.36m) CS, 10°, 20 mm.t (19.41m) XWS, 5°, 15 mm.t (19.46m) XWS, 10°, 10 mm.t (19.48m) XWS, 10°, 2 mm.t (19.52m) XWS, 15°, 3 mm.t (19.65m) XWS, 15°, 15 mm.t (19.76m) J, 15°, P, S, Fe Sn (19.86m) XWS, 5°, 5 mm.t	

Depth scale: 14 (RL 37), 15 (RL 36), 16 (RL 35), 17 (RL 34), 18 (RL 33), 19 (RL 32)

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT	**Core Size:** NMLC	**R.L. Surface:** ~51.0 m
Date: 3/11/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK308	**Bearing:** N/A	**Logged/Checked By:** A.C.K./A.B.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	Formation
100% RETURN				Interbedded SILTSTONE: grey and dark grey, and CLAYSTONE: grey, bedded sub-horizontally.	HW	M	1.5	Bringelly Shale
				Extremely Weathered siltstone, silty CLAY, medium plasticity, grey.	XW	Hd		
		30	21	Interbedded SILTSTONE: grey and dark grey, and CLAYSTONE: grey, bedded sub-horizontally.	SW	M	0.40, 0.30, 0.90, 0.50, 0.70	
		29	22					
		28	23		FR	M - H	1.1, 0.70, 1.2	
		27	24					
				END OF BOREHOLE AT 24.12 m				
		26	25					
		25	26					

Point load scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH

DEFECT DETAILS

SPACING (mm): 600, 200, 60, 20

DESCRIPTION: Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness

Specific / General

(20.12m) CS, 0°, 30 mm.t
(20.59m) XWS, 0°, 8 mm.t
(20.67m) XWS, 10°, 5 mm.t
(20.80m) XWS, 10°, 35 mm.t
(20.86m) CS, 10°, 30 mm.t
(20.92m) XWS, 0°, 40 mm.t
(21.75m) J, 30°, P, S, Cn
(21.90m) XWS, 0°, 5 mm.t
(21.96m) XWS, 5°, 15 mm.t
(22.04m) J, 50°, P, S, Cn
(22.09m) XWS, 5°, 15 mm.t
(22.20m) Cr, 10°, 5 mm.t
(22.26m) J, 30°, P, R, XW
(22.52m) Cr, 5°, 15 mm.t
(22.55m) XWS, 5°, 5 mm.t
(22.62m) J, 30°, P, S, Cn
(22.88m) XWS, 5°, 80 mm.t
(23.02m) XWS, 35°, 50 mm.t
(23.15m) XWS, 5°, 3 mm.t
(23.18m) XWS, 10°, 1 mm.t
(23.35m) J, 30°, P, S, Cn, 50 mm.t
(23.62m) XWS, 10°, 10 mm.t
(23.85m) J, 85°, C, S, Cn

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 33570LT
Borehole No: BH502
Depth: 6.20m – 15.00m
KODAK Gray Scale
KODAK Color Control Patches
33570LTBH502 START CORING AT 6.20m
6
7
8
9
10
11
12
13
14


JKGeotechnics
Job No: 33570LT
Borehole No: BH502
Depth: 15.0m - 24.12m
KODAK Gray Scale
KODAK Color Control Patches
15
16
17
18
19
20
21
22
23
24
END OF BOREHOLE AT 24.12m

JKGeotechnics

BOREHOLE LOG

Borehole No.
503

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Method:** SPIRAL AUGER **R.L. Surface:** ~53.9 m
Date: 4/11/20 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.C.K./A.B.

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	RL (m AHD)	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
				0		FILL: Silty sandy clay, low plasticity, dark grey brown, fine to medium grained.	w~PL			APPEARS MODERATELY COMPACTED
	DB, DS	N = 7 3,3,4	53	1		FILL: Silty clay, high plasticity, light grey and orange brown, trace of fine to medium grained sand and sand bands, fine to medium grained ironstone gravel.				
	DS	N = 8 3,4,4	52	2						
	DS	N = 21 7,10,11	51	3	CH	Silty CLAY: high plasticity, light grey brown and orange brown, with fine to medium grained sand.	w<PL	Hd	>600 >600 >600	RESIDUAL
	DS	N = 19 6,8,11	50	4		Silty CLAY: high plasticity, light grey mottled red brown, trace of fine to medium grained ironstone gravel.	w>PL	VSt - Hd	360 360 350	
ON COMPLETION OF AUGERING	DS	N=SPT 12/ 50mm REFUSAL	49, 48, 47	5, 6	-	Extremely Weathered claystone: silty CLAY, high plasticity, light grey, with orange brown, iron indurated bands.	XW	Hd	>600 >600	BRINGELLY SHALE VERY LOW TO LOW 'TC' BIT RESISTANCE

JK 9.02.4 LIB.GLB Log JK AUGERHOLE - MASTER 33570LT KINGSWOOD.GPJ <<DrawingFile>> 18/12/2020 14:23 10.01.00.01 Datgel Lab and In Situ Tool - DGD | Lib: JK 9.02.4 2019-05-31 Prj: JK 9.01.0 2018-03-20

JKGeotechnics

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Method:** SPIRAL AUGER **R.L. Surface:** ~53.9 m
Date: 4/11/20 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.C.K./A.B.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
▶				DS		46	8		-	Extremely Weathered claystone: silty CLAY, high plasticity, grey brown.	XW	Hd		
										SANDSTONE: fine grained, light grey brown, with extremely weathered seams and low strength bands.	DW	M - H		MODERATE RESISTANCE
						45	9			CLAYSTONE: dark grey.		L		LOW RESISTANCE
						44, 43, 42, 41, 40	10, 11, 12, 13			REFER TO CORED BOREHOLE LOG				

JKGeotechnics

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT	**Core Size:** NMLC	**R.L. Surface:** ~53.9 m
Date: 4/11/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK308	**Bearing:** N/A	**Logged/Checked By:** A.C.K./A.B.

START CORING AT 9.10m

Water Loss\Level: 100% RETURN
Formation: Bringelly Shale

Depth (m)	CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components)	Weathering	Strength	Point Load Strength Index $I_s(50)$	Defect Details – Description (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness)
9.10–10.70	CLAYSTONE: dark grey, bedded sub-horizontally, with occasional high strength fine grained sandstone laminae.	MW	L	0.30, 0.10, 0.60	(9.33m) XWS, 5°, 2 mm.t (9.42m) XWS, 5°, 2 mm.t (9.65m) XWS, 5°, 2 mm.t (9.88m) XWS, 0°, 5 mm.t (9.92m) XWS, 0°, 10 mm.t (10.49m) XWS, 5°, 30 mm.t (10.61m) J, 85°, P, R, XW FILLED (10.64m) J, 90°, P, R, Fe Sn
10.70–10.90		HW	VL		(10.78m) XWS, 5°, 10 mm.t (10.81m) XWS, 5°, 10 mm.t
10.90–11.50		MW	L - M	0.10	(10.97m) XWS, 5°, 5 mm.t
11.50–11.70		XW	Hd		
11.70–12.80		HW	L	0.30	(11.82m) XWS, 0°, 20 mm.t (12.18m) XWS, 0°, 20 mm.t (12.36m) XWS, 0°, 15 mm.t
12.80–13.18	Extremely Weathered claystone: silty CLAY, medium plasticity, dark grey.	XW	Hd		
13.18–13.90	CLAYSTONE: dark grey, bedded sub-horizontally, with occasional high strength fine grained sandstone laminae.	MW	L	0.40, 0.30	(13.52m) XWS, 5°, 15 mm.t (13.55m) XWS, 5°, 10 mm.t (13.60m) XWS, 0°, 5 mm.t (13.61m) XWS, 0°, 5 mm.t (13.65m) XWS, 0°, 15 mm.t (13.72m) XWS, 0°, 20 mm.t
13.90–14.45	Extremely Weathered claystone: silty CLAY, medium plasticity, dark grey.	XW	Hd		
14.45–15.05	CLAYSTONE: dark grey, sub-horizontally.	MW	L	0.20	
15.05–15.22		XW	Hd		
15.22–15.35		MW	L	0.30	
15.35–16.00	Extremely Weathered claystone: silty CLAY, medium plasticity, dark grey, with very low strength bands.	XW	Hd		

RL (m AHD): 44 at ~9.9 m, 43 at ~10.9 m, 42 at ~11.9 m, 41 at ~12.9 m, 40 at ~13.9 m, 39 at ~14.9 m, 38 at ~15.9 m.

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Core Size:** NMLC **R.L. Surface:** ~53.9 m
Date: 4/11/20 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.C.K./A.B.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	Formation
100% RETURN		37	17	Extremely Weathered claystone: silty CLAY, medium plasticity, dark grey, with very low strength bands. *(continued)*	XW	Hd		Bringelly Shale
				CLAYSTONE: dark grey, bedded sub-horizontally.	MW	L - M	0.40, 0.30	
		36	18	Extremely Weathered claystone: silty CLAY, medium plasticity, dark grey.	XW	Hd		
		35, 34, 33	19, 20, 21	CLAYSTONE: dark grey, bedded sub-horizontally.	SW	M	0.30, 0.60, 0.60, 0.60, 0.60, 0.40, 0.30, 0.10	
		32, 31	22	END OF BOREHOLE AT 21.49 m				

Strength index scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH

DEFECT DETAILS – SPACING (mm): 600, 200, 60, 20

DESCRIPTION – Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness

Specific / General

- (17.31m) XWS, 5°, 3 mm.t
- (17.33m) XWS, 5°, 3 mm.t
- (17.44m) XWS, 5°, 4 mm.t
- (17.64m) XWS, 5°, 10 mm.t
- (18.46m) XWS, 0°, 5 mm.t
- (18.60m) J, 40°, P, S, Cn
- (18.78m) XWS, 0°, 30 mm.t
- (18.88m) XWS, 0°, 20 mm.t
- (18.94m) XWS, 0°, 5 mm.t
- (18.98m) XWS, 0°, 10 mm.t
- (19.25m) XWS, 0°, 30 mm.t
- (19.38m) XWS, 0°, 5 mm.t
- (19.47m) XWS, 0°, 5 mm.t
- (19.72m) XWS, 5°, 15 mm.t
- (19.80-19.89m) XWS x 6, 0°, 1 mm.t
- (19.85m) XWS, 0°, 90 mm.t
- (20.02m) XWS, 0°, 2 mm.t
- (20.04m) XWS, 0°, 3 mm.t
- (20.10m) XWS, 0°, 2 mm.t
- (20.19m) XWS, 0°, 10 mm.t
- (20.35m) Ji, 75 - 90°, Un
- (20.67m) J, 75°, P, R, Cn
- (20.75m) J, 30°, P, S, Cn
- (21.09m) XWS, 0°, 25 mm.t
- (21.16m) J, 45°, P, S, Cn
- (21.29m) J, 50°, P, S, Cn
- (21.37m) XWS, 5°, 20 mm.t

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 33570LT
Borehole No: BH503
Depth: 9.10m - 18.00m
KODAK Gray Scale
KODAK Color Control Patches
33570LT BH503 START CORING AT 9.10m
9
10
11
12
13
14
15
16
17


JKGeotechnics
Job No: 33570LT
Borehole No: BH503
Depth: 18.00m -21.49
KODAK Gray Scale
KODAK Color Control Patches
18
19
20
21
END OF BOREHOLE AT 21.49m

JKGeotechnics

BOREHOLE LOG

Borehole No.
504

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Method:** SPIRAL AUGER **R.L. Surface:** ~54.1 m
Date: 20/11/20 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** B.S./A.B.

Groundwater Record	Field Tests	RL (m AHD)	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING		54	0		FILL: Silty sand, fine to medium grained, dark brown, trace of roots, root fibres, fine to medium grained ironstone gravel and wire fragments.	M			MULCH COVER VACUUM EXCAVATED TO 1.0m
					as above, but with fine to coarse grained sandstone gravel and sandstone cobbles.	w>PL			
		53	1		FILL: Silty clay, low to medium plasticity, light grey and red brown.				
	N = 18 6,8,10	52	2		FILL: Silty clay, low plasticity, red brown, orange brown and grey, trace of ash, root fibres, fine to medium grained ironstone gravel and sandy silty clay bands.	w~PL			APPEARS WELL COMPACTED
	N = 8 3,3,5	51	3	CI	Silty CLAY: medium plasticity, grey mottled red brown, trace of root fibres and fine to medium grained ironstone gravel.	w~PL	Hd	450 420 400	RESIDUAL
			4	CI-CH	Silty CLAY: medium to high plasticity, light grey, fissured, trace of fine to coarse grained ironstone gravel.	w<PL			
	N=SPT 17/ 149mm REFUSAL	50		-	Extremely Weathered claystone: silty CLAY, high plasticity, grey, with iron indurated bands.	XW	Hd	600 600 600	BRINGELLY SHALE
		49	5		CLAYSTONE: grey and brown, with iron indurated and extremely weathered seams.	DW	VL		VERY LOW 'TC' BIT RESISTANCE
		48	6		REFER TO CORED BOREHOLE LOG				

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Core Size:** NMLC **R.L. Surface:** ~54.1 m
Date: 20/11/20 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** B.S./A.B.

Water Loss\Level	Depth (m)	RL (m AHD)	CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	Formation
	to 5.75	49 – ~48.35	START CORING AT 5.75m				
100% RETURN	5.75 – 8.0		LAMINITE: Claystone, dark grey and brown, interlaminated with sandstone, fine grained, grey.	HW	VL - L; M	0.20; 0.10; 1.0; 0.80; 0.60	Bringelly Shale
	8.0 – 8.7		CLAYSTONE: dark grey, bedded sub-horizontally.	MW	VL - L	0.030; 0.10	
	8.7 – 9.12		Extremely Weathered claystone: silty CLAY, high plasticity, grey, with very low strength bands.	XW	Hd		
	9.12 – 10.12		LAMINITE: Claystone, dark grey, interlaminated with sandstone, fine grained grey, bedded sub-horizontally.	MW	L - M	2.4; 0.20	
	10.12 –		CLAYSTONE: dark grey, bedded sub-horizontally, with fine grained grey sandstone laminae.		L; VL - L; VL	0.20; 0.30; 0.70; 0.60	

DEFECT DETAILS — DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness)

Specific	General
(6.06m) XWS, 0°, 70mm.t	
(6.62m) XWS, 0°, 25mm.t	
(6.81m) XWS, 0°, 15mm.t	
(6.86m) XWS, 0°, 10mm.t	
(7.15m) XWS, 0°, 10mm.t	
(7.25m) XWS, 0°, 8mm.t	
(7.62m) XWS, 0°, 10mm.t	
(7.68m) XWS, 0°, 11mm.t	
(7.73m) XWS, 0°, 50mm.t	
(7.86m) Be, 0°, P, R, Fe Sn	
(7.91m) XWS, 0°, 30mm.t	
(9.12m) XWS, 0°, 95mm.t	
(9.29m) XWS, 0°, 20mm.t	
(9.34m) XWS, 0°, 20mm.t	
(9.83m) J, 70°, Cu, Ro, Cn	
(10.16m) Be, 0°, P, R, Clay Ct	
(10.32m) XWS, 0°, 130mm.t	
(10.59-10.70m) Fragmented Zone	
(10.84-10.90m) Fragmented Zone	
(11.13m) Be, 0°, P, S, Cn	
(11.33m) Be, 0°, Un, R, Clay Ct	

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
504
3 / 4

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT	**Core Size:** NMLC	**R.L. Surface:** ~54.1 m
Date: 20/11/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK308	**Bearing:** N/A	**Logged/Checked By:** B.S./A.B.

Water Loss\Level: 80% RETURN (to approx. 18.0 m); 50% RETURN (below approx. 18.0 m)

RL (m AHD): 42, 41, 40, 39, 38, 37, 36 — Depth (m): 13, 14, 15, 16, 17, 18

Formation: Bringelly Shale

CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components)	Weathering	Strength	Point Load Strength Index $I_s(50)$
CLAYSTONE: dark grey, bedded sub-horizontally, with fine grained grey sandstone laminae. *(continued)*	MW	L - M	0.20
Extremely Weathered claystone: silty CLAY, high plasticity, grey.	XW	Hd	
CLAYSTONE: dark grey, bedded sub-horizontally.	HW	VL	0.050, 0.10
Extremely Weathered claystone: silty CLAY, high plasticity, grey.	XW	Hd	
CLAYSTONE: dark grey, bedded sub-horizontally, with occasional coal seams.	SW	L - M	0.30
as above, but without coal seams.	SW	VL - L; L	0.10, 0.20, 0.30, 0.30, 0.20
Extremely Weathered claystone: silty CLAY, high plasticity, grey.	XW	Hd	
CLAYSTONE: dark grey, bedded sub-horizontally.	SW	M	0.60
Extremely Weathered claystone, silty CLAY, high plasticity, grey.	XW	Hd	
CLAYSTONE: dark grey and grey, with occasional fine grained sandstone laminae, bedded sub-horizontally.	SW	L - M; M	0.30, 0.60, 0.50, 0.40

Point load scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH

Spacing (mm): 600, 200, 60, 20

DEFECT DETAILS — DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness)

Specific:
- (12.15m) XWS, 0°, 25mm.t
- (12.35m) XWS, 0°, 25mm.t
- (12.48m) XWS, 0°, 100mm.t
- (13.41m) J, 70°, P, S, Clay Ct
- (13.68m) Be, 0°, Un, R, Clay FILLED, 2 mm.t
- (13.92m) XWS, 0°, 80mm.t
- (14.41m) XWS, 0°, 30mm.t
- (14.57m) XWS, 0°, 130mm.t
- (15.35m) Be, 0°, Un, Ro, Clay FILLED, 5 mm.t
- (15.53m) XWS, 0°, 70mm.t
- (15.66-15.81m) Fragmented Zone
- (17.15m) Be, 0°, P, R, Clay Ct
- (17.65m) J, 30°, Un, S, Clay Ct
- (17.76m) Be, 0°, P, S, Clay Ct
- (17.94m) J, 80 - 90°, Un, S, Cn

General

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

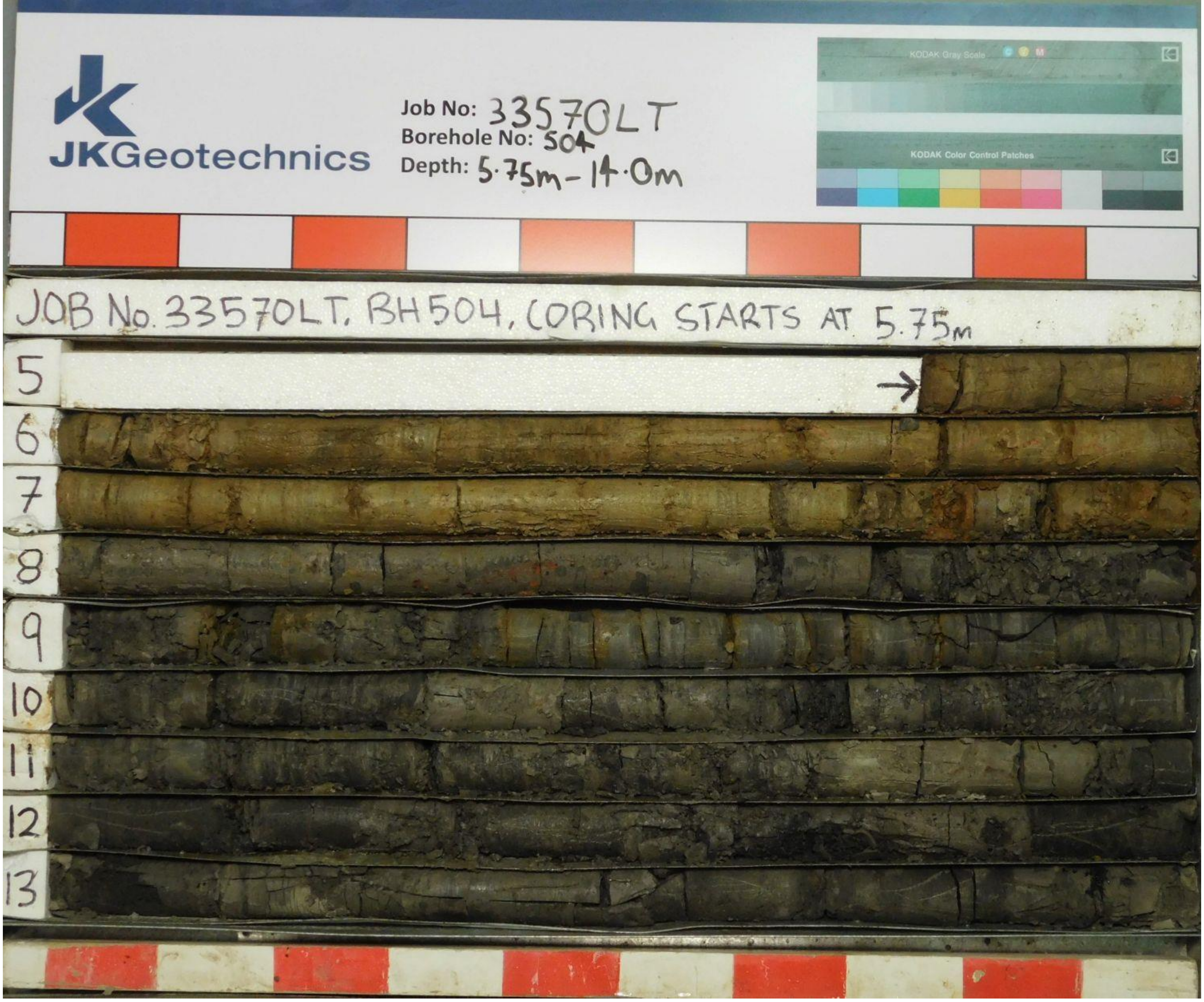
CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT	**Core Size:** NMLC	**R.L. Surface:** ~54.1 m
Date: 20/11/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK308	**Bearing:** N/A	**Logged/Checked By:** B.S./A.B.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components)	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	SPACING (mm)	DEFECT DETAILS – DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness) Specific	General	Formation
50% RETURN		35 – 33	– 21		CLAYSTONE: dark grey and grey, with occasional fine grained sandstone laminae, bedded sub-horizontally. *(continued)*	SW	L - M	0.20, 0.60, 0.60, 0.30		(19.12m) Be, 0°, Un, S, Cn (19.59m) Be, 0°, P, S, Cn (20.20m) Be, 0°, Un, S, Clay Ct (20.97m) CS, 0°, 11mm.t		Bringelly Shale
		33 – 29	21 – 25		END OF BOREHOLE AT 21.03 m							

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 33570LT
Borehole No: 504
Depth: 5.75m - 14.0m
KODAK Gray Scale
KODAK Color Control Patches
JOB No. 33570LT. BH504, CORING STARTS AT 5.75m
5
6
7
8
9
10
11
12
13


JKGeotechnics
Job No: 33570LT
Borehole No: 504
Depth: 14.0-21.03m
KODAK Gray Scale
KODAK Color Control Patches
14
15
16
17
18
19
20
21
END OF HOLE AT 21.03m

JKGeotechnics

BOREHOLE LOG

Borehole No.
505

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Method:** SPIRAL AUGER **R.L. Surface:** ~54.2 m
Date: 19/11/20 **Datum:** AHD
Plant Type: JK308 **Logged/Checked By:** A.C.K./A.B.

Groundwater Record	SAMPLES (ES / U50 / DB / DS)	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING			54	0			CONCRETE: 0.14mm.t				NO OBSERVED REINFORCEMENT
						-	FILL: Clayey gravel, medium to coarse grained, igneous.	M			VACUUM EXCAVATED TO 1.05m
			53	1		CH	Silty CLAY: high plasticity, light grey and orange brown, trace of medium to coarse grained ironstone gravel.	w>PL	(VSt)		RESIDUAL
			52	2							
		N = 13 6,6,7	51	3		CI	Silty CLAY: medium plasticity, light grey mottled red brown, with fine grained sand.	w<PL	Hd	560 >600 >600	
ON 10/12/20			50	4		-	CLAYSTONE: grey brown, with iron indurated bands and extremely weathered seams.	DW	L		BRINGELLY SHALE VERY LOW TO LOW 'TC' BIT RESISTANCE
			49	5			REFER TO CORED BOREHOLE LOG				GROUNDWATER MONITORING WELL INSTALLED TO 19.9m. CLASS 18 MACHINE SLOTTED 50mm DIA. PVC STANDPIPE 7.9m TO 19.9m. CASING 0.0m TO 7.9m. 2mm SAND FILTER PACK 1.4m TO 19.9m. BENTONITE SEAL 0.9m TO 1.4m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.
			48	6							

JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
505

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT | **Core Size:** NMLC | **R.L. Surface:** ~54.2 m
Date: 19/11/20 | **Inclination:** VERTICAL | **Datum:** AHD
Plant Type: JK308 | **Bearing:** N/A | **Logged/Checked By:** A.C.K./A.B.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Core Description (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components)	Weathering	Strength	Point Load Strength Index $I_s(50)$	Defect Details – Description (Specific)
ON 10/12/20		50		START CORING AT 4.60m				
ON COMPLETION OF CORING (water level); 100% RETURN		49	5	Extremely Weathered claystone: silty CLAY, medium to high plasticity, grey brown, with iron indurated seams.	XW	Hd		
		48	6	CLAYSTONE: dark grey brown, bedded sub-horizontally.	HW	L	0.10	(6.24m) Fragmented Zone, 0°, 40 mm.t
					XW	Hd		
					HW	L	0.70	
					MW	M - H		
		47	7		HW	L	0.20	(6.83m) Fragmented Zone, 0°, 150 mm.t
							0.20	(7.35m) Fragmented Zone, 0°, 320 mm.t
					MW			
		46	8	Extremely Weathered claystone: silty CLAY, medium plasticity, grey, with very low to low strength seams.	XW	Hd		
		45	9	CLAYSTONE: grey, bedded sub-horizontally.	HW	L	0.30	(8.73m) XWS, 10°, 30 mm.t (8.75m) Be, 10°, P, R, Cb FILLED (8.78m) XWS, 16°, 70 mm.t
					MW		0.30	
					HW		0.20	(9.21m) XWS, 0°, 100 mm.t
					MW		0.20	
		44	10		HW		0.10	(10.31m) CS, 0°, 15 mm.t
					MW		0.20	(10.73m) XWS, 0°, 5 mm.t (10.92m) XWS, 0°, 10 mm.t

Formation: Bringelly Shale

Strength scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH
Spacing (mm): 600, 200, 60, 20
Defect Details: Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness — Specific / General

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
505

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT	**Core Size:** NMLC	**R.L. Surface:** ~54.2 m
Date: 19/11/20	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK308	**Bearing:** N/A	**Logged/Checked By:** A.C.K./A.B.

Columns: Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION (Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components) | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH) | DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20); DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness) Specific / General | Formation

RL (m AHD): 43, 42, 41, 40, 39, 38, 37
Depth (m): 12, 13, 14, 15, 16, 17

Water Loss\Level: 100% RETURN

CORE DESCRIPTION: CLAYSTONE: grey, bedded sub-horizontally, with occasional high strength sandstone seams.

Weathering	Strength	Point Load Strength Index $I_s(50)$
MW	M	0.40
XW	Hd	
MW	L - M	0.40
XW	Hd	
MW	L - M	0.40, 0.10
XW	Hd	
MW	L	0.40, 0.20, 0.20, 0.20
HW	VL	0.080, 0.090, 0.10
MW	L	0.30, 0.30
SW	H	1.4

Defect Details (Specific):

- (11.09m) XWS, 0°, 5 mm.t
- (11.58m) XWS, 5°, 25 mm.t
- (11.63m) XWS, 5°, 5 mm.t
- (11.72m) XWS, 5°, 3 mm.t
- (13.18m) XWS, 5°, 10 mm.t
- (14.06m) XWS, 0°, 5 mm.t
- (14.73m) J, 70°, Un, S, Cn
- (16.88m) XWS, 10°, 20 mm.t
- (17.15m) J, 30°, P, S, Cn

Formation: Bringelly Shale

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JKGeotechnics

CORED BOREHOLE LOG

Borehole No.
505
4 / 4

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED NEPEAN HOSPITAL REDEVELOPMENT STAGE 2
Location: DERBY STREET, KINGSWOOD, NSW

Job No.: 33570LT **Core Size:** NMLC **R.L. Surface:** ~54.2 m
Date: 19/11/20 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK308 **Bearing:** N/A **Logged/Checked By:** A.C.K./A.B.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	DEFECT DETAILS: SPACING (mm) (600, 200, 60, 20)	DEFECT DETAILS: DESCRIPTION (Type, orientation, defect shape and roughness, defect coatings and seams, openness and thickness) Specific / General	Formation
100% RETURN		36, 35	19		CLAYSTONE: grey, bedded sub-horizontally, with occasional high strength sandstone seams. *(continued)*	MW	L			(18.15m) J, 80°, P, S, Cn	Bringelly Shale
							VL - L	0.10			
							M	0.70, 1.2			
						HW	VL	0.070			
						MW	M				
		34, 33, 32, 31, 30	20, 21, 22, 23, 24		END OF BOREHOLE AT 19.90 m						

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FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JKGeotechnics
Job No: 33570LT
Borehole No: 505
Depth: 4.6m - 13.0m
KODAK Gray Scale
KODAK Color Control Patches
33570LT BH505 START CORING AT 4.60m
4
5
6
7
8
9
10
11
12

JKGeotechnics
Job No: 33570LT
Borehole No: 505
Depth: 13.0m-19.9m
KODAK Gray Scale
KODAK Color Control Patches
13
14
15
16
17
18
19
20
END OF BOREHOLE AT 19.90m

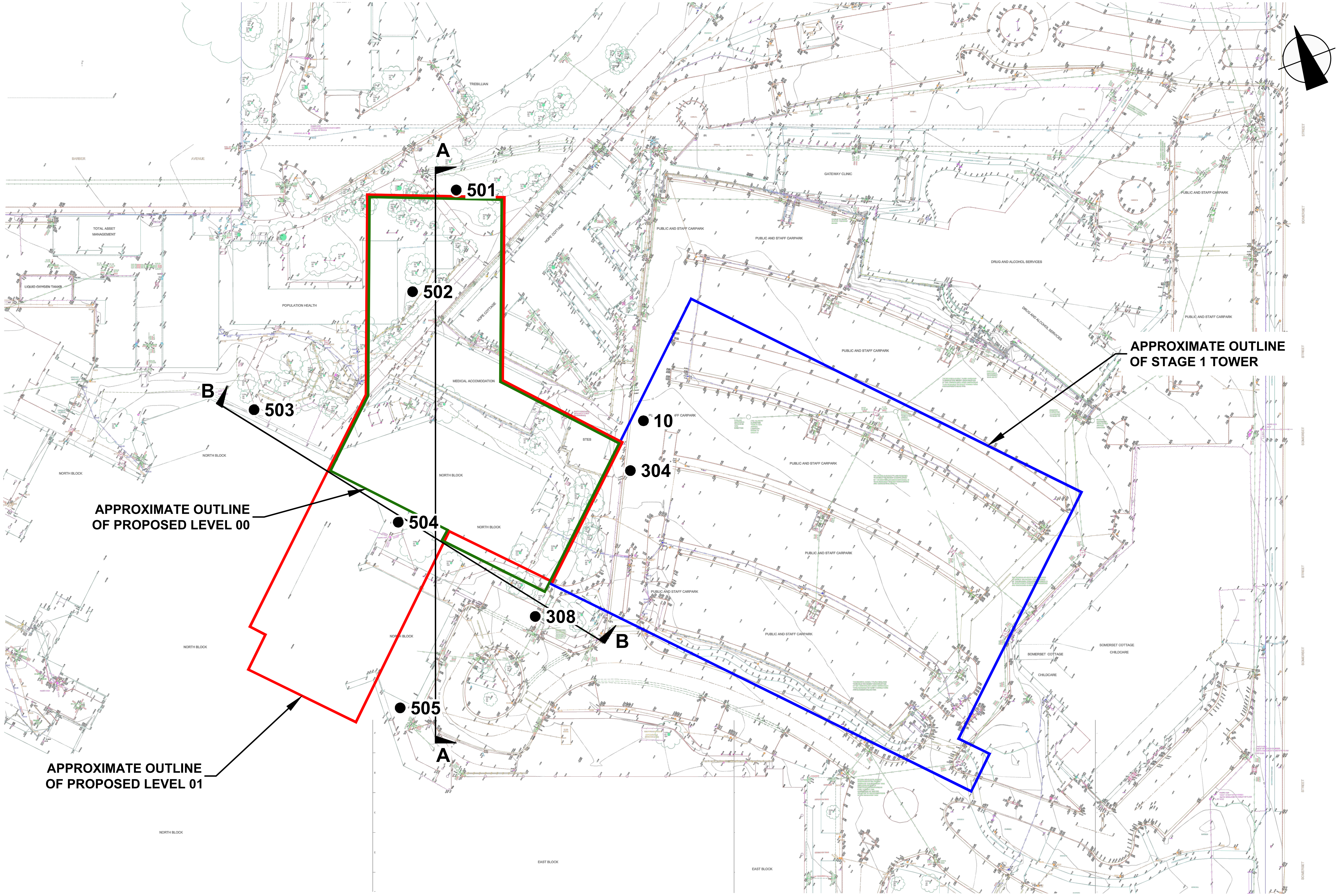
AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

This plan should be read in conjunction with the JK Geotechnics report.

Title:	**SITE LOCATION PLAN**
Location:	NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW
Report No: 33570LT	Figure No: 1

JKGeotechnics

PLOT DATE: 22/12/2020 1:03:41 PM DWG FILE: Y:\33000'S\33570LT KINGSWOOD\CAD\33570LT.DWG



NOTES:
1. BOREHOLES 501 TO 505 WERE DRILLED AS PART OF OUR CURRENT INVESTIGATION.
2. BOREHOLE 10 WAS DRILLED AS PART OF OUR JANUARY 2017 INVESTIGATION FOR STAGE 1.
3. BOREHOLES 304 AND 308 WERE DRILLED AS PART OF OUR AUGUST 2018 INVESTIGATION FOR STAGE 1.

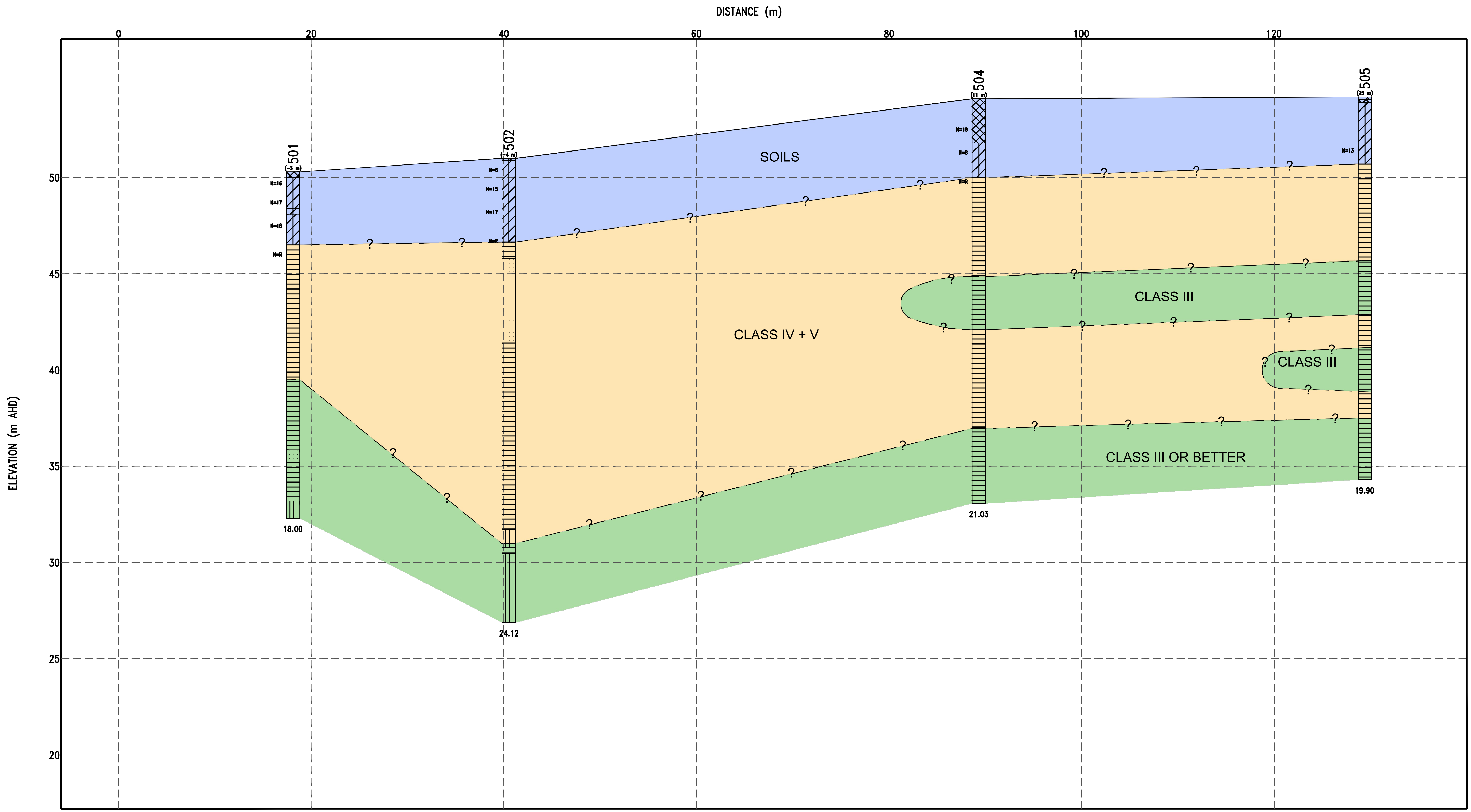
0 8 16 24 32 40
SCALE 1:800 @A3 METRES

This plan should be read in conjunction with the JK Geotechnics report.

Title:	BOREHOLE AND SECTION LINES LOCATION PLAN
Location:	NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW
Report No:	33570LT
Figure No:	2

JKGeotechnics

PLOT DATE: 22/12/2020 1:03:56 PM DWG FILE: Y:\33000'S\33570LT KINGSWOOD\CAD\33570LT.DWG



MATERIAL GRAPHIC

SANDY SILTY CLAY (CL, CI, CH)

SILTY CLAY (CL, CI, CH)

CLAYSTONE

CONCRETE

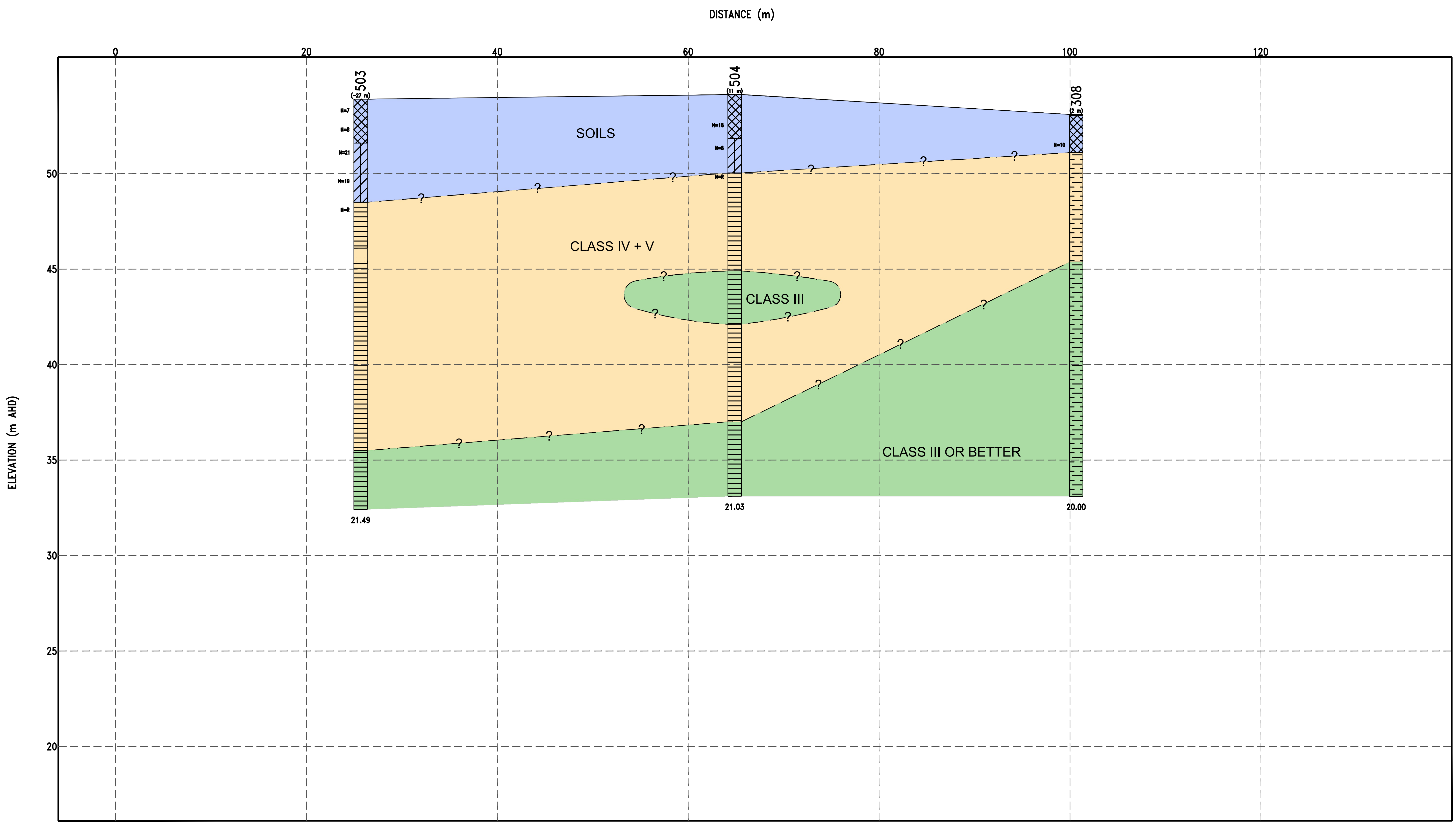
FILL

SANDSTONE

SILTSTONE

H: SCALE 1:400 @A3 METRES (0 4 8 12 16 20)	
V: SCALE 1:200 @A3 METRES (0 2 4 6 8 10)	
This plan should be read in conjunction with the JK Geotechnics report.	
Title:	GRAPHICAL BOREHOLE SUMMARY SECTION A-A
Location:	NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW
Report No:	33570LT
Figure No:	3

JKGeotechnics



MATERIAL GRAPHIC

- ASPHALTIC CONCRETE
- NO CORE
- SILTY CLAY (CL, CI, CH)
- FILL
- SANDSTONE
- SHALE, MUDSTONE

H: SCALE 1:400 @A3 METRES (0, 4, 8, 12, 16, 20)

V: SCALE 1:200 @A3 METRES (0, 2, 4, 6, 8, 10)

This plan should be read in conjunction with the JK Geotechnics report.

Title:	GRAPHICAL BOREHOLE SUMMARY SECTION B-B
Location:	NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW
Report No:	33570LT
Figure No:	4

JKGeotechnics

VIBRATION EMISSION DESIGN GOALS

German Standard DIN 4150 – Part 3: 1999 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, OR, maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 1 below.

It should be noted that peak vibration velocities higher than the minimum figures in Table 1 for low frequencies may be quite 'safe', depending on the frequency content of the vibration and the actual condition of the structure.

It should also be noted that these levels are 'safe limits', up to which no damage due to vibration effects has been observed for the particular class of building. 'Damage' is defined by DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should damage be observed at vibration levels lower than the 'safe limits', then it may be attributed to other causes. DIN 4150 also states that when vibration levels higher than the 'safe limits' are present, it does not necessarily follow that damage will occur. Values given are only a broad guide.

Table 1: DIN 4150 – Structural Damage – Safe Limits for Building Vibration

Group	Type of Structure	Peak Vibration Velocity in mm/s			
		At Foundation Level at a Frequency of:			Plane of Floor of Uppermost Storey
		Less than 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 and 2 and have intrinsic value (eg. buildings that are under a preservation order).	3	3 to 8	8 to 10	8

Note: For frequencies above 100Hz, the higher values in the 50Hz to 100Hz column should be used.

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 1726:2017 *'Geotechnical Site Investigations'*. 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 soil classification table qualified by the grading of other particles present (eg. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

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 (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

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

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	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 fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) is referred to as 'laminite'.

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 shrink-swell behaviour, 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 methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock 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 a large 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. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, 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 limited 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 cuttings. 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 assessed 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. 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, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, 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 NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom 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 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'*.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg 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.

A modification to the SPT 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.

Cone Penetrometer Testing (CPT) and Interpretation: The cone penetrometer is sometimes referred to as a Dutch Cone. The test is described in Australian Standard 1289.6.5.1–1999 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Static Cone Penetration Resistance of a Soil – Field Test using a Mechanical and Electrical Cone or Friction-Cone Penetrometer'*.

In the tests, a 35mm or 44mm 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 a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the frictional resistance on a separate 134mm or 165mm 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. The CPT does not provide soil sample recovery.

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. There are two scales presented for the cone resistance. The lower scale has a range of 0 to 5MPa and the main scale has a range of 0 to 50MPa. For cone resistance values less than 5MPa, the plot will appear on both scales.
- 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 CPT and SPT values can be developed for both sands and clays but may be site specific.

Interpretation of CPT 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.

There are limitations when using the CPT in that it may not penetrate obstructions within any fill, thick layers of hard clay and very dense sand, gravel and weathered bedrock. Normally a 'dummy' cone is pushed through fill to protect the equipment. No information is recorded by the 'dummy' probe.

Flat Dilatometer Test: The flat dilatometer (DMT), also known as the Marchetti Dilometer comprises a stainless steel blade having a flat, circular steel membrane mounted flush on one side.

The blade is connected to a control unit at ground surface by a pneumatic-electrical tube running through the insertion rods. A gas tank, connected to the control unit by a pneumatic cable, supplies the gas pressure required to expand the membrane. The control unit is equipped with a pressure regulator, pressure gauges, an audio-visual signal and vent valves.

The blade is advanced into the ground using our CPT rig or one of our drilling rigs, and can be driven into the ground using an SPT hammer. As soon as the blade is in place, the membrane is inflated, and the pressure required to lift the membrane (approximately 0.1mm) is recorded. The pressure then required to lift the centre of the membrane by an additional 1mm is recorded. The membrane is then deflated before pushing to the next depth increment, usually 200mm down. The pressure readings are corrected for membrane stiffness.

The DMT is used to measure material index (I_D), horizontal stress index (K_D), and dilatometer modulus (E_D). Using established correlations, the DMT results can also be used to assess the 'at rest' earth pressure coefficient (K_o), over-consolidation ratio (OCR), undrained shear strength (C_u), friction angle (ϕ), coefficient of consolidation (C_h), coefficient of permeability (K_h), unit weight (γ), and vertical drained constrained modulus (M).

The seismic dilatometer (SDMT) is the combination of the DMT with an add-on seismic module for the measurement of shear wave velocity (V_s). Using established correlations, the SDMT results can also be used to assess the small strain modulus (G_o).

Portable Dynamic Cone Penetrometers: Portable Dynamic Cone Penetrometer (DCP) tests are carried out by driving a 16mm diameter rod with a 20mm diameter cone end with a 9kg hammer dropping 510mm. The test is described in Australian Standard 1289.6.3.2–1997 (R2013) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – 9kg Dynamic Cone Penetrometer Test'*.

The results are used to assess the relative compaction of fill, the relative density of granular soils, and the strength of cohesive soils. Using established correlations, the DCP test results can also be used to assess California Bearing Ratio (CBR).

Refusal of the DCP can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Vane Shear Test: The vane shear test is used to measure the undrained shear strength (C_u) of typically very soft to firm fine grained cohesive soils. The vane shear is normally performed in the bottom of a borehole, but can be completed from surface level, the bottom and sides of test pits, and on recovered undisturbed tube samples (when using a hand vane).

The vane comprises four rectangular blades arranged in the form of a cross on the end of a thin rod, which is coupled to the bottom of a drill rod string when used in a borehole. The size of the vane is dependent on the strength of the fine grained cohesive soils; that is, larger vanes are normally used for very low strength soils. For borehole testing, the size of the vane can be limited by the size of the casing that is used.

For testing inside a borehole, a device is used at the top of the casing, which suspends the vane and rods so that they do not sink under self-weight into the 'soft' soils beyond the depth at which the test is to be carried out. A calibrated torque head is used to rotate the rods and vane and to measure the resistance of the vane to rotation.

With the vane in position, torque is applied to cause rotation of the vane at a constant rate. A rate of 6° per minute is the common rotation rate. Rotation is continued until the soil is sheared and the maximum torque has been recorded. This value is then used to calculate the undrained shear strength. The vane is then rotated rapidly a number of times and the operation repeated until a constant torque reading is obtained. This torque value is used to calculate the remoulded shear strength. Where appropriate, friction on the vane rods is measured and taken into account in the shear strength calculation.

LOGS

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

The terms and symbols used in preparation of the logs are defined in the following pages.

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 reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised 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 assess 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 Soils for Engineering Purposes'* or appropriate NSW Government Roads & Maritime Services (RMS) test methods. 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.

Reasonable 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.
- Details of the development that the Company could not reasonably be expected to anticipate.

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 rather than at some later stage, well after the event.

REPRODUCTION OF INFORMATION FOR CONTRACTUAL PURPOSES

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. Licence to use the documents may be revoked without notice if the Client is in breach of any obligation 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 an experienced geotechnical engineer/engineering geologist.

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 and appropriate footing or pile founding depths, or

iii) full time engineering presence on site.

SYMBOL LEGENDS

SOIL

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

ROCK

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

OTHER MATERIALS

- BRICKS OR PAVERS
- CONCRETE
- ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
ine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

$$C_U = \frac{D_{60}}{D_{10}} \quad and \quad C_C = \frac{(D_{30})^2}{D_{10}\,D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

NOTES:

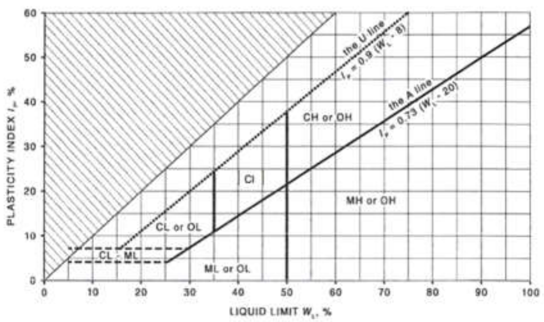
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

2 Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.

3 Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.

4 The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



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LOG SYMBOLS

Log Column	Symbol	Definition
Groundwater Record	▼	Standing water level. Time delay following completion of drilling/excavation may be shown.
	C	Extent of borehole/test pit collapse shortly after drilling/excavation.
	▶	Groundwater seepage into borehole or test pit noted during drilling or excavation.
Samples	ES	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 analysis.
	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. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	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° 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 (Fine Grained Soils)	w > PL	Moisture content estimated to be greater than plastic limit.
	w ≈ PL	Moisture content estimated to be approximately equal to plastic limit.
	w < PL	Moisture content estimated to be less than plastic limit.
	w ≈ LL	Moisture content estimated to be near liquid limit.
	w > LL	Moisture content estimated to be wet of liquid limit.
(Coarse Grained 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 ≤ 25kPa.
	S	SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.
	F	FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.
	St	STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.
	VSt	VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.
	Hd	HARD – unconfined compressive strength > 400kPa.
	Fr	FRIABLE – strength not attainable, soil crumbles.
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.

Density Index/ Relative Density (Cohesionless Soils)	Symbol		Density Index (I_D) Range (%)	SPT 'N' Value Range (Blows/300mm)
	VL	VERY LOOSE	≤ 15	0 – 4
	L	LOOSE	> 15 and ≤ 35	4 – 10
	MD	MEDIUM DENSE	> 35 and ≤ 65	10 – 30
	D	DENSE	> 65 and ≤ 85	30 – 50
	VD	VERY DENSE	> 85	> 50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other assessment.		

Log Column	Symbol	Definition
Hand Penetrometer Readings	300 250	Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.

Log Column	Symbol	Definition
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as: RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock. EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock. ALLUVIAL – soil deposited by creeks and rivers. ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents. MARINE – soil deposited in a marine environment. AEOLIAN – soil carried and deposited by wind. COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits. LITTORAL – beach deposited soil.

Classification of Material Weathering

<table>
<tr><th colspan="2">Term</th><th colspan="2">Abbreviation</th><th>Definition</th></tr>
<tr><td colspan="2">Residual Soil</td><td colspan="2">RS</td><td>Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.</td></tr>
<tr><td colspan="2">Extremely Weathered</td><td colspan="2">XW</td><td>Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.</td></tr>
<tr><td>Highly Weathered</td><td rowspan="2">Distinctly Weathered (Note 1)</td><td>HW</td><td rowspan="2">DW</td><td>The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.</td></tr>
<tr><td>Moderately Weathered</td><td>MW</td><td>The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Slightly Weathered</td><td colspan="2">SW</td><td>Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Fresh</td><td colspan="2">FR</td><td>Rock shows no sign of decomposition of individual minerals or colour changes.</td></tr>
</table>

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'*. There is some change in rock strength.

Rock Material Strength Classification

Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Guide to Strength: Point Load Strength Index $I_{s(50)}$ (MPa)	Guide to Strength: Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Abbreviations Used in Defect Description

Cored Borehole Log Column		Symbol Abbreviation	Description
Point Load Strength Index		• 0.6	Axial point load strength index test result (MPa)
		x 0.6	Diametral point load strength index test result (MPa)
Defect Details	– Type	Be	Parting – bedding or cleavage
		CS	Clay seam
		Cr	Crushed/sheared seam or zone
		J	Joint
		Jh	Healed joint
		Ji	Incipient joint
		XWS	Extremely weathered seam
	– Orientation	Degrees	Defect orientation is measured relative to normal to the core axis (ie. relative to the horizontal for a vertical borehole)
	– Shape	P	Planar
		C	Curved
		Un	Undulating
		St	Stepped
		Ir	Irregular
	– Roughness	Vr	Very rough
		R	Rough
		S	Smooth
		Po	Polished
		Sl	Slickensided
	– Infill Material	Ca	Calcite
		Cb	Carbonaceous
		Clay	Clay
		Fe	Iron
		Qz	Quartz
		Py	Pyrite
	– Coatings	Cn	Clean
		Sn	Stained – no visible coating, surface is discoloured
		Vn	Veneer – visible, too thin to measure, may be patchy
		Ct	Coating ≤ 1mm thick
		Filled	Coating > 1mm thick
	– Thickness	mm.t	Defect thickness measured in millimetres

APPENDIX A

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L3 **Method:** SPIRAL AUGER **R.L. Surface:** ~51.3 m
Date: 24/8/18 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** K.S./L.S.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING							0		-	ASPHALTIC CONCRETE: 20mm.t	M			PREVIOUSLY EXCAVATED AND BACKFILLED
						51				FILL: Silty gravelly sand, fine to coarse grained, brown and dark brown, with clay.				
						50	1		CI-CH	Silty CLAY: medium to high plasticity, light grey and red brown, with fine to coarse grained ironstone gravel.	w<PL	VSt		RESIDUAL
				DS	N = 9 3,4,5								300 360 350	
						49	2							
						48	3							
				DS			4							
						47			-	SHALE: grey.	XW - DW	VL - L		BRINGELLY SHALE VERY LOW TO LOW 'TC' BIT RESISTANCE
											DW			
						46	5							
									-	SANDSTONE: fine to medium grained, grey and orange brown.	DW	L - M		LOW TO MODERATE RESISTANCE
						45	6			REFER TO CORED BOREHOLE LOG				

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
304
2 / 4

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L3	**Core Size:** NMLC	**R.L. Surface:** ~51.3 m
Date: 24/8/18	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** K.S./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH)	SPACING (mm) (600, 200, 60, 20)	DEFECT DETAILS — DESCRIPTION: Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness (Specific / General)	Formation
		46			START CORING AT 5.72m						
100% RETURN			6		SANDSTONE: fine to medium grained, grey and orange brown.	MW	L - M			(5.83m) Be, 0°, P, S, Cn (6.02m) Be, 0°, P, S, Cn	Bringelly Shale
		45			SHALE: dark grey.	MW - SW				(6.15m) XWS, 0°, 8 mm.t (6.19m) Be, 0°, P, S, Cn (6.50m) XWS, 0°, 6 mm.t (6.57m) XWS, 0°, 80 mm.t	
		44	7				VL - L				
		43	8				L - M			(7.66m) XWS, 0°, 9 mm.t (7.68m) J, 90°, P, S, Cn (7.70m) Be, 0°, P, S, Cn (7.84m) Be, 10°, P, S, Cn (7.87m) J, 90°, Un, S, Cn (7.91m) Be, 0°, P, S, Cn (8.00m) Be, 0°, P, S, Cn (8.02m) J, 90°, Un, S, Cn (8.04m) Be, 0°, P, S, Cn (8.37m) XWS, 0°, 3 mm.t	
		42	9						200 60 20	(8.73m) Be, 0°, P, S, Cn (9.08m) Fractured Zone, 22mm.t (9.16m) XWS, 0°, 3 mm.t (9.76m) XWS, 10°, 4 mm.t	
		41	10							(10.06m) Be, 0°, P, S, Cn (10.10m) J, 40°, P, Sl, Cn	
		40	11							(10.93m) XWS, 0°, 70 mm.t (11.03m) XWS, 0°, 6 mm.t (11.04m) XWS, 0°, 5 mm.t (11.09m) XWS, 0°, 9 mm.t (11.47m) J, 40°, P, S, Cn (11.58m) J, 55°, P, Sl, Cn	
						SW - FR			200 60 20		

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L3	**Core Size:** NMLC	**R.L. Surface:** ~51.3 m
Date: 24/8/18	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK500	**Bearing:** N/A	**Logged/Checked By:** K.S./L.S.

Column headings: Water Loss\Level | Barrel Lift | RL (m AHD) | Depth (m) | Graphic Log | CORE DESCRIPTION – Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components | Weathering | Strength | POINT LOAD STRENGTH INDEX $I_s(50)$ (VL -0.1, L -0.3, M -1, H -3, VH -10, EH) | DEFECT DETAILS – SPACING (mm) (600, 200, 60, 20) | DESCRIPTION – Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness (Specific / General) | Formation

RL (m AHD): 39, 38, 37, 36, 35, 34, 33
Depth (m): 13, 14, 15, 16, 17, 18

Water Loss\Level: 100% RETURN

CORE DESCRIPTION: SHALE: dark grey. *(continued)*

Weathering	Strength
SW - FR	L - M (to ~13.5 m), M (~13.5 m to ~18.5 m)
MW	L - M (from ~18.5 m)

DEFECT DETAILS:

- (12.12m) Be, 0°, Un, S, Cn
- (13.46m) XWS, 0°, 22 mm.t
- (14.61m) XWS, 0°, 80 mm.t
- (14.97m) XWS, 0°, 30 mm.t
- (15.02m) XWS, 0°, 20 mm.t
- (15.11m) XWS, 0°, 55 mm.t
- (15.56m) Fractured Zone, 21mm.t
- (17.26m) Fractured Zone, 26mm.t
- (17.85m) Be, 0°, P, S, Cn
- (18.10m) Be, 0°, P, S, Cn
- (18.45m) Fractured Zone, 15mm.t

Formation: Bringelly Shale

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
304
4 / 4

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L3 **Core Size:** NMLC **R.L. Surface:** ~51.3 m
Date: 24/8/18 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK500 **Bearing:** N/A **Logged/Checked By:** K.S./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT SPACING (mm)	DEFECT DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness — Specific	General	Formation
100% RETURN		32			SHALE: dark grey. *(continued)*	SW	M - H			(19.38m) Be, 0°, P, S, Cn (19.45m) Be, 0°, P, S, Cn		Bringelly Shale
			20							(20.15m) Fractured Zone, 18mm.t		
		31			END OF BOREHOLE AT 20.36 m							
		30	21									
		29	22									
		28	23									
		27	24									
		26	25									

Point load scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH
Spacing scale: 600, 200, 60, 20

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
29845L BH304 START CORING AT 5·72m
5
6
7
8
9
10
11
12
13


14
15
16
17
18
19
20
END OF BH304 AT 20·36m

JK Geotechnics
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

Borehole No.
308

BOREHOLE LOG

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L3 **Method:** SPIRAL AUGER **R.L. Surface:** ~53.1 m
Date: 17/8/18 TO 19/8/18 **Datum:** AHD
Plant Type: JK500 **Logged/Checked By:** T.C./L.S.

Groundwater Record	SAMPLES (ES / U50 / DB / DS)	Field Tests	RL (m AHD)	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel Density	Hand Penetrometer Readings (kPa)	Remarks
DRY ON COMPLETION OF AUGERING			53	0		-	ASPHALTIC CONCRETE: 50mm.t				
							FILL: Gravelly sand, fine to coarse grained, grey and brown, siltstone bands.	M			PREVIOUSLY EXCAVATED AND BACKFILLED
	DS	N = 10 2,3,7	52	1							
			51	2		-	SHALE: grey and red brown, with iron indurated bands.	XW	EL		BRINGELLY SHALE VERY LOW 'TC' BIT RESISTANCE
	DS		50	3		-	SHALE: brown and grey, with high strength bands.	DW	VL - L		VERY LOW RESISTANCE WITH HIGH BANDS
	DS		49 / 48	4 / 5					L		LOW RESISTANCE
			47	6			REFER TO CORED BOREHOLE LOG				

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
308
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L3 | **Core Size:** NMLC | **R.L. Surface:** ~53.1 m
Date: 17/8/18 TO 19/8/18 | **Inclination:** VERTICAL | **Datum:** AHD
Plant Type: JK500 | **Bearing:** N/A | **Logged/Checked By:** T.C./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ (VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	SPACING (mm) (600, 200, 60, 20)	DEFECT DETAILS DESCRIPTION Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness — Specific	General	Formation
		47			START CORING AT 6.20m						
100% RETURN					SHALE: grey and dark grey, with fine grained sandstone bands.	XW	EL	<<			Bringelly Shale
						DW	VL - L			(6.57m) XWS, 0°, 30 mm.t (6.64m) XWS, 0°, 40 mm.t (6.71m) XWS, 0°, 50 mm.t	
		46	7		SHALE: grey and dark grey, with fine grained sandstone bands.	FR	L - M				
		45	8							(7.64m) XWS, 0°, 30 mm.t	
		44	9		SHALE: grey and dark grey.					(8.80m) Be, 0°, P, S, FILLED, SANDY CLAY (9.34m) J, 45°, P, Sl, Cn (9.80m) XWS, 0°, 5 mm.t	
		43	10							(10.23m) XWS, 0°, 10 mm.t (10.28m) J, 45°, P, S, Cn	
		42	11							(11.05m) XWS, 0°, 10 mm.t (11.12m) J, 45°, Un, S, Cn (11.74m) Cr, 0°, 20 mm.t	
		41	12							(12.96m) Cr, 0°, 10 mm.t	

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
308
3 / 3

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L3 **Core Size:** NMLC **R.L. Surface:** ~53.1 m
Date: 17/8/18 TO 19/8/18 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK500 **Bearing:** N/A **Logged/Checked By:** T.C./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION: Rock Type, grain characteristics, colour, texture and fabric, features, inclusions and minor components	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$	DEFECT DETAILS: SPACING (mm)	DEFECT DETAILS: DESCRIPTION (Type, orientation, defect roughness and shape, defect coatings and seams, openness and thickness) Specific	General	Formation
100% RETURN		40			SHALE: dark grey, thinly laminated.	FR	L - M					Bringelly Shale
							M					
		39	14									
		38	15									
					SHALE: grey thinly laminated at 0-5°.					(15.80m) Be, 20°, P, S, Cn		
		37	16							(16.50m) J, 90°, Un, S, Cn		
		36	17									
		35	18							(18.52m) XWS, 10°, 10 mm.t		
		34	19							(19.12m) J, 70°, Un, Sl, Cn		
										(19.24m) XWS, 0°, 30 mm.t		
										(19.80m) J, 90°, Un, Sl, Cn		

Point load scale: VL -0.1, L -0.3, M -1, H -3, VH -10, EH. Spacing scale: 600, 200, 60, 20.

END OF BOREHOLE AT 20.00 m

FRACTURES NOT MARKED ARE CONSIDERED TO BE DRILLING AND HANDLING BREAKS


JK Geotechnics
29845L
BH308
START : CORING AT 6.20m
6
7
8
9
10
11
12
13
14


15
16
17
18
19

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

BOREHOLE LOG

Borehole No. 10

Client: HEALTH INFRASTRUCTURE

Project: NEPEAN HOSPITAL REDEVELOPMENT

Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L **Method:** SPIRAL AUGER **R.L. Surface:** ~51.1 m

Date: 10/1/17 **Datum:** AHD

Plant Type: JK305 **Logged/Checked By:** A.B./L.S.

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	-	ASPHALTIC CONCRETE: 40mm.t	M			
				FILL: Gravelly sand, fine to coarse grained, brown, fine to medium grained, grey igneous gravel.				
	N = 10 4,5,5		CH	as above, but orange brown.	MC>PL	VSt	380 310 250	
				SILTY CLAY: high plasticity, grey mottled red brown.				
	N = 11 4,4,7			SILTY CLAY: high plasticity, light grey, trace of medium grained ironstone gravel.		H	220 320 410	
					MC~PL			
	N = 28 7,13,15	3					540 520	
			-	SHALE: grey and dark grey, with clay seams.	XW	EL		REMOULDS TO A MATERIAL WITH CLAY PROPERTIES
		4		SANDSTONE: fine grained, light brown, with shale seams and clay seams.	XW - DW	EL - VL		VERY LOW 'TC' BIT RESISTANCE
		5			DW	VL - L		LOW RESISTANCE
				SANDSTONE: fine grained, light grey.	SW	H		HIGH RESISTANCE
		6		REFER TO CORED BOREHOLE LOG				

RL (m AHD): 51, 50, 49, 48, 47, 46, 45 (at depths ~0.1, 1.1, 2.1, 3.1, 4.1, 5.1, 6.1 m). Samples columns: ES, U50, DB, DS.

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
10
2 / 3

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L **Core Size:** NMLC **R.L. Surface:** ~51.1 m
Date: 10/1/17 **Inclination:** VERTICAL **Datum:** AHD
Plant Type: JK305 **Bearing:** N/A **Logged/Checked By:** A.B./L.S.

Water Loss\Level	RL (m AHD)	Depth (m)	CORE DESCRIPTION: Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength
	46		START CORING AT 5.94m		
100% RETURN	45	6	SANDSTONE: fine grained, light grey, with iron indurated bands.	SW	M - H
	44	7	as above, but trace of dark grey laminae.		M
			SHALE: dark grey and grey, with fine grained, grey sandstone bands.		L - M
	43	8			L
					M
	42	9			
					L
	41	10			
					M
			CORE LOSS 0.13m		
	40	11	SHALE: grey.	XW	EL
				DW	VL
				XW	EL

POINT LOAD STRENGTH INDEX $I_s(50)$: EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH

DEFECT SPACING (mm): 500, 300, 100, 50, 30, 10

DEFECT DETAILS – DESCRIPTION: Type, inclination, thickness, planarity, roughness, coating.

Specific	General
(7.28m) J, 90°, P, R	
(7.53m) XWS, 0°, 4 mm.t	
(7.67m) XWS, 0°, 10 mm.t	
(7.95m) XWS, 0°, 7 mm.t	
(8.03m) XWS, 0°, 5 mm.t	
(8.61m) J, 90°, Un, S	
(8.74m) J, 90°, P, S	
(8.86m) J, 90°, P, R	
(8.98m) J, 90°, P, S	
(9.04m) FRAGMENTED ZONE, 0°, 3 mm.t	
(9.43m) XWS, 0°, 1 mm.t	
(9.61m) XWS, 0°, 2 mm.t	
(9.66m) XWS, 0°, 40 mm.t	
(9.75m) Be, 0°, 20 mm.t	
(10.06m) FRAGMENTED ZONE, 0°, 15 mm.t	
(10.11m) XWS, 0°, 1 mm.t	
(10.29m) XWS, 0°, 10 mm.t	
(10.50m) J, 90°, P, R, XW INFILL	
(10.76m) CS, 0°, 3 mm.t	
(11.58m) XWS, 0°, 100 mm.t	

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GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS

CORED BOREHOLE LOG

Borehole No.
10

Client: HEALTH INFRASTRUCTURE
Project: NEPEAN HOSPITAL REDEVELOPMENT
Location: NEPEAN HOSPITAL, DERBY STREET, KINGSWOOD, NSW

Job No.: 29845L	**Core Size:** NMLC	**R.L. Surface:** ~51.1 m
Date: 10/1/17	**Inclination:** VERTICAL	**Datum:** AHD
Plant Type: JK305	**Bearing:** N/A	**Logged/Checked By:** A.B./L.S.

Water Loss\Level	Barrel Lift	RL (m AHD)	Depth (m)	Graphic Log	CORE DESCRIPTION Rock Type, grain characteristics, colour, structure, minor components.	Weathering	Strength	POINT LOAD STRENGTH INDEX $I_s(50)$ EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH	DEFECT SPACING (mm) 500 300 100 50 30 10	DEFECT DETAILS – DESCRIPTION Type, inclination, thickness, planarity, roughness, coating. Specific	General
100% RETURN		39			SHALE: grey. *(continued)*	XW	EL				
						DW	L			(12.57m) XWS, 0°, 140 mm.t	
		38	13							(12.88m) J, 30°, P, R (13.02m) J, 30°, P, R (13.11m) J, 30°, P, R (13.18m) XWS, 0°, 35 mm.t (13.29m) XWS, 0°, 2 mm.t (13.40m) J, 20°, P, R (13.48m) XWS, 0°, 3 mm.t	
		37	14		SHALE: grey and dark grey.		L - M			(13.76m) FRAGMENTED ZONE, 0°, 80 mm.t (13.82m) CS, 0°, 1 mm.t (13.84m) CS, 0°, 2 mm.t (14.21m) CS, 0°, 80 mm.t (14.43m) CS, 0°, 140 mm.t (14.58m) J, 90°, P, S, XW INFILL	
		36	15		SHALE: grey and dark grey, with fine grained, grey sandstone bands.	SW	M			(14.93m) Be, 0°, P, S (15.09m) J, 90°, P, R (15.33m) XWS, 0°, 20 mm.t	
							VL				
		35	16				L - M			(16.22m) J, 45°, P, R	
		34	17		END OF BOREHOLE AT 16.26 m						
		33	18								


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JOB No. 29845L BH10 START CORING AT 5.94m
5
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CORE LOSS: 0.13m
11
12
13
14
15
16.
EOH AT 16.26m