REPORT TO

HEALTH INFRASTRUCTURE

ON

GEOTECHNICAL INVESTIGATION

FOR

PROPOSED MPS STAGE 5

AT

BLAYNEY DISTRICT HOSPITAL, OSMAN STREET, BLAYNEY NSW

Date: 2 February 2023

Ref: 35521LFrpt

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DOCUMENT REVISION RECORD

Report Reference	Report Status	Report Date
35521LFrpt	For Information Only	30 November 2022
35521LFrpt	Final Report	2 February 2023

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ATTACHMENTS

1 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed MPS Stage 5 at Blayney District Hospital, Blayney, NSW. The location of the site is shown in Figure 1. The investigation was commissioned by signed Consultancy Agreement, Ref: HI22330, and was carried out in general accordance with our fee proposal, Ref: P57148LFrev1, dated 13 September 2022.

We understand from the supplied documents that it is proposed to construct a Multipurpose Service (MPS) at the existing Blayney District Hospital comprising of a 29-bed facility. At this stage the location of the proposed facility has not been determined and all current external areas are being considered for the development. We expect the MPS will be constructed at existing grade and therefore expect only minor excavation or filling will be required. Furthermore, we expect the new building(s) will be similar to the existing buildings, (i.e. one to two storey structures), and therefore structural loads are expected to be relatively low for structures of this type.

The purpose of the investigation was to obtain geotechnical information on the subsurface conditions, and to use this as a basis for providing comments and recommendations on geotechnical aspects of the proposed development, such as summary of subsurface profile, site preparation and earthworks, excavation conditions and support, site classifications, footings as well as earthquake design and pavement parameters.

2 INVESTIGATION PROCEDURE

Prior to the commencement of the fieldwork, a specialist sub-contractor reviewed available 'Before You Dig' information and electro-magnetically scanned each investigation location for buried services.

The fieldwork for the investigation was carried out on 24 to 28 October 2022, and comprised the following:

- Auger drilling of eleven boreholes (BH1, and BH11 to BH20 inclusive) to maximum depths of 6m below existing ground levels using our truck-mounted JK400 drill rig with a Tungsten Carbide (TC) drill bit. The borehole depth was extended by a Standard Penetration Test (SPT) to 6.45m at each of these locations.
- Due to access constraints for a drill rig, nine boreholes (BH2 to BH10 inclusive) were drilled using a hand auger to refusal depths ranging from 0.6m to 2.2m below existing ground levels.
- The hand augered boreholes were augmented by nine Dynamic Cone Penetration (DCP) tests, which extended to refusal depths ranging from 1.6m to 2.6m below existing surface levels. The DCP tests were carried out adjacent to their respective hand augered boreholes (i.e. DCP2 was carried out adjacent to BH2 etc).

The apparent compaction of the fill and the strength of the natural clayey soils encountered in the auger drilled boreholes were assessed from Standard Penetration Test (SPT) 'N' values, augmented by hand penetrometer test results on cohesive samples recovered in the SPT split tube sampler. The DCP tests were carried out to further assess the relative compaction/strength of the soil profile at the hand auger drilled boreholes.

Groundwater observations were made during and on completion of auger drilling. Borehole collapse occurred in a number of boreholes preventing further groundwater observations. In BH1, BH12, BH14, BH15 and BH17, Class 18 machine slotted PVC standpipes were installed and finished with a cast iron gatic cover to allow longer term groundwater monitoring to be completed. The standpipe in BH17 was decommissioned on 28 October 2022 due to the presence of a locally charged confined aquifer resulting in water flowing out of the standpipe. No longer term monitoring of groundwater levels was carried out.

Selected soil samples were returned to NATA accredited laboratories (Soil Test Services Pty Ltd [STS] and Envirolab Services Pty Ltd) for moisture content, Atterberg limit, linear shrinkage, shrink-swell, California Bearing Ratio (CBR), pH, chloride content, sulphate content and resistivity testing. The test results are summarised in the attached STS Tables A to C and Envirolab Services Certificate of Analysis 309464.

The fieldwork was completed in the full-time presence of our geotechnical engineer who set out the borehole locations, nominated the testing and sampling, and prepared the attached borehole logs and DCP sheets. The borehole locations are shown on the attached Figure 2, and these were set out by a differential GPS unit, which also provided the relative levels shown on the attached logs. The height datum used is the Australian Height Datum (AHD). Geotechnical sections have been generated of the site based on the investigation results and these have been presented in Figures 3 to 6. For more details of the investigation procedures and their limitations and a glossary of terms and symbols used, reference should be made to the attached Report Explanation Notes.

3 RESULTS OF INVESTIGATION

3.1 Site Description

Blayney District Hospital is located within a gently undulating area, which slopes towards the east and north at about 3°. The site is bound by Martha Street to the south and Osman Street to the east. Martha Street itself (Mid-Western Highway) slopes at about 2-4°.

The site itself appeared to have been cut to level evident by the presence of batter slopes along the southern street frontage of the hospital with Martha Street. Small to large trees and vegetation covered the majority of the batter slope which varied between about 10° and 15° with no signs of instability observed.

At the time of fieldwork, the site contained a hospital complex comprising of several single-storey brick and weatherboard structures, mostly towards the central portion of the site. These structures appeared in good condition based upon a cursory external inspection. Two asphaltic concrete (AC) carparks were located on the eastern and western sides of the site, connected by an AC access road that leads from Osman Street into the site. The driveway appeared in moderate condition with several longitudinal and crocodile cracks ranging from about 1 to5mm wide observed along the driveway, mostly along the re-built AC which appeared to be excavated for buried services search. Several potholes with radii ranging from 0.2m to 0.5m and depths between 0.05m to 0.1m were also present along the access road, where some appeared to have been patched up with concrete. The remaining site was generally grass covered and landscaped, the northern portion of the site around the Aged Care facilities were enclosed by shrubs and trees along the boundaries of site. The northern area in particular was soft underfoot at the time of our observations.

The neighbouring northern properties comprise of residential lots containing single storey brick houses that generally appear in good condition based upon a cursory inspection from within the subject site and street frontages. The surface levels are relatively similar across the common boundary and the houses are set back greater than 3m from the common boundary.

An ambulance station is present west of the subject site comprising of single storey structures. A single storey brick nursing home is present north-west. The neighbouring properties maintain the same levels as the subject site.

3.2 Subsurface Conditions

The 1:100,000 series geological map of Blayney (Geological Survey of NSW, Geological Series Sheet 8730) indicates the site to be underlain by Wombiana Formation, generally comprising siltstone and limestone. An alluvial profile associated with Belubula River is present about 500m east of the site.

The boreholes have disclosed a generalised profile of fill overlying predominantly residual silty clay, with occasional layers of clayey silt. No bedrock was encountered, although the deeper clays showed remnant rock structure. Groundwater is present at relatively shallow depth in some areas of the site. Reference should be made to the attached borehole logs for specific details at each location. A summary of the subsurface conditions encountered in the boreholes is provided below:

Pavement and Fill

A number of boreholes encountered asphaltic concrete (AC) pavement at the surface which was measured to be 50mm thick.

Fill was encountered below the pavement, or from the surface in all boreholes. The fill extended to depths ranging from 0.3m to 1.2m below existing surface level. The fill material was variable across the site, typically ranging from gravelly and sandy fill below existing AC pavements, to clayey fill in landscaped and grassed areas. The fill also contained varying proportions of inclusions such as fine to coarse grained ironstone, sandstone and igneous gravels, brick and concrete fragments, root fibres, slag and ash. The fill generally appeared to be poorly to well compacted.

Residual Soil

Residual silty clay of low to medium plasticity was encountered below the fill in all boreholes and it extended to the borehole termination depths. The residual clays were typically initially stiff to very stiff strength, increasing to hard strength with depth. The moisture content of the clays were initially greater than their plastic limit and then gradually becoming equal to or less than their plastic limit with depth. The clays also contained varying amounts of ironstone gravels and there was also evidence of remnant rock structure.

In a number of boreholes, a thin layer of clayey silt of low plasticity was initially encountered overlying silty clay. The clayey silts were typically of soft to firm strength, with this lower strength likely to be as a result of water softening given the 'wet' conditions at the time of the investigation.

Groundwater

Groundwater seepage was encountered during or on completion of drilling in BH2 to BH8 inclusive, BH17 and BH20, mostly ranging from depths between 0.85m and 1.4m, although the seepage at BH20 was encountered at 6m below ground level. Groundwater monitoring wells were installed and developed in BH1, BH12, BH14, BH15 and BH17 on completion of auger drilling, the groundwater levels were then measured on completion of fieldwork on 28 October 2022 and no long-term groundwater monitoring was carried out. The measured groundwater levels are summarised in the below:

Depth(m) and Reduced Level (AHD) to Top of Measured Groundwater Levels		
Borehole Number	**Groundwater Depth (bgl, m)**	**RL of Groundwater Table (m)**
BH1	4.38	869.32
BH12	3.43	872.03
BH14	3.02	872.12
BH15	0.81	875.41

As discussed in Section 2 above, the standpipe in BH17 was decommissioned on 28 October 2022 due to the presence of a locally charged confined aquifer resulting in water flowing out of the standpipe.

3.3 Laboratory Test Results

Based on the shrink-swell, Atterberg limits and linear shrinkage test results, the residual silty are of low to medium plasticity. Reference should be made to the attached STS Tables A and C for further details.

The four day soaked CBR tests on samples of the residual clay compacted to 98% of their Standard Maximum Dry Density (SMDD), returned CBR values between 5% and 9% for the residual clays. Reference should be made to the attached STS Table B for further details.

The following table summarises the soil chemistry test results from Envirolab Services. Reference should be made to the attached Certificate of Analysis No. 309464 for further details.

Sample	Depth (m)	Soil Type	pH	Chloride mg/kg	Sulphate mg/kg	Resistivity ohm.cm
BH3	0.5 to 0.6	FILL: Silty Clay	8.5	<10	85	7,900
BH3	0.7 to 1.0	Silty Clay	7.9	<10	55	16,000
BH5	0.35 to 0.65	Silty Clay	6.9	<10	<10	30,000
BH6	0.25 to 0.35	FILL: Silty Clay	6.5	24	10	20,000

Sample	Depth (m)	Soil Type	pH	Chloride mg/kg	Sulphate mg/kg	Resistivity ohm.cm
BH10	0.4 to 0.6	FILL: Silty Clay	6.8	<10	10	27,000
BH13	3.0 to 3.45	Silty Clay	5.8	21	40	18,000
BH19	1.7 to 1.95	Silty Clay	6.3	<10	<10	120,000
BH19	6.0 to 6.45	Silty Clay	7.1	<10	<10	40,000
BH20	4.5 to 4.95	Silty Clay	6.3	<10	25	41,000

4 COMMENTS AND RECOMMENDATIONS

The comments and recommendations provided below are based on an assumed proposed development and therefore should be considered preliminary only. Once development details are known, this report must be reviewed to confirm if the comments and recommendations are still applicable to the development.

4.1 Site Preparation

Prior to any excavation commencing we recommend that reference be made to the NSW Government "Code of Practice Excavation Work" dated January 2020 or the most recent version at the time of works commencing.

Site preparation is expected to comprise demolition of the existing building(s), removal of trees and stripping of topsoil and/or root affected soils. We also assume that partial demolition of the existing access road will be required.

Following the above site preparation, in areas where no excavation is required, any obvious deleterious or contaminated existing fill should be removed. These stripped materials should be taken offsite as they are not suitable for re-use as engineered fill. However, from a geotechnical perspective (i.e. assuming these materials are not contaminated), existing gravelly fill materials from below existing pavements may be re-used as engineered fill, provided they are separately stockpiled, inspected and approved by the geotechnical engineers. The topsoil and/or root affected soils may also be separately stockpiled and used for subsequent landscaping purposes, or appropriately disposed off site. If the depth of topsoil is critical, then we recommend test pits are excavated to confirm the topsoil thickness. We recommend test pits in lieu of boreholes, as test pits allow a more detailed visual inspection of the soil, compared to boreholes where the soil is assessed from a small diameter borehole, the drill spoil from that borehole and SPT samples.

Trees dry out the surrounding clayey soils in and around their root systems. Removal of trees usually results in an increase in the soil moisture content over time, leading to swelling of the soils, which may have a detrimental impact on the performance of proposed buildings and paved surfaces founded/supported in the clayey soil profile within the site. Therefore, trees should only be removed where absolutely necessary and as soon as practicable, in order for the moisture content of the clayey subsoils to recover; ideally this would be years in advance of construction though we understand this is usually not practical.

We expect any cut and fill earthworks to be relatively minor and therefore expect to encounter fill, and residual soils. The soil materials should be readily excavated using the buckets of conventional earthmoving equipment, such as hydraulic excavators.

The subgrade will comprise clay soils and silt in some areas. Silts are highly susceptible to softening, as well as clays to a lesser degree. The silts and clays are likely to provide an unsuitable subgrade if proper site drainage is not implemented during construction. It is therefore important to provide good drainage in order to promote run-off and reduce ponding. Earthworks platforms should be graded to maintain cross-falls during construction. If the clays are exposed to periods of rainfall, softening will result and site trafficability will be poor. Furthermore, the soils may no longer be suitable for re-use as engineered fill or as a suitable subgrade. If softening occurs, the subgrade should be over-excavated to below the depth of moisture softening. The material removed should be replaced with engineered fill. Such work would likely cause delays to the earthworks program. Trafficability may be improved by the use of a sacrificial surface layer of crushed demolition rubble.

4.2 Footings

Due to the possibility of abnormal moisture conditions due to existing pavements and trees, we consider that the site classifies as Class 'P' in accordance with AS2870-2011 'Residential Slabs and Footings'. If the footings are designed to be founded below the fill on the inferred natural residual soils, consideration must still be given to the potential for the natural silty clays to shrink and swell with changes in moisture content. In our opinion, any new footings may be designed on the basis of shrink-swell movements similar to Class 'M' site as described in AS2870 'Residential Slabs and Footings'. We note that in the strictest sense AS2870 does not apply to development such as this, however it provides a useful guide for footing design on reactive clay sites. Reference may also be made to AS2870 for design, construction, performance criteria and maintenance precautions on reactive clay sites.

We note the above classification does not take into account the placement of any new fill or the removal of the surface cracked zone of clay soils and therefore we recommend the above site classification is reviewed once details of the earthworks are known, primarily the type and depth of any new fill placement. If slabs are suspended between footings founded below the shrink-swell zone of the soils then void formers of at least 60mm would need to be provided to separate the slab from the reactive subgrade.

We expect relatively low structural loads will apply to this development, and therefore we expect high level footings would be appropriate. High level footings, such as stiffened raft slabs, strip or pad footings founded on natural residual clay of at least stiff strength may be designed based on a preliminary ABP of 100kPa. We note the presence of softened upper clays in parts of the site, such as the northern area, and therefore we recommend allowance for over-excavation in areas to at least 1m depth in order to encounter at least stiff clays. From a geotechnical perspective, we consider the over-excavations may be backfilled with mass concrete.

The presence of groundwater and the potential impact to the founding conditions within clay given the susceptibility of the clays to soften when wet. . We therefore recommend a blinding layer is poured without delay in the base of the footings to reduce the risk of softening. If the soils were to soften, they would no longer be suitable for the above ABP.

Subgrade preparation recommendations below stiffened raft slabs are provided in Section 4.6. The designer should also note that there are some trees and pavements at the site and that these will affect the performance of footings on clay soils. A potential 'abnormal moisture condition' may exist where the trees and pavements are to be removed or increase substantially and consideration must be given to this in the design.

If piled footings are preferred, then we consider screw piles to be the most appropriate for the site. Screw piles are typically on a design and construct basis and certified by the contractor. We do not recommend bored piles due to the presence of groundwater which will soften the clays in the base and side of the piles. There could also be potential for collapse of bored piles due to groundwater and softened soils which would require the use of liners. As discussed above, in BH17 a locally charged confined aquifer appeared to have been encountered and there is risk that bored piles may intersect this aquifer resulting in significant groundwater ingress into the pile holes and potentially to surface. Notwithstanding this, as a guide, a 300mm diameter pile founded at least 3m below surface level in very stiff clays may be designed based on an ABP of 400kPa.

Based on the soil aggressivity testing, the clayey soils would be classified as having a 'Non-aggressive' exposure classification for concrete piles in accordance with Table 6.4.2(c) of AS2159-2009 'Piling – Design and Installation'. For steel piles, the soils would be classified as 'Non-aggressive' in accordance with Table 6.5.2(c) of AS2159-2009.

We recommend that at least the initial stages of footing excavations are inspected by a geotechnical engineer to confirm a suitable founding stratum is being achieved. The requirements for further inspections can be assessed at that time and the frequency will depend on the level of 'sign-off' required.

4.3 Earthquake Design Classification

Based upon AS1170.4-2007 "Structural Design Actions, Part 4: Earthquake Actions in Australia", the following design parameters may be adopted:

- Hazard Factor (Z) = 0.08;
- Class C_e – Shallow soil site.

We note that whilst bedrock was not encountered within the investigation depths, we consider Class C_e applies given it is highly unlikely that bedrock is greater than 60m depth which would be required in order to classify the site as Class D_e – Deep or Soft soil site.

4.4 Retaining Walls

We recommend temporary batter slopes no steeper than 1 Vertical (V) in 1 Horizontal (H) through the clay soils. If space allows, permanent batters may be formed at no steeper than 1 Vertical to 3 Horizontal. The batters should also be vegetated to prevent erosion. These recommended batter slopes are on the basis that no surcharge will be applied within 2H of the batter crest, where H is the height of the batter. Furthermore, whilst no groundwater seepage was observed over the existing batters present along the southern boundary, based on BH15 which encountered groundwater at about 0.8m depth, there is potential for new temporary and permanent batters to encounter groundwater seepage depending the depth of excavation required.

If space does not allow for permanent batters, or permanent batters are not preferred, then for the limited retention heights expected, cantilevered gravity type retaining walls may be adopted. For any cantilevered gravity type retaining walls supporting soil materials, we recommend that walls be designed on the basis of an 'active' earth pressure coefficient (K_a) of 0.35 where some wall movements are tolerable and assuming a horizontal backfill surface. If retaining walls are temporarily propped, backfilled and permanently supported by the structure, or if wall movements need to be reduced, then an 'at rest' earth pressure co-efficient (K_o) of 0.55 should be adopted. A bulk unit weight of 20kN/m^3 should be adopted for the soil profile. Surcharge loads (e.g. nearby footings, compaction stresses, sloping retained surfaces, construction loads etc) should be allowed for in the design using the appropriate above earth pressure coefficient. The retaining walls should be designed as fully drained, otherwise hydrostatic pressures would be in addition to the above earth pressures.

Any backfill behind retaining walls should comprise engineered fill in order to reduce post construction settlements. We note that compaction of engineered fill behind retaining walls is very difficult and time consuming to carry out effectively, and it is inevitable that even with good quality control and compaction that some post construction settlements will occur. Post construction settlements can cause adverse impacts on paving, landscaped retaining walls or other structures and services founded on or within the backfill. If potential post construction settlements are deemed problematic by the designers, then we recommend that further geotechnical advice be obtained. However, due to the limited space that may be available behind the walls, our preference for backfill behind retaining walls is to backfill using a single sized durable gravel, such as 'blue metal' or crushed concrete gravel (free of fines). These granular materials do not require significant compactive effort and provide better long term performance in regard to settlement than soil materials. A non-woven geotextile filter fabric should be placed over the cut faces prior to backfilling and then over the top surface of the gravel in order to reduce subsoil erosion. A clay capping layer should be provided above the free draining backfill material to reduce the likelihood of surface water entering the backfill and surcharging the retaining walls.

4.5 Subgrade Preparation

Earthworks recommendations provided in this report should be complemented by reference to AS3798.

4.5.1 Subgrade Preparation

If the floor slabs are proposed to be fully suspended on the piled footings, then no particular subgrade preparation would be necessary other than stripping all root-affected or deleterious topsoil/fill. However, based on the reactivity of the clay soils, as discussed above, we recommend the use of void formers at least 60mm thick under the building floor slabs to separate the slab from the subgrade. Further advice in this regard can be provided once details of the footing system and site earthworks (cut and fill) are known.

Recommendations for subgrade preparation below stiffened raft slabs and slabs on ground are outlined below. Slab-on-ground (other than stiffened raft slabs) should also be constructed separate from the footings of the building (i.e. designed as 'floating').

1. All root affected or deleterious fill or topsoil must be removed; there may be an extensive zone of root affected soil where trees have been removed. These stripped materials should be taken off site as they are not suitable for reuse as engineered fill. Where depressions result from stripping, they may be infilled with inert well-graded granular fill such as crushed sandstone, placed and compacted in layers as engineered fill.
2. Where existing uncontrolled fill is present and the proposed building will be formed over areas of existing fill, then the existing fill must be excavated to the natural subgrade. We recommend excavation of the fill extend at least 1m beyond the building footprint.
3. Following the above, the entire subgrade should be proof rolled with 6 passes of an at least 8 tonne smooth drum roller used in static or non-vibratory mode of operation. The purpose of the proof rolling is to detect any soft or heaving areas.
4. The final pass of proof rolling should be undertaken in the presence of an experienced geotechnician or geotechnical engineer, to detect any unstable or soft subgrade areas, and to allow for some further improvement in strength/compaction. Care should be taken not to over-compact clayey subgrade areas.
5. If dry conditions prevail at the time of construction, the clay subgrade may become desiccated or have shrinkage cracks prior to pouring any concrete slabs. If this occurs then the subgrade must be watered and rolled until the cracks disappear. This should be completed immediately prior to pouring concrete.
6. Unstable subgrade detected during proof rolling should be locally excavated down to a stiff or sound base and replaced with engineered fill or further advice from the geotechnical engineers should be sought. Any fill placed to raise site levels should also be engineered fill. From the borehole results we expect there may be some areas where this is required, such as the northern area, particularly following periods of wet weather. Good site drainage will be critical and preferably the earthworks are carried out during good weather to reduce the risks of the soils being softened by water.

4.5.2 Engineered Fill

Any fill used to backfill unstable subgrade areas, raise surface levels or backfill service trenches should be engineered fill. Materials preferred for use as engineered fill are well-graded granular materials, such as crushed sandstone (or locally acquired and approved granular materials), free of deleterious substances and having a maximum particle size not exceeding 75mm. Such fill should be compacted in horizontal layers not greater than 200mm loose thickness, to a minimum density of 98% of Standard Maximum Dry Density (SMDD). For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness and with a reduced maximum particle size of 40mm for the engineered fill.

From a geotechnical perspective, the existing fill and residual clays at the site may be acceptable for re-use as engineered fill on condition that the soils used are clean (i.e. free of organics and inclusions greater than 75mm size (or 40mm size, as necessary), and free of contaminants. However, soils with a high silt content or 'wet' soils in portions of the site, such as the northern area, are unlikely to be suitable for re-use in their current moisture condition and would need to be allowed to 'dry' in order to be suitable. These site won clayey soils should be compacted in maximum 200mm loose layers to a density strictly between 98% and 102% of SMDD and at moisture content within 2% of their Standard Optimum Moisture Content (SOMC). All clay fill should preferably be used in the lower fill layers. Thus, the use of clay materials for engineered fill will entail more rigorous earthwork supervision and compaction control, time for possible moisture conditioning and hence, possibly a greater eventual cost for earthworks. Consideration must also be made by the building designer of the greater reactive potential of new fills comprising reactive clays as opposed to existing clayey soils, as discussed in Section 4.2 above.

Density tests should be regularly carried out on engineered fill to confirm the above specifications are achieved. Density tests should be carried out at the frequencies outlined in AS3798 (Table 8.1) for the volume of fill involved. Within the proposed building footprint and particularly if the engineered fill will be supporting structural loads, then the fill must be placed under Level 1 supervision, as defined in AS3798-2007. Areas where engineered fill will not be supporting structural loads, then a reduced Level 2 control of fill compaction may be adopted. Any areas of insufficient compaction will require reworking and retesting to confirm the required specification has been achieved. Preferably, the geotechnical testing authority (GTA) should be engaged directly on behalf of the client and not by the earthworks subcontractor.

4.6 Pavement Design Parameters

The design of new pavements will depend on subgrade preparation, subgrade drainage, the nature and composition of fill excavated or imported to the site, as well as vehicle loadings and use. Various alternative types of construction could be used for the pavements. Concrete construction would undoubtedly be the best in areas where heavy vehicles maneuver. Flexible pavements may have a lower initial cost but maintenance will be higher. These factors should be considered when making the final choice. We recommend that reference also be made to AS2870 for drainage and vegetation precautions on reactive clay sites.

Based on the subsurface conditions and laboratory test results, we recommend the pavements with a silty clay subgrade be designed based on a CBR value of 5% or an estimated subgrade reaction modulus (for concrete slabs or pavements) of 30kPa/mm (750mm diameter plate). The pavement sections where imported fill is used to raise site levels, by at least 0.5m may be designed on the basis of a four-day soaked CBR value of the imported fill material.

Whilst the above CBR value is reasonable, we noted the upper soils contained a higher silt content and are therefore highly susceptible to softening, evident particularly over the northern area of the site where the soils are already softened. The presence of such soils has an impact on a number of relevant items:

- The soils are unlikely to pass a proof roll and we therefore recommend allowance be made for over-excavation of the softened soils and importation of select fill to provide a suitable subgrade for the pavement construction. The select fill may comprise a 300mm thick layer of crushed sandstone or an approved granular material. Placement of a geofabric over the subgrade may also be necessary if the soils are particularly soft, such as those encountered in the northern area extending to depths of 0.6m to 0.9m.
- Maintaining adequate drainage during construction and in the long-term will be critical to avoid softening of the soils which could lead to earthworks issues. The pavement design should allow for sufficient drainage, including sub-soil drains, as discussed further below.

Concrete pavements should have a sub-base layer of at least 100mm thickness of crushed rock to latest revision of Transport for NSW QA specification 3051 (2010) unbound base material (or equivalent good quality and durable fine crushed rock) which is compacted using a heavy roller to at least 100% of Standard Maximum Dry Density (SMDD). Adequate moisture conditioning to within 2% of Standard Optimum Moisture Content (MOMC) should be provided during placement so as to reduce the potential for material breakdown during compaction. Concrete pavements should be designed with an effective shear transmission of all joints by way of either doweled or keyed joints.

Careful attention to subsurface and surface drainage is required in view of the effect of moisture on the clay subgrade. The surface of the pavement and the subgrade should be sloped to shed water, and adequate subsurface drainage should be installed around the pavement to intercept and dispose of water flows. The drainage trenches should be excavated with a longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. The subsoil drainage should extend at least 0.3m below the subgrade levels.

4.7 Further Geotechnical Input

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

- Additional geotechnical investigation, if deemed required.
- Review of civil and structural drawings.
- Inspection of footing excavations.
- Inspection of proof rolling soil subgrade.
- Testing of engineered fill

5 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.

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 LIMITS AND LINEAR SHRINKAGE TEST REPORT

Client: JK Geotechnics
Project: Proposed Hospital Development
Location: 3 Osman Street, Blayney, NSW

Report No.: 35521LF - A
Report Date: 16/11/2022

AS 1289	TEST METHOD	2.1.1	3.1.2	3.2.1	3.3.1	3.4.1
BOREHOLE NUMBER	DEPTH m	MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX %	LINEAR SHRINKAGE %
1	1.50 - 1.90	19.9	-	-	-	-
2	0.50 - 0.60	25.2	-	-	-	-
4	0.50 - 0.70	22.9	21	13	8	3.0*
5	0.70 - 0.80	18.8	-	-	-	-
6	1.35 - 1.55	28.5	38	13	25	12.5*
7	0.70 - 0.85	18.0	-	-	-	-
9	0.30 - 0.40	21.5	31	17	14	6.0*
11	1.70 - 1.95	20.1	34	13	21	8.5*
11	4.50 - 4.95	26.0	-	-	-	-
12	3.00 - 3.45	21.0	-	-	-	-
15	0.70 - 0.95	15.8	23	14	9	4.0
16	0.70 - 0.95	22.0	39	13	26	12.0
17	0.70 - 0.95	19.5	43	15	28	11.0*
18	3.00 - 3.45	38.9	-	-	-	-
19	1.70 - 1.95	19.7	-	-	-	-
20	2.20 - 2.40	22.8	49	16	33	11.5*

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: 01/11/2022.
- Sampled and supplied by client. Samples tested as received.
- * Denotes Linear Shrinkage cracked.

NATA
NATA Accredited Laboratory Number:1327

Accredited for compliance with ISO/IEC 17025 - Testing.

16/11/2022
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
Project: Proposed Hospital Development
Location: 3 Osman Street, Blayney, NSW

Report No.: 35521LF - B
Report Date: 8/11/2022
Page 1 of 1

BOREHOLE NUMBER		BH 9	BH 15	BH 16	BH 19
DEPTH (m)		0.30 - 0.50	0.30 - 1.50	0.50 - 1.50	0.50 - 1.50
Surcharge (kg)		9.0	9.0	9.0	9.0
Maximum Dry Density (t/m^3)		1.76 STD	1.90 STD	1.75 STD	1.86 STD
Optimum Moisture Content (%)		16.5	13.6	18.3	14.9
Moulded Dry Density (t/m^3)		1.73	1.85	1.71	1.82
Sample Density Ratio (%)		98	98	98	98
Sample Moisture Ratio (%)		103	102	99	101
Moisture Contents					
Insitu (%)		21.7	19.6	22.1	18.5
Moulded (%)		17.1	13.9	18.2	15.0
After soaking and After Test, Top 30mm(%)		18.8	18.3	24.2	20.4
Remaining Depth (%)		18.0	14.5	19.9	15.8
Material Retained on 19mm Sieve (%)		3*	0	0	0
Swell (%)		0.0	1.0	0.5	0.0
C.B.R. value:	@2.5mm penetration			7	5
	@5.0mm penetration	6	9		

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.
- BH 15 & BH 16 dried back prior to testing as the samples were too saturated.
- * Denotes not used in test sample.
- Date of receipt of sample: 01/11/2022.

NATA

NATA Accredited Laboratory Number:1327

08/11/2022
Authorised Signature / Date
(D. Treweek)

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SOIL TEST SERVICES
ABN 43 002 145 173

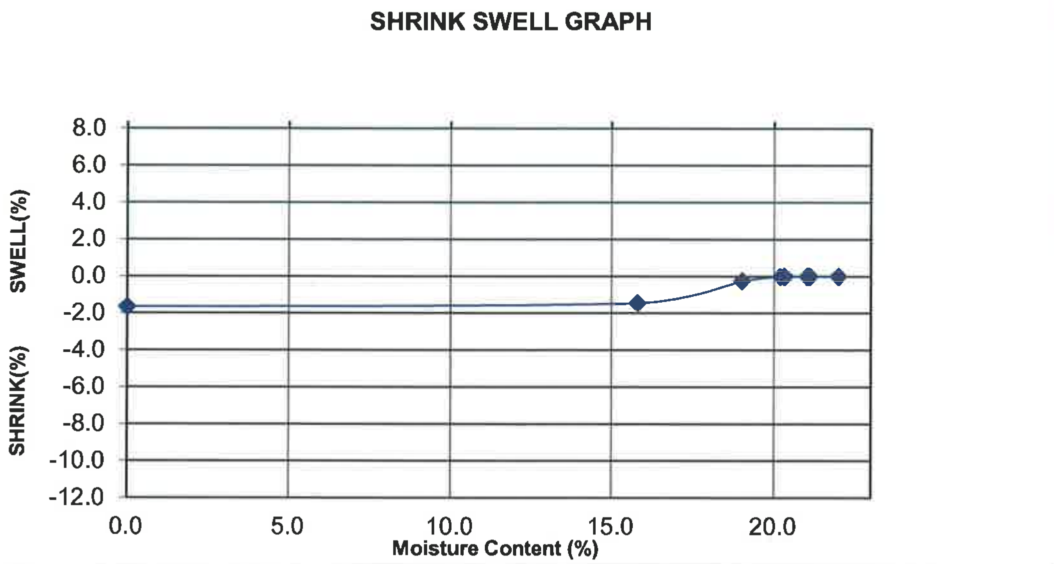
TABLE C
SHRINK - SWELL TEST REPORT
TEST METHOD: AS1289 7.1.1

Client: JK Geotechnics
Project: Proposed Hospital Development
Location: 3 Osman Street, Blayney, NSW

Report No.: 35521LF - C
Report Date: 10/11/2022

Borehole No.: 17		Depth: 1.00 - 1.20m	
MOISTURE CONTENT (SWELL)		ESTIMATED UNCONFINED COMPRESSIVE STRENGTH	
BEFORE TEST	AFTER TEST	BEFORE TEST	AFTER TEST
20.3%	22.0%	>500 kPa	280,420 kPa

LOAD	SETTLEMENT UNDER LOAD BEFORE SATURATION	SWELL ON SATURATION	SHRINKAGE
25	-1.3%	0.0%	1.6%



SHRINK SWELL INDEX
0.90 %/pF

Notes: Sampled and supplied by client. Sample tested as received.
- Suction Value used in calculation = 1.8pF
- Volume Change Coefficient (α) was assumed = 2
- Visually estimated inclusions by volume = 0-5%
- Shrinkage Cracking = Moderate
- Soil Crumbling = none
- Date of receipt of sample: 01/11/2022.

Authorised Signature / Date
(D. Treweek)
10/11/22

Envirolab Services Pty Ltd
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CERTIFICATE OF ANALYSIS 309464

Client Details

Client	JK Geotechnics
Attention	Cho Sum Yip
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**35521LF, Blayney**
Number of Samples	9 Soil
Date samples received	01/11/2022
Date completed instructions received	01/11/2022

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.

Report Details

Date results requested by	08/11/2022
Date of Issue	08/11/2022

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Results Approved By
Diego Bigolin, Inorganics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		309464-1	309464-2	309464-3	309464-4	309464-5
Your Reference	UNITS	BH3	BH3	BH5	BH6	BH0
Depth		0.5-0.6	0.7-1.0	0.35-0.65	0.25-0.35	0.6
Date Sampled		24/10/2022	24/10/2022	24/10/2022	26/10/2022	28/10/2022
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	07/11/2022	07/11/2022	07/11/2022	07/11/2022	07/11/2022
Date analysed	-	07/11/2022	07/11/2022	07/11/2022	07/11/2022	07/11/2022
pH 1:5 soil:water	pH Units	8.5	7.9	6.9	6.5	6.8
Chloride, Cl 1:5 soil:water	mg/kg	<10	<10	<10	24	<10
Sulphate, SO4 1:5 soil:water	mg/kg	85	55	<10	10	10
Resistivity in soil*	ohm m	79	160	300	200	270

Misc Inorg - Soil					
Our Reference		309464-6	309464-7	309464-8	309464-9
Your Reference	UNITS	BH13	BH19	BH19	BH20
Depth		3-3.45	1.7-1.95	6-6.45	4.5-4.95
Date Sampled		27/10/2022	25/10/2022	25/10/2022	25/10/2022
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	07/11/2022	07/11/2022	07/11/2022	07/11/2022
Date analysed	-	07/11/2022	07/11/2022	07/11/2022	07/11/2022
pH 1:5 soil:water	pH Units	5.8	6.3	7.1	6.3
Chloride, Cl 1:5 soil:water	mg/kg	21	<10	<10	<10
Sulphate, SO4 1:5 soil:water	mg/kg	40	<10	<10	25
Resistivity in soil*	ohm m	180	1,200	400	410

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	309464-2
Date prepared	-			07/11/2022	1	07/11/2022	07/11/2022		07/11/2022	07/11/2022
Date analysed	-			07/11/2022	1	07/11/2022	07/11/2022		07/11/2022	07/11/2022
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	8.5	8.4	1	99	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	99	92
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	85	83	2	92	80
Resistivity in soil*	ohm m	1	Inorg-002	<1	1	79	80	1	[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.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

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.

JKGeotechnics

BOREHOLE LOG

Borehole No.
1
1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 873.70m
Date: 25/10/22 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0		-	ASPHALTIC CONCRETE: 50mm.t				
						FILL: Clayey sand, fine to medium grained, brown, with fine to coarse grained igneous gravel, brick fragments and slag.	M			APPEARS WELL COMPACTED
		N = 11 6,6,5				FILL: Gravelly clayey sand, fine to medium grained, brown, low to medium plasticity, with fine to coarse grained igneous gravel and ash.	M			SCREEN: 10.87kg 0.05-0.5m NO FCF SCREEN: 2.45kg 0.5-1.0m NO FCF
			1		CL	Silty CLAY: low plasticity, light grey mottled orange brown and dark grey, trace of fine to medium grained ironstone gravel.	w>PL	VSt		RESIDUAL
		N > 19 6,8, 11/100mm REFUSAL							350 320 380	
			2							
		N = 16 7,8,8	3						280 350 320	
1 DAY AFTER PUMP OUT			4				w<PL	Hd		VERY LOW 'TC' BIT RESISTANCE
AFTER 1 DAY OF DRILLING		N > 22 7,14, 8/100mm REFUSAL	5						600 600 600	GROUNDWATER MONITORING WELL INSTALLED TO 6.0m. CLASS 18 MACHINE SLOTTED / HAND SLOTTED 50mm DIA. PVC STANDPIPE 6.0m TO 2.0m. CASING 2.0m TO 0.1m. 2mm SAND FILTER PACK 6.0m TO 1.45m. BENTONITE SEAL 1.45m TO 0.85m. BACKFILLED WITH SAND AND CUTTINGS TO THE SURFACE. COMPLETED WITH A CONCRETED GATIC COVER.
		N = 28 7,13,15	6						600 600 600	
						END OF BOREHOLE AT 6.45m				
			7							

JKGeotechnics

BOREHOLE LOG

Borehole No.
2
1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** HAND AUGER **R.L. Surface:** 872.98m
Date: 24/10/22 **Datum:** AHD
Plant Type: - **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		REFER TO DCP TEST RESULTS SHEET	0			FILL: Silty clay, medium plasticity, brown, trace of fine to coarse grained igneous and ironstone gravel, root fibres, glass and concrete rubbles.	w<PL			APPEARS POORLY TO MODERATELY COMPACTED
					ML	Clayey SILT: low plasticity, brown mottled orange brown, trace of fine grained igneous gravel and ash.	w>PL	S-F	30 30 20	SCREEN: 12.6kg 0-0.1m NO FCF
			1		CL-CI	Silty CLAY: low to medium plasticity, light grey mottled orange brown and dark brown, trace of fine to coarse grained igneous gravel and ash.	w>PL	F	50 50 50	SCREEN: 2.45kg 0.1-0.4m NO FCF
								VSt-Hd		RESIDUAL HP TESTING ON REMOULDED SAMPLES
						END OF BOREHOLE AT 1.5m				HAND AUGER REFUSAL ON CLAY
			2							
			3							
			4							
			5							
			6							
			7							

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BOREHOLE LOG

Borehole No. 3

1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** HAND AUGER **R.L. Surface:** 873.63m
Date: 24/10/22 **Datum:** AHD
Plant Type: - **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		REFER TO DCP TEST RESULTS SHEET	0			FILL: Silty clay, medium plasticity, dark brown, trace of root fibres and ash.	w≈PL w≈PL			APPEARS MODERATELY COMPACTED SCREEN: 10.47kg 0.1-0.4m NO FCF
						FILL: Silty clay, medium to high plasticity, brown and red brown, trace of fine to coarse grained slag and igneous gravel.	w<PL			
			1			FILL: Silty clay, medium plasticity, dark brown, trace of brick fragments and igneous gravel.				SCREEN: 3.40kg 0.1-0.4m NO FCF
					ML	Clayey SILT: low plasticity, brown mottled orange brown, trace of ash.	w>PL	F		RESIDUAL
					CL-CI	Silty CLAY: low to medium plasticity, dark brown mottled red brown, trace of ash and fine to medium grained ironstone gravel.	w>PL	F-St	80 90 100	
						Silty CLAY: low to medium plasticity, light grey mottled orange brown, trace of ash and fine to medium grained igneous and ironstone gravel.	w>PL	VSt-Hd		HAND AUGER REFUSAL ON IRONSTONE/ STIFF CLAY
			2			END OF BOREHOLE AT 1.6m				
			3							
			4							
			5							
			6							
			7							

JKGeotechnics

BOREHOLE LOG

Borehole No. 4

1/1

Client: HEALTH INFRASTRUCTURE

Project: PROPOSED HOSPITAL DEVELOPMENT

Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** HAND AUGER **R.L. Surface:** 872.42m

Date: 25/10/22 **Datum:** AHD

Plant Type: - **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		REFER TO DCP TEST RESULTS SHEET	0		ML	Clayey SILT: low plasticity, dark brown and orange brown, trace of ash and root fibres.	w>PL			GRASS COVER
					CL	Silty CLAY: low plasticity, light grey mottled orange brown, trace of fine to medium grained ironstone gravel.	w>PL	(S-F)		RESIDUAL SCREEN: 10.30kg 0-0.1m NO FCF
			1					(St-VSt)		
								(Hd)		
						END OF BOREHOLE AT 1.4m				HAND AUGER REFUSAL ON IRONSTONE GRAVEL
			2							
			3							
			4							
			5							
			6							
			7							

JKGeotechnics

BOREHOLE LOG

Borehole No. 5

1/1

Client: HEALTH INFRASTRUCTURE

Project: PROPOSED HOSPITAL DEVELOPMENT

Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** HAND AUGER **R.L. Surface:** 872.92m

Date: 24/10/22 **Datum:** AHD

Plant Type: - **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		REFER TO DCP TEST RESULTS SHEET	0			FILL: Silty clay, medium plasticity, dark brown, trace of root fibres, slag and brick fragments and ash.	w>PL			GRASS COVER
					ML	Clayey SILT: low to medium plasticity, grey, trace of root fibres, ash and fine to medium grained ironstone gravel.	w>PL			APPEARS POORLY COMPACTED SCREEN: 10.53kg 0-0.1m NO FCF SCREEN: 5.87kg 0.1-0.3m NO FCF
			1		CI	Silty CLAY: medium plasticity, brown mottled grey, with fine to medium grained ironstone gravel, trace of root fibres and ash.	w>PL	(F- St) VSt		RESIDUAL
						END OF BOREHOLE AT 1.5m				HAND AUGER REFUSAL ON IRONSTONE GRAVEL
			2							
			3							
			4							
			5							
			6							
			7							

JKGeotechnics

BOREHOLE LOG

Borehole No.
6
1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** HAND AUGER **R.L. Surface:** 873.60m
Date: 26/10/22 **Datum:** AHD
Plant Type: - **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
					REFER TO DCP TEST RESULTS SHEET	0			FILL: Silty clay, medium plasticity, brown, trace of fine to medium grained igneous gravel and slag.	w>PL			GRASS COVER APPEARS POORLY COMPACTED
						1		CL-CI	Silty CLAY: low to medium plasticity, light grey mottled orange brown, trace of fine to medium grained ironstone gravel and ash.	w>PL	(S-F)		SCREEN: 12.05kg 0-0.1m NO FCF RESIDUAL
						2					(St-VSt)		
									END OF BOREHOLE AT 2.2m				HAND AUGER REFUSAL ON IRONSTONE GRAVEL
						3							
						4							
						5							
						6							
						7							

JKGeotechnics

BOREHOLE LOG

Borehole No. 7

1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** HAND AUGER **R.L. Surface:** 872.65m
Date: 26/10/22 **Datum:** AHD
Plant Type: - **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		REFER TO DCP TEST RESULTS SHEET	0			FILL: Clayey silt, low plasticity, dark brown, trace of root fibres and ash.	w>PL			GRASS COVER
					CL	Silty CLAY: low plasticity, light grey mottled orange brown.	w>PL	(VS)		SCREEN: 11.98kg 0-0.2m NO FCF
										RESIDUAL
			1					(St-VSt)		
							w≈PL	(Hd)		
						END OF BOREHOLE AT 1.6m				HAND AUGER REFUSAL ON HARD CLAY
			2							
			3							
			4							
			5							
			6							
			7							

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BOREHOLE LOG

Borehole No. **8**

1/1

Client: HEALTH INFRASTRUCTURE

Project: PROPOSED HOSPITAL DEVELOPMENT

Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** HAND AUGER **R.L. Surface:** 873.87m

Date: 27/10/22 **Datum:** AHD

Plant Type: - **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	SAMPLES (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		REFER TO DCP TEST RESULTS SHEET	0			FILL: Clayey silt, low plasticity, dark brown, trace of steel parts, root fibres and fine to coarse grained igneous gravel.	w>PL			GRASS COVER
					CL	Silty CLAY: low plasticity, brown, trace of fine to medium grained ironstone gravel and ash.	w≈PL w>PL	(S-F) (St-VSt)		SCREEN: 11.30kg 0-0.1m NO FCF 10L BUCKET RESIDUAL
			1		CI	Silty CLAY: medium plasticity, light grey mottled orange brown, trace of root fibres.	w≈PL			
			2			END OF BOREHOLE AT 1.8m				HAND AUGER REFUSAL ON STIFF CLAY
			3							
			4							
			5							
			6							
			7							

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BOREHOLE LOG

Borehole No. 9

1/1

Client: HEALTH INFRASTRUCTURE

Project: PROPOSED HOSPITAL DEVELOPMENT

Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** HAND AUGER **R.L. Surface:** 873.86m

Date: 28/10/22 **Datum:** AHD

Plant Type: - **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	SAMPLES ES U50 DB DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		REFER TO DCP TEST RESULTS SHEET	0			FILL: Clayey silt, dark brown, trace of root fibres.	w>PL			GRASS COVER
					CL	Silty CLAY: low plasticity, red brown and brown, trace of root fibres and ash.	w>PL	(S-F)		SCREEN: 7.90kg 0-0.1m NO FCF 8L BUCKET
			1		CL-CI	Silty CLAY: low to medium plasticity, light grey mottled orange brown, trace of ash and fine to medium grained igneous gravel.	w≈PL	(VSt -Hd)		RESIDUAL
						END OF BOREHOLE AT 1.65m				HAND AUGER REFUSAL ON GRAVEL
			2							
			3							
			4							
			5							
			6							
			7							

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BOREHOLE LOG

Borehole No.
10

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** HAND AUGER **R.L. Surface:** 874.43m
Date: 28/10/22 **Datum:** AHD
Plant Type: - **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION	■			■	REFER TO DCP TEST RESULTS SHEET	0			FILL: Silty clay, medium plasticity, brown, with fine to coarse grained igneous and ironstone gravel, brick fragments, root fibres, ash, fine grained igneous cobbles and slag.	w>PL			GRASS COVER APPEARS POORLY COMPACTED SCREEN: 11.10kg 0-0.2m NO FCF 10L BUCKET SCREEN: 11.05kg 0.2-0.6m NO FCF HAND AUGER REFUSAL ON COBBLE IN FILL
									END OF BOREHOLE AT 0.6m				
						1							
						2							
						3							
						4							
						5							
						6							
						7							

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BOREHOLE LOG

Borehole No.
11
1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 874.53m
Date: 27/10/22 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0		ASPHALTIC CONCRETE: 50mm.t				
				-	FILL: Sand, fine to medium grained, light brown, with silt and fine to medium grained sandstone gravel and slag.	M			SCREEN: 9.55kg 0.05-1.0m NO FCF
			1						SCREEN: 1.72kg 1.0-1.2m NO FCF
				CL	Silty CLAY: low plasticity, light grey mottled orange brown and red brown, with fine to medium grained ironstone gravel and ash.	w≈PL	VSt-Hd		RESIDUAL
		N = 15 3,7,8						380 430 510	
			2						
		N = 10 5,5,5	3					300 400 450	
			4	CI	Silty CLAY: medium plasticity, brown mottled orange brown and dark grey, trace of fine grained ironstone gravel.				
		N = 11 5,5,6						300 350 380	
			5						
		N = 12 4,5,7	6					300 320 350	
					END OF BOREHOLE AT 6.45m				
			7						

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BOREHOLE LOG

Borehole No. 12

Client: HEALTH INFRASTRUCTURE

Project: PROPOSED HOSPITAL DEVELOPMENT

Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 875.46m

Date: 26/10/22 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION		0		FILL: Clayey silt, low plasticity, dark brown, trace of root fibres and fine to coarse grained igneous gravel.	w>PL			GRASS COVER
	N = 6 3,2,4		CL	Silty CLAY: low plasticity, brown mottled grey, trace of fine to medium grained ironstone gravel and ash.	w>PL	(F- St)		SCREEN: 10.45kg 0-0.1m NO FCF 1 MORE SAMPLE 0.8-1.0m RESIDUAL
	N = 13 3,5,8	1	CI	Silty CLAY: medium plasticity, light grey mottled orange brown and dark grey, trace of fine to medium grained ironstone gravel and ash.	w>PL	Hd	430 500 520	
	N = 22 6,10,12	2–3					550 550 500	
1 DAY AFTER PUMP OUT				as above, but without ash.				GROUNDWATER MONITORING WELL INSTALLED TO 6.0m. CLASS 18 MACHINE SLOTTED PVC. STANDPIPE 6.0m TO 2.0m. CASING 2.0m TO 0.13m. 2mm SAND FILTER PACK 6.0m TO 1.1m. BENTONITE SEAL 1.1m TO 0.3m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETE GATIC COVER.
	N = 22 8,10,12	4–5					500 550 570	
				as above, but with ash.				
	N = 17 6,9,8	6					400 450 500	
		7		END OF BOREHOLE AT 6.45m				

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BOREHOLE LOG

Borehole No. 13

1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 874.40m
Date: 27/10/22 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		ASPHALTIC CONCRETE: 50mm.t				
			-	FILL: Sand, fine to medium grained, light brown, with silt and fine to coarse grained sandstone and igneous gravel.	M			SCREEN: 4.45kg 0.05-0.5m NO FCF 4L BUCKET
	N = 19 9,8,11		CI	Silty CLAY: medium plasticity, light grey mottled orange brown and red brown, trace of fine to medium grained ironstone gravel and ash.	w>PL	Hd	>600 >600 >600	RESIDUAL
		1						
	N = 20 8,10,10	2					450 480 400	
					w≈PL			
	N = 13 6,6,7	3					500 450 470	
		4		Silty CLAY: medium plasticity, light grey mottled orange brown, trace of fine to medium grained ironstone gravel, root fibres and ash.	w>PL	VSt		
	N = 13 5,7,6	5					350 300 320	SLIGHT ORGANIC ODOUR
	N = 8 4,4,4	6					230 250 300	
		7		END OF BOREHOLE AT 6.45m				

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BOREHOLE LOG

Borehole No. **14**
1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 875.15m
Date: 26/10/22 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0			FILL: Clayey silt, low plasticity, dark brown, trace of root fibres, fine to coarse graiend igneous gravel, slag and coal.	w>PL			GRASS COVER SCREEN: 11.28kg 0-0.1m NO FCF
	N = 14 2,6,8			CL-CI	Silty CLAY: low to medium plasticity, light grey mottled orange brown and red brown, trace of ash and fine to medium grained ironstone gravel.	w>PL	VSt-Hd	350 400 450	SCREEN: 3.80kg 0.1-0.5m NO FCF RESIDUAL
		1				w≈PL	Hd		
	N = 25 8,13,12							>600 >600 >600	
		2							
1 DAY AFTER PUMP OUT	N = 17 5,7,10	3			as above, but without ash.			450 500 520	SPT WENT MORE THAN 0.45m GROUNDWATER MONITORING WELL INSTALLED TO 6.0m. CLASS 18 MACHINE SLOTTED PVC. STANDPIPE 6.0m TO 2.0m. CASING 2.0m TO 0m. 2mm SAND FILTER PACK 6.0m TO 1.5m. BENTONITE SEAL 1.5m TO 0.9m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETE GATIC COVER.
		4							
	N = 16 6,8,8	5						540 550 580	
	N = 18 7,11,7	6						500 570 530	
		7			END OF BOREHOLE AT 6.45m				

SAMPLES: ES, U50, DB, DS

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BOREHOLE LOG

Borehole No.
15
1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 876.22m
Date: 26/10/22 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		FILL: Clayey silt, low plasticity, grey, trace of root fibres, brick and tile fragments.	w>PL			GRASS COVER SCREEN: 10.90kg 0-0.1m NO FCF
1 DAY AFTER PUMP OUT	N = SPT SUNK 200mm		CL	Silty CLAY: low plasticity, light grey mottled orange brown, trace of fine to medium grained ironstone gravel.	w>PL w≈PL	(S-F) Hd		SCREEN: 2.45kg 0.1-0.3m NO FCF RESIDUAL
	N > 18 13,18/ 150mm REFUSAL		CI	Silty CLAY: medium plasticity, orange brown mottled light grey and dark grey, trace of fine to medium grained ironstone gravel and ash.	w<PL	Hd	450 500 500	
	N > 22 8,13,9/ 50mm REFUSAL	3						GROUNDWATER MONITORING WELL INSTALLED TO 6.0m. CLASS 18 MACHINE SLOTTED PVC. STANDPIPE 3.75m TO 0.75m. CASING 0.75m TO 0.2m. 2mm SAND FILTER PACK 6.0m TO 0.5m. BENTONITE SEAL 0.5m TO 0.3m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETE GATIC COVER.
	N = 18 7,8,10		ML	Clayey SILT: low plasticity, red brown mottled orange brown.	w<PL	Hd	430 420 450	
	N = 27 9,12,15	6						
				END OF BOREHOLE AT 6.45m				

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BOREHOLE LOG

Borehole No. **16**

Client: HEALTH INFRASTRUCTURE

Project: PROPOSED HOSPITAL DEVELOPMENT

Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 874.46m

Date: 27/10/22 **Datum:** AHD

Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Samples (ES, U50, DB, DS)	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION			0			ASPHALTIC CONCRETE: 50mm.t				
	ES, DS				-	FILL: Sand, fine to medium grained, light grey, with silt, fine to medium grained sandstone gravel and slag.	M			SCREEN: 5.40kg 0.05-0.3m NO FCF 5L BUCKET
	ES, DB, DS	N = 22 7,10,12			CI	Silty CLAY: medium plasticity, light grey mottled orange brown and red brown, trace of fine to medium grained ironstone gravel.	w≈PL	Hd	550 >600 >600	RESIDUAL
			1							
	DS	N = 18 7,8,10							450 450 480	
			2							
	DS	N = 25 6,12,13	3					VSt	380 350 320	
						as above, but with fine to medium grained igneous gravel and ash.	w>PL			
			4							
	DS	N = 11 6,5,6							250 310 350	
			5							
	DS	N = 18 6,8,10	6					VSt-Hd	360 380 430	
						END OF BOREHOLE AT 6.45m				
			7							

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BOREHOLE LOG

Borehole No. **17**

1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 874.35m
Date: 25/10/22 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		0	-	ASPHALTIC CONCRETE: 50mm.t				
				FILL: Clayey sand, fine to medium grained, red brown, low plasticity, trace of fine to medium grained igneous gravel.	M			SCREEN: 6.79kg 0.05-0.4m NO FCF
	N = 21 6,10,11		CI	Silty CLAY: medium plasticity, light grey mottled orange brown, trace of fine to medium grained ironstone gravel.	w≈PL	Hd	500 550 600	RESIDUAL
		1						GROUNDWATER MONITORING WELL INSTALLED TO 5.95m. CLASS 18 MACHINE SLOTTED PVC. STANDPIPE 5.95m TO 1.95m. CASING 1.95m TO 0.12m. 2mm SAND FILTER PACK 6.0m TO 1.4m. BENTONITE SEAL 1.4m TO 0. 55m. BACKFILLED WITH SAND TO THE SURFACE. COMPLETED WITH A CONCRETE GATIC COVER.
	N = 25 10,12,13			as above, but brown mottled red brown.	w≈PL	Hd	450 500 550	
		2						
				Clayey SILT or Silty CLAY: medium plasticity, light brown mottled orange brown, trace of fine grained ironstone gravel, ash and root fibres.	w≈PL	VSt		
	N = 9 2,4,5	3					250 320 280	
▶					w>PL			
		4						
	N = 10 4,5,5						200 230 250	
		5						
		6						
	N = 17 6,8,9							
				END OF BOREHOLE AT 6.45m				
		7						

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BOREHOLE LOG

Borehole No.
18
1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 874.26m
Date: 25/10/22 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0	-	ASPHALTIC CONCRETE: 50mm.t	M			SCREEN: 2.50kg 0.05-0.3m NO FCF 8L BUCKET
				FILL: Sand, fine to medium grained, light grey, with silt and fine to medium grained sandstone gravel.				
	N > 20 10,14, 6/50mm REFUSAL			FILL: Silty clay, low to medium plasticity, brown mottled light grey and dark grey, trace of fine to medium grained igneous gravel and ash.	w≈PL		>600 >600 >600	SCREEN: 8.30kg 0.3-1.0m NO FCF 8L BUCKET
	N = 9 3,4,5	1	CI	Silty CLAY: medium plasticity, brown mottled red brown, trace of ash and fine to medium grained igneous gravel.	w≈PL	VSt	350 330 400	RESIDUAL
	N = 8 3,4,4	2	CL-CI	Silty CLAY: low to medium plasticity, brown mottled orange brown and red brown, trace of ash.	w>PL	St	200 180 180	
	N = 12 5,5,7	4				St-VSt	250 280 230	
	N = 19 7,9,10	5 / 6			w≈PL	VSt-Hd	420 380 400	
		7		END OF BOREHOLE AT 6.45m				

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BOREHOLE LOG

Borehole No. **19**
1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 873.97m
Date: 25/10/22 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0	-	ASPHALTIC CONCRETE: 50mm.t				
				FILL: Gravelly sand, fine to medium grained, red brown, fine to coarse grained igneous, trace of clay nodules and slag.	M			SCREEN: 7.24kg 0.05-0.4m NO FCF
	N = 23 9,10,13	1	CL-CI	Silty CLAY: low to medium plasticity, light grey mottled orange brown and dark grey, trace of fine to medium grained ironstone gravel and ash.	w≈PL	Hd	400 450 520	RESIDUAL
	N = 18 6,8,10	2					420 500 600	
	N = 8 4,4,4	3		Silty CLAY: low to medium plasticity, light brown mottled grey, red brown and orange brown, trace of ash.	w>PL	VSt	250 280 320	
	N = 11 3,5,6	4, 5			w<PL	VSt-Hd	350 400 420	
	N = 20 8,10,10	6					450 500 420	
		7		END OF BOREHOLE AT 6.45m				

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BOREHOLE LOG

Borehole No. 20

1/1

Client: HEALTH INFRASTRUCTURE
Project: PROPOSED HOSPITAL DEVELOPMENT
Location: 3 OSMAN STREET, BLAYNEY, NSW

Job No.: 35521LF **Method:** SPIRAL AUGER **R.L. Surface:** 873.91m
Date: 25/10/22 **Datum:** AHD
Plant Type: JK400 **Logged/Checked by:** C.S.Y./O.F.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
		0		ASPHALTIC CONCRETE: 50mm.t				
			-	FILL: Clayey sand, fine to medium grained, red brown, with fine to coarse grained igneous gravel, trace of brick fragments and slag.	M			APPEARS WELL COMPACTED
	N = 17 6,8,9			FILL: Gravelly sand, fine to medium grained, grey, fine to coarse grained igneous and ironstone gravel, with clay nodules, trace of brick fragments and slag.	M			SCREEN: 3.30kg 0.05-0.5m NO FCF; SCREEN: 4.77kg 0.5-1.2m NO FCF
		1						
	N > 27 9,12, 15/100mm REFUSAL		CI	Silty CLAY: medium plasticity, light grey mottled orange brown, trace of fine to medium grained ironstone gravel and ash.	w>PL	VSt	250 270 300	RESIDUAL; SPT REFUSAL ON IRONSTONE GRAVEL
		2				Hd		
	N = 20 6,9,11	3			w<PL		450 400 500	
AFTER 2 HOURS		4						
	N = 24 11,11,13			as above, but with trace of extremely weathered siltstone bands.				
ON COMPLETION		5		Silty CLAY: medium plasticity, orange brown mottled red brown, trace of extremely weathered siltstone bands.	w<PL	Hd		
	N = 20 7,10,10	6						
				END OF BOREHOLE AT 6.45m				
		7						

DYNAMIC CONE PENETRATION TEST RESULTS

Client:	HI C/- APP		
Project:	PROPOSED HOSPITAL DEVELOPMENT		
Location:	3 OSMAN STREET, BLAYNEY, NSW		
Job No.	35521LF	Hammer Weight & Drop: 9kg/510mm	
Date:	24/10/22 - 28/10/22	Rod Diameter: 16mm	
Tested By:	C.S.Y.	Point Diameter: 20mm	

Test Location	**BH2**	**BH3**	**BH4**	**BH5**	**BH6**	**BH7**	**BH8**
Surface RL	872.98m	873.63m	872.42m	872.92m	873.60m	872.65m	873.87m
Depth (mm)	Number of Blows per 100mm Penetration						
0 - 100	2	3	SUNK	1	SUNK	SUNK	SUNK
100 - 200	3	4	1	1	1	↓	1
200 - 300	3	6	1	3	1	↓	1
300 - 400	4	13	↓	3	2	↓	1
400 - 500	2	20	1	3	2	1	2
500 - 600	↓	16	2	5	8	1	1
600 - 700	3	6	2	3	6	2	2
700 - 800	2	3	3	2	2	3	4
800 - 900	3	2	3	2	2	5	6
900 - 1000	2	4	3	1	1	7	7
1000 - 1100	3	3	4*	2	1	8	5
1100 - 1200	3	2	5	3	1	11	5
1200 - 1300	8	3	8	2	1	11	3
1300 - 1400	12	4	12	15	3	14	4
1400 - 1500	14	7	9	19	2	17	4
1500 - 1600	14*	9	13	11	2	21	7
1600 - 1700	15	8	18	16	4	REFUSAL	6
1700 - 1800	12/50mm	13	10	16	3		7
1800 - 1900	REFUSAL	20	REFUSAL	18	4		8
1900 - 2000		15		REFUSAL	8		13
2000 - 2100		11/50mm			8		13/50mm
2100 - 2200		REFUSAL			7		REFUSAL
2200 - 2300					8		
2300 - 2400					15		
2400 - 2500					15		
2500 - 2600					18		
2600 - 2700					7		
2700 - 2800					REFUSAL		
2800 - 2900							
2900 - 3000							

Remarks:
1. The procedure used for this test is described in AS1289.6.3.2-1997 (R2013)
2. Usually 8 blows per 20mm is taken as refusal
3. Datum of levels is AHD

*Moisture

JKGeotechnics

DYNAMIC CONE PENETRATION TEST RESULTS

Client:	HI C/- APP		
Project:	PROPOSED HOSPITAL DEVELOPMENT		
Location:	3 OSMAN STREET, BLAYNEY, NSW		
Job No.	35521LF		Hammer Weight & Drop: 9kg/510mm
Date:	24/10/22 - 28/10/22		Rod Diameter: 16mm
Tested By:	C.S.Y.		Point Diameter: 20mm

Test Location	**BH9**	**BH10**					
Surface RL	873.86m	874.43m					
Depth (mm)	Number of Blows per 100mm Penetration						
0 - 100	1	SUNK					
100 - 200	1	2					
200 - 300	1	2					
300 - 400	2	4					
400 - 500	3	9					
500 - 600	4	4					
600 - 700	4	4					
700 - 800	15	5					
800 - 900	11	3					
900 - 1000	8	5					
1000 - 1100	10	5					
1100 - 1200	10	4					
1200 - 1300	16	8					
1300 - 1400	12	9					
1400 - 1500	13	12					
1500 - 1600	20	13					
1600 - 1700	25	18					
1700 - 1800	REFUSAL	12/50mm					
1800 - 1900		REFUSAL					
1900 - 2000							
2000 - 2100							
2100 - 2200							
2200 - 2300							
2300 - 2400							
2400 - 2500							
2500 - 2600							
2600 - 2700							
2700 - 2800							
2800 - 2900							
2900 - 3000							

Remarks:
1. The procedure used for this test is described in AS1289.6.3.2-1997 (R2013)
2. Usually 8 blows per 20mm is taken as refusal
3. Datum of levels is AHD

AERIAL IMAGE SOURCE: MAPS.SIX.NSW.GOV.AU

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

Title: **SITE LOCATION PLAN**

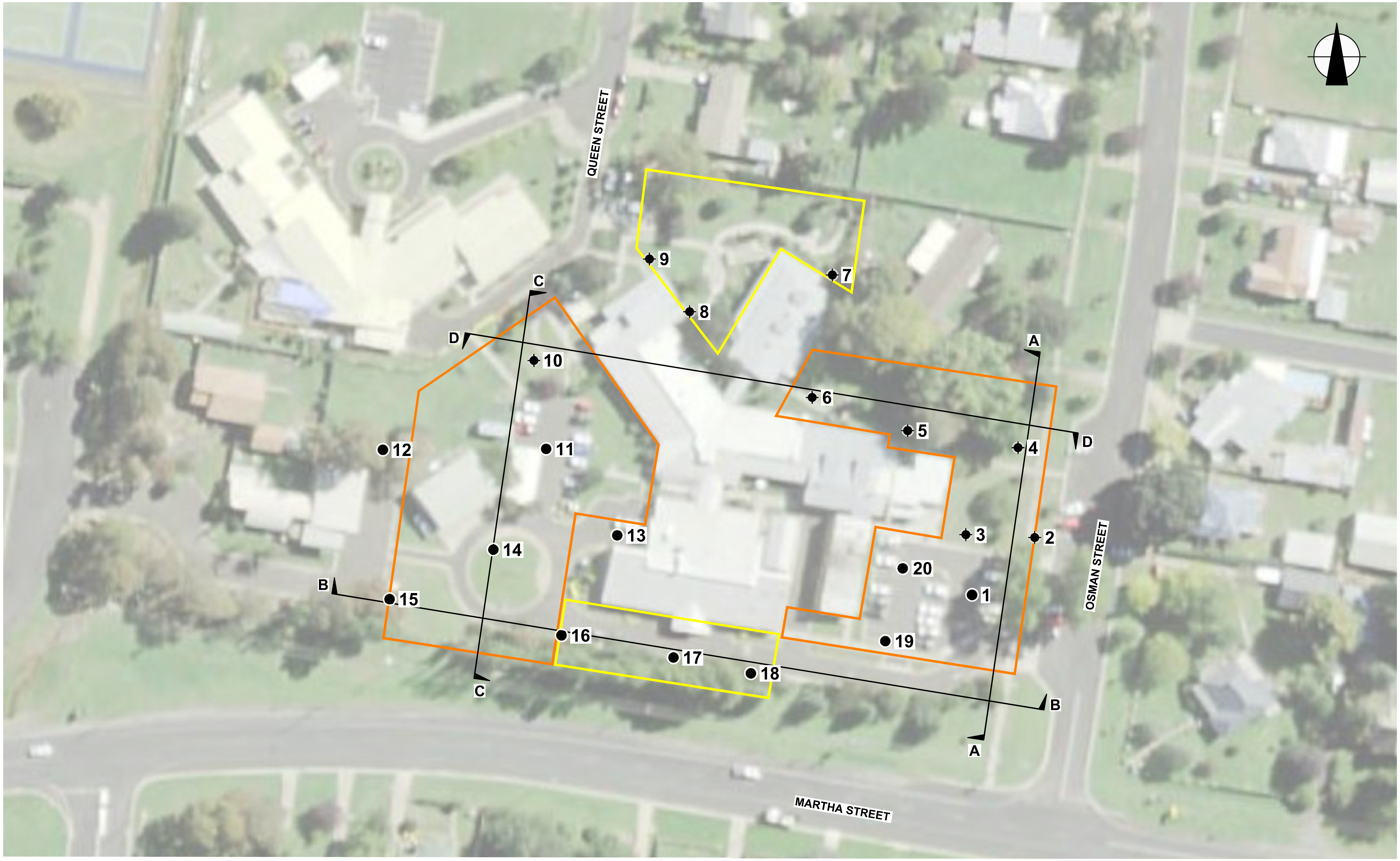
Location: BLAYNEY DISTRICT HOSPITAL, 3 OSMAN STREET, BLAYNEY, NSW

Report No: 35521LF

Figure No: 1

JKGeotechnics

PLOT DATE: 1/11/2022 2:15:57 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\35000'S\35521LF BLAYNEY\CAD\35521LF.DWG



LEGEND

- ● AUGER BOREHOLE
- ⌖ HAND AUGER BOREHOLE AND DCP TEST

NOTES:

1. REFER TO FIGURE 3 FOR CROSS SECTION A-A.
2. REFER TO FIGURE 4 FOR CROSS SECTION B-B.
3. REFER TO FIGURE 5 FOR CROSS SECTION C-C.
4. REFER TO FIGURE 6 FOR CROSS SECTION D-D.

AERIAL IMAGE SOURCE: MAPS.SIX.NSW.GOV.AU

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 LOCATION PLAN**

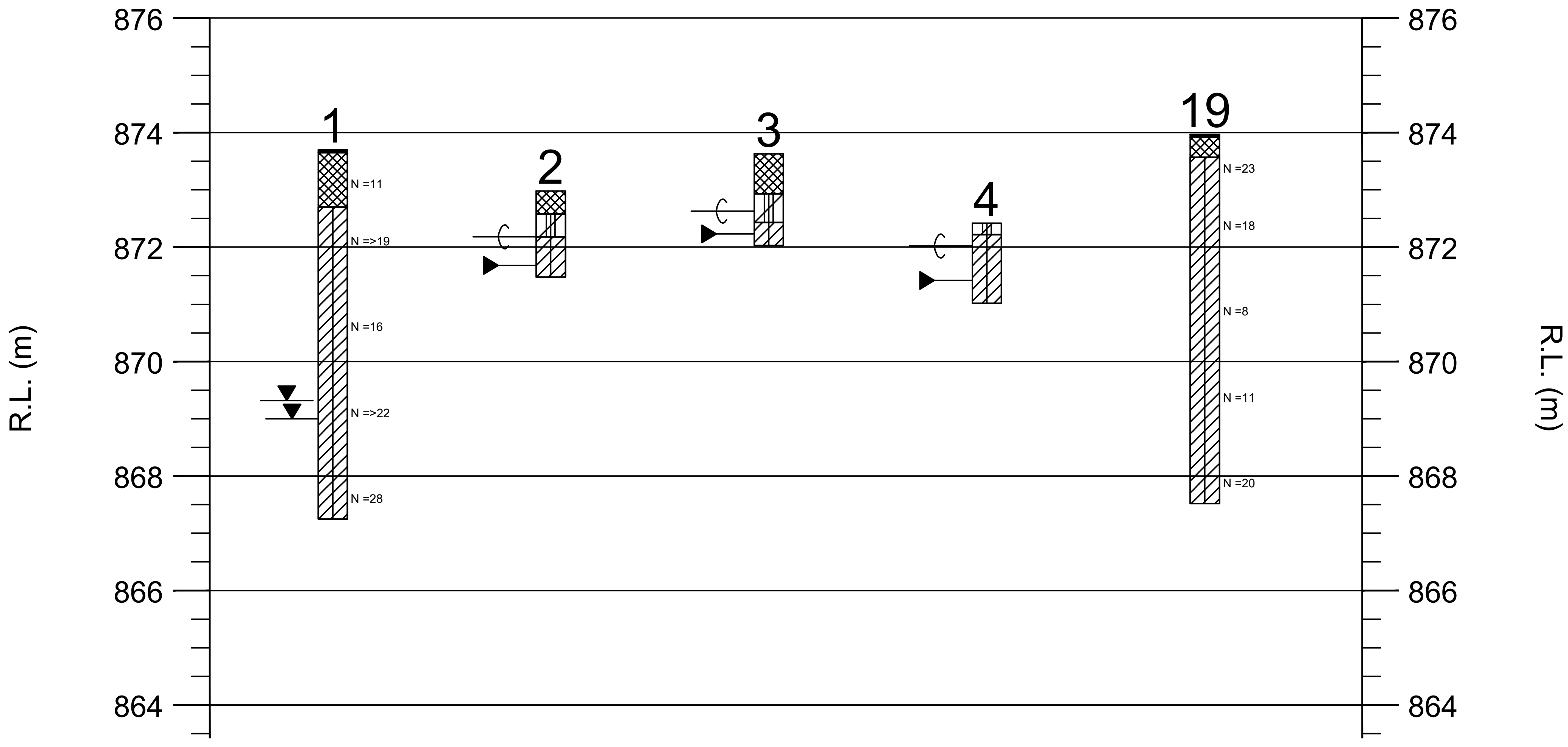
Location: BLAYNEY DISTRICT HOSPITAL, 3 OSMAN STREET, BLAYNEY, NSW

Report No: 35521LF

Figure No: 2

JKGeotechnics

PLOT DATE: 20/12/2022 2:39:55 PM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\35000'S\35521LF BLAYNEY\CAD\35521LF.DWG



LEGEND

Asphaltic/ Bituminous Paving

Fill

Silty Clay

Clayey Silt

Observed water level

Borehole Collapse Depth

Groundwater seepage level

N SPT "N" VALUE

Nc SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

0 1 2 3 4 5

V: SCALE 1:100 @A3 METRES

H: NOT TO SCALE

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

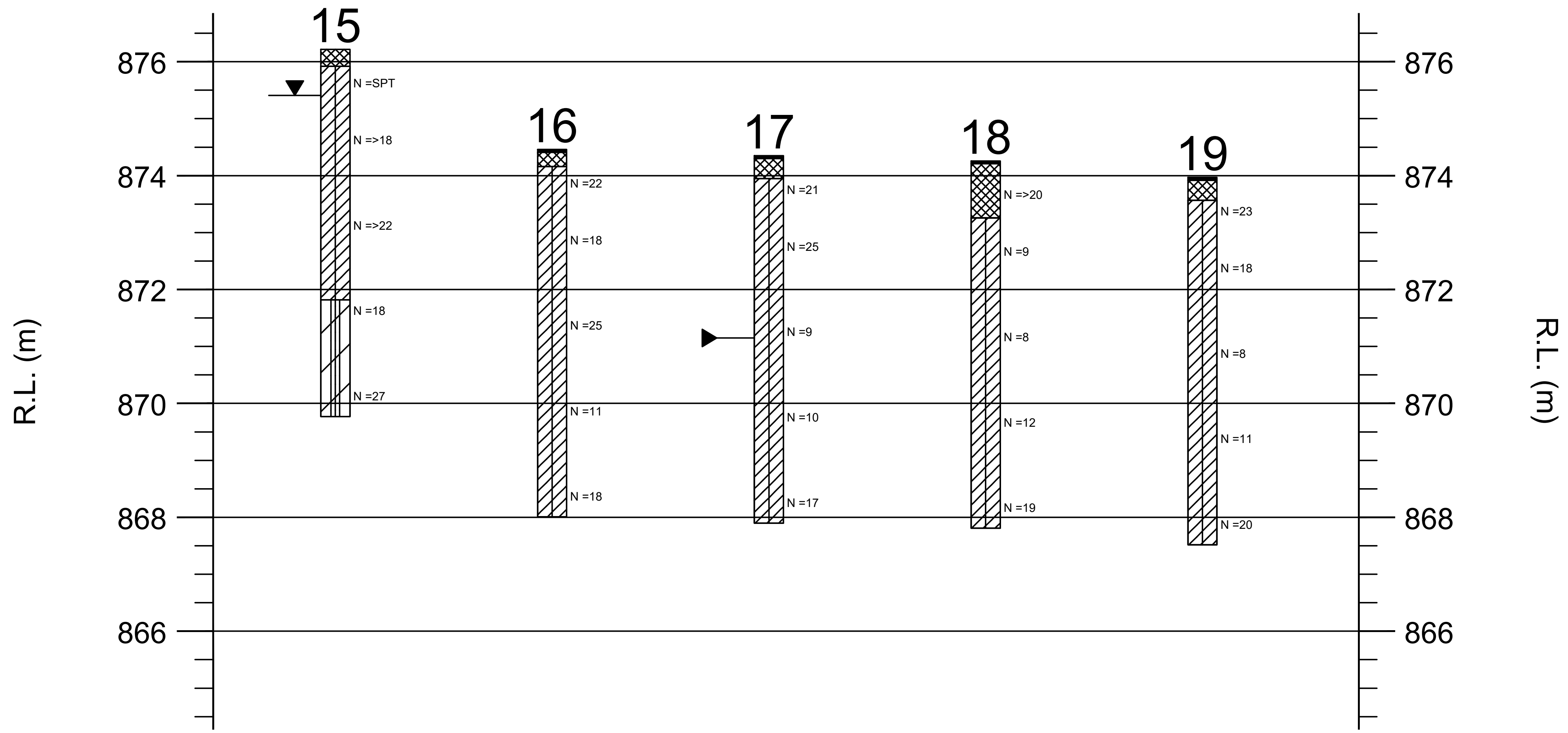
Title: **GRAPHICAL BOREHOLE SUMMARY SECTION A-A**

Location: BLAYNEY DISTRICT HOSPITAL, 3 OSMAN STREET, BLAYNEY, NSW

Report No: 35521LF

Figure No: 3

JKGeotechnics



LEGEND

- Asphaltic/ Bituminous Paving
- Fill
- Silty Clay
- Clayey Silt
- Observed water level
- Borehole Collapse Depth
- Groundwater seepage level
- N — SPT "N" VALUE
- Nc — SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

0 1 2 3 4 5

V: SCALE 1:100 @A3 METRES

H: NOT TO SCALE

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

Title: **GRAPHICAL BOREHOLE SUMMARY SECTION B-B**

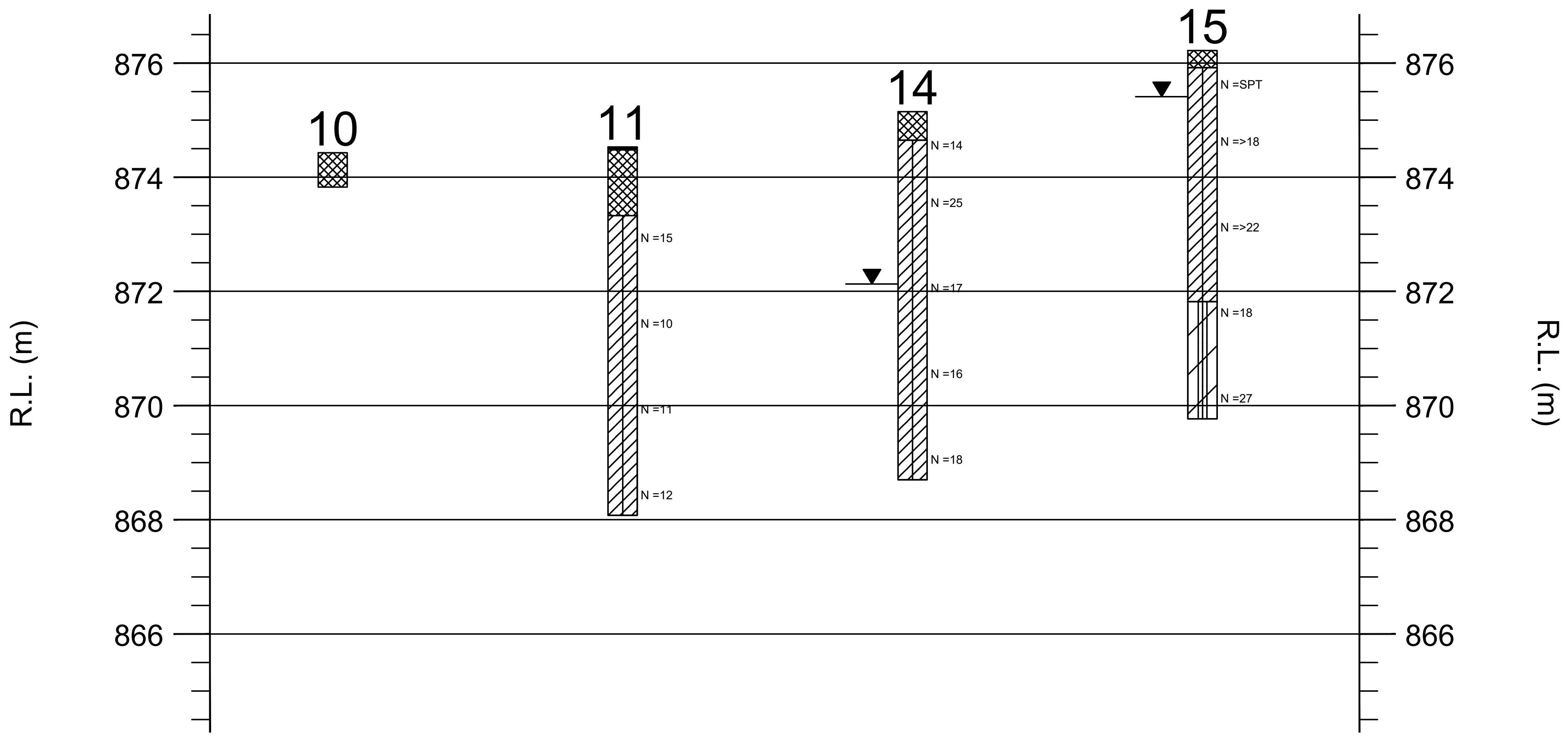
Location: BLAYNEY DISTRICT HOSPITAL, 3 OSMAN STREET, BLAYNEY, NSW

Report No: 35521LF

Figure No: 4

JKGeotechnics

PLOT DATE: 13/12/2022 11:29:47 AM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\35000'S\35521LF BLAYNEY\CAD\35521LF.DWG



LEGEND

- Asphaltic/ Bituminous Paving
- Fill
- Silty Clay
- Clayey Silt
- Observed water level
- Borehole Collapse Depth
- Groundwater seepage level
- N — SPT "N" VALUE
- Nc — SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

0 1 2 3 4 5

V: SCALE 1:100 @A3 METRES

H: NOT TO SCALE

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

Title: **GRAPHICAL BOREHOLE SUMMARY SECTION C-C**

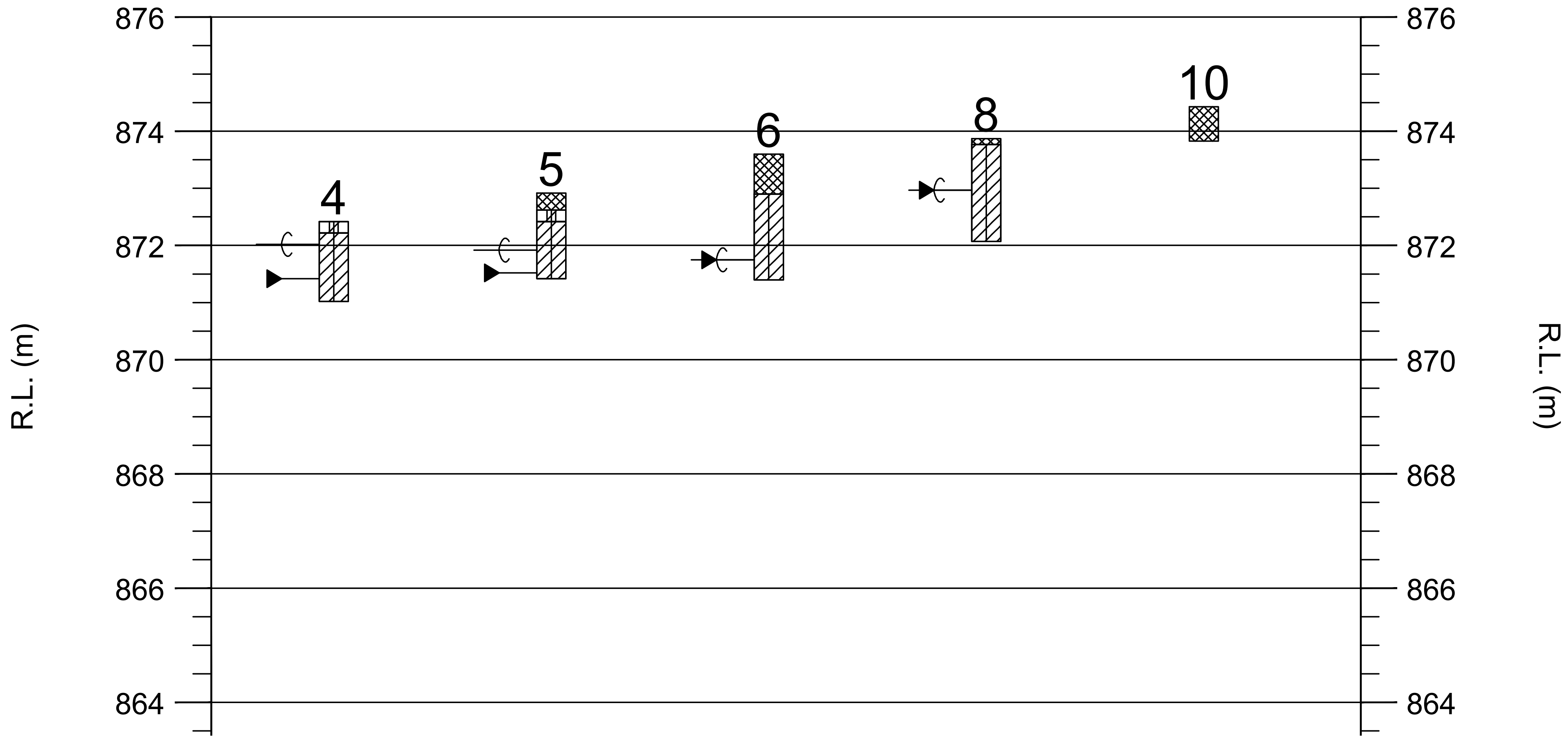
Location: BLAYNEY DISTRICT HOSPITAL, 3 OSMAN STREET, BLAYNEY, NSW

Report No: 35521LF

Figure No: 5

JKGeotechnics

PLOT DATE: 13/12/2022 11:29:56 AM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\35000'S\35521LF BLAYNEY\CAD\35521LF.DWG



LEGEND

- Asphaltic/ Bituminous Paving
- Fill
- Silty Clay
- Clayey Silt
- Observed water level
- Borehole Collapse Depth
- Groundwater seepage level
- N — SPT "N" VALUE
- Nc — SOLID CONE BLOW COUNTS PER 150mm

NOTE: REFER TO BOREHOLE LOGS

0 1 2 3 4 5

V: SCALE 1:100 @A3 METRES

H: NOT TO SCALE

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

Title:	**GRAPHICAL BOREHOLE SUMMARY SECTION D-D**
Location:	BLAYNEY DISTRICT HOSPITAL, 3 OSMAN STREET, BLAYNEY, NSW
Report No: 35521LF	Figure No: 6

JKGeotechnics

PLOT DATE: 13/12/2022 11:30:06 AM DWG FILE: S:\6 GEOTECHNICAL\6F GEOTECHNICAL JOBS\35000'S\35521LF BLAYNEY\CAD\35521LF.DWG

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:

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

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:

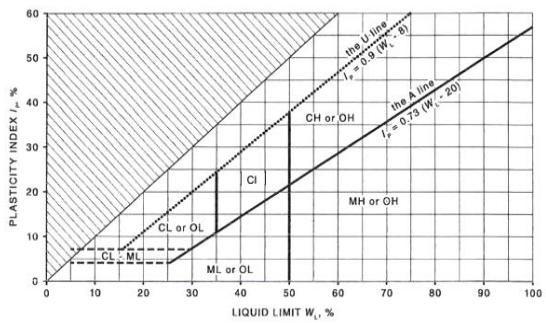
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

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.

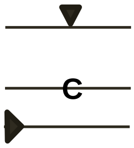
3 Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.

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



LOG SYMBOLS

Log Column	Symbol	Definition
Groundwater Record		Standing water level. Time delay following completion of drilling/excavation may be shown. Extent of borehole/test pit collapse shortly after drilling/excavation. Groundwater seepage into borehole or test pit noted during drilling or excavation.
Samples	ES U50 DB DS ASB ASS SAL	Sample taken over depth indicated, for environmental analysis. Undisturbed 50mm diameter tube sample taken over depth indicated. Bulk disturbed sample taken over depth indicated. Small disturbed bag sample taken over depth indicated. Soil sample taken over depth indicated, for asbestos analysis. Soil sample taken over depth indicated, for acid sulfate soil analysis. 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 PID = 100	Vane shear reading in kPa of undrained shear strength. Photoionisation detector reading in ppm (soil sample headspace test).
Moisture Condition (Fine Grained Soils)	w > PL $w \approx$ PL w < PL $w \approx$ LL w > LL	Moisture content estimated to be greater than plastic limit. Moisture content estimated to be approximately equal to plastic limit. Moisture content estimated to be less than plastic limit. Moisture content estimated to be near liquid limit. Moisture content estimated to be wet of liquid limit.
(Coarse Grained Soils)	D M W	DRY – runs freely through fingers. MOIST – does not run freely but no free water visible on soil surface. WET – free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS S F St VSt Hd Fr ( )	VERY SOFT – unconfined compressive strength ≤ 25kPa. SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa. FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa. STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa. VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa. HARD – unconfined compressive strength > 400kPa. FRIABLE – strength not attainable, soil crumbles. Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.
Density Index/ Relative Density (Cohesionless Soils)		**Density Index (I_D) Range (%)** — **SPT 'N' Value Range (Blows/300mm)**
	VL	VERY LOOSE — ≤ 15 — 0 – 4
	L	LOOSE — > 15 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.
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 $Is_{(50)}$ (MPa)	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