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St Aloysius' College, Kirribilli

SSD Masterplan

Geotechnical Interpretive Report

Prepared for:

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Bloompark Consulting

Date:
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Prepared by:

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Revision

REVISION	DATE	COMMENT	PREPARED BY	REVIEWED BY	APPROVED BY
01	27 January 18	DRAFT	J Durnell	J Holliday	**J Durnell**
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Contents

1. Introduction

This report presents the results of a geotechnical investigation undertaken by Wood & Grieve Engineers (WGE) for the following proposed upgrades to St Aloysius' College in Kirribilli, NSW:

- Junior School – Construction of sports hall and 2 level addition
- Senior School -Construction of a new adjoining single storey classroom structure
- Main Campus – Construction of a new building and repurposing of existing structures

The geotechnical investigation was commissioned by Bloompark Consulting Pty Ltd on behalf of St Aloysius' College ABN 46 621 313 264 (email dated 26 November 2017) and was undertaken in general accordance with the WGE proposal dated 6th October 2017.

The aims of the investigation were to assess the subsurface soil and groundwater conditions, and provide comments and recommendations regarding geotechnical and soil contamination matters to assist in the design and construction of the proposed development.

1.1 Proposed development

1.1.1 Junior School

The Burton Street site (see below) comprises:

- A new playspace with multipurpose hall below;
- A new courtyard and;
- A new second level addition over the classrooms.

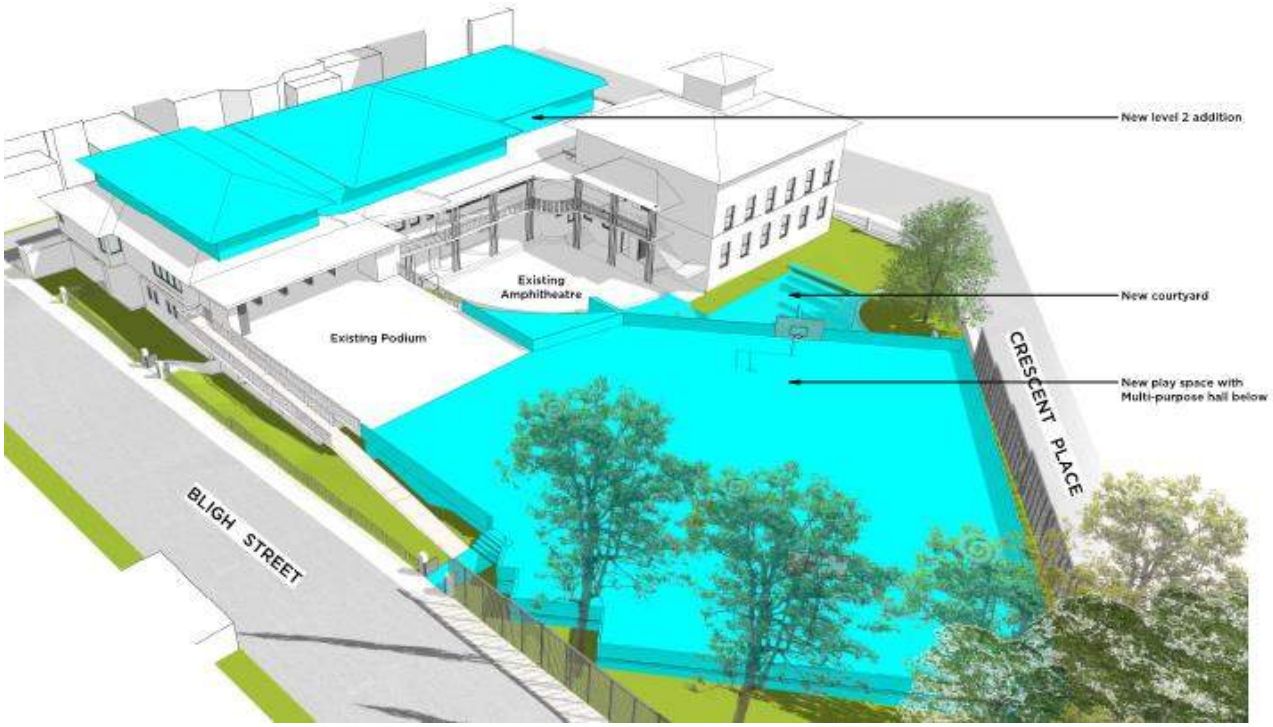

Figure 1 Proposed Junior School Development

Partial basement constructions are approximately 9 m deep and required to form the multi-purpose hall and court yard as the principal elements of civil & structural engineering works. The multi-purpose hall structure is to be formed as an insitu concrete structure with shoring works envisaged to support the perimeter envelope including Crescent Place and Bligh Street boundaries. Once shoring is placed, Sandstone and fill material is to be cut to form the local excavation with surplus excavated material exported from the site as required.

The new level 2 addition is envisaged as a lightweight structure supported upon a new primary steelwork frame formed within the envelope of the existing floor plan. The new structure is to founded upon the underlying Sandstone with local strengthening works provided as may be required to the existing structure.

1.1.2 Senior School

It is proposed to construct a new single storey classroom. Structural works within this campus relate primarily to the classroom extension that will be located adjacent to the Robertson Lane boundary. Works within this location are subject to NSW Heritage requirements and more particularly defined by the limited access for contractor and sub-contractor access. With all significant elements of structure subject to limiting manual handing requirements construction phase methodology has been considered and incorporated within the design from the outset.

The proposed classroom extension is expected to be founded upon the underlying Sandstone formation (circa 900mm) with pumped concrete strip and pad foundations detailed to support the external masonry. Brick and blockwork cavity wall together with blockwork sleeper walls are provided to support a precast suspended floor slab. To allow for limiting handling requirements the proposed suspended floor is formed with precast beam elements supporting permanent form and insulation. The overlying pumped concrete slab is to be finished to reflect architects requirements.

Figure 2 Architectural Render of the proposed single storey structure

1.1.3 Main Campus – New Build

The proposed development incorporates significant new build elements to the eastern extents of the site reflecting both client and architectural requirements whist recognizing the significant vertical level differences across the development area, see below.

Figure 3 Main campus - New Build Arrangement

The proposed three storey structure, located along the eastern site boundary is built upon existing classroom and playground areas and provides new classroom, active roof terrace and school circulation over three floors. Formed as a reinforced concrete framed structure and founded upon the underlying Sandstone the structure is detailed to recognise the interface of new and existing frames along both the southern and northern boundaries.

2. Scope of Work

A geotechnical investigation was scoped by WGE. The scope of investigation was constrained by limited available space to undertake intrusive investigations. The scope comprised the following:

- Junior School
  - 1 no rotary cored borehole to 15m bgl (Metres Below Ground Level)
  - 1 no rotary cored borehole to 8m bgl
  - Groundwater monitoring installation
  - Allowance for 4 monitoring visits over 4 weeks
- Senior School
  - 2 no hand excavated trial pits and associated reinstatement up to 1.10m bgl
- Main Campus
  - 2 hand excavated trial pits and associated reinstatement up to 0.30m bgl
  - Rock mapping of cut faces enclosed by the existing structure
  - 1 no rotary cored borehole to 15m bgl
- Site wide
  - Allowance for groundwater 4 monitoring visits over 4 weeks
  - NATA Laboratory testing to Australian Standards on selected samples
  - Compilation of a Geotechnical Investigations Report

3. Site Description

St Aloysius' College (the site) operations are located in Kirribilli, NSW and is located across three campuses. It is bisected by local roads and interspersed with light commercial and residential properties. All three campus sites were investigated for this project. For clarity the term "the site" will refer to the three sites, and where specific detail for a particular site we refer to the site by Junior School, Senior School and Main Campus.

Figure 4 St Aloysius Site Overview

3.1 Junior school

The Junior school is located on Burton Street Kirribilli. School buildings are present on the northern, western and southern boundary, the areas of the site investigated was the basketball court located in the south eastern corner (refer to the figure below). To the North of the basketball court a slope is present that falls to the north, the surface is artificial turf, and falls to a seating area and the north eastern boundary along Crescent Place.

Figure 5 Aerial Image of the Junior School Site and Borehole Locations (Source Nearmap)

3.2 Senior School

The senior site is located along Jefferys and Upper Pitt Street adjacent to Robertson Lane in a small paved courtyard on the south western side of Senior School, The location of the geotechnical Investigation was accessible by foot along a walkway approximately 1.3m wide with a number of flights of stars. The site location was bounded on the North, West and South by the existing school structure, to the east a sandstone retaining wall is present with a handrail and public footpath at the crest. Flower beds are present at the toe of the retaining wall.

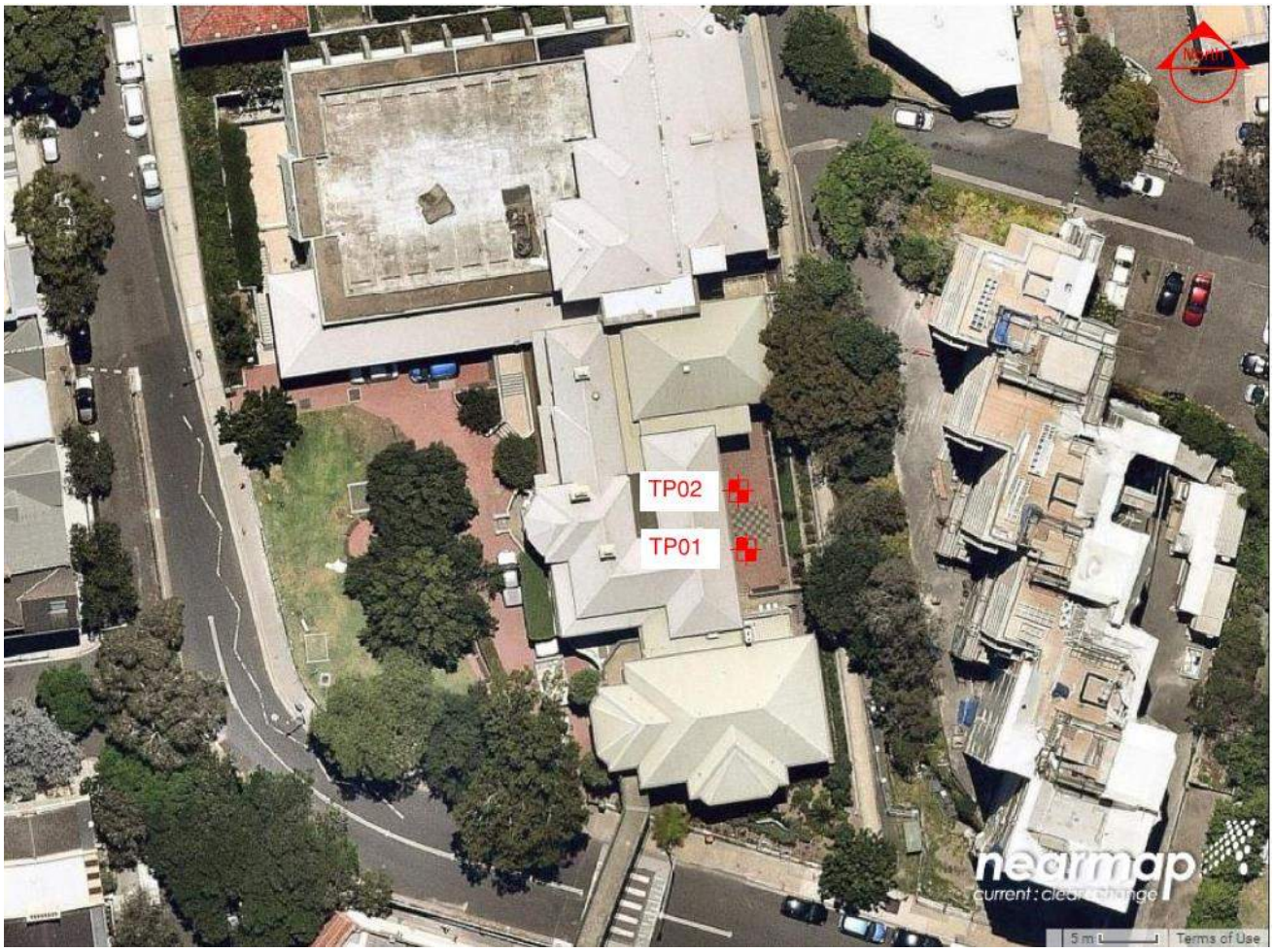

Figure 6 Senior School Site and trial pit locations (Source Nearmap)

3.3 Main Campus

Bounded by Upper Pitt Street, Jeffrey Street and Kirribilli Avenue the existing St Aloysius' College site incorporates three primary building elements enclosing a central courtyard playground (See figure below). The local topography is noted to fall (circa 14m) from the Upper Pitt Street elevation down to the lower Kirribilli Avenue with the interconnecting Jeffrey's Street which illustrates the significant change in level across the north/south axis of the site.

The existing structures on this campus have been developed during the colleges occupation of the site, with the Great Hall and Chapel elements noted as constructed circa 1961/62.

An eastern / central courtyard is contained in the centre of the site by existing multi-storey buildings comprising, libraries, classrooms and administrative offices. The eastern building of the main campus site is located on Upper Pitt street, the school structure is present comprising classrooms, hall are located on the north, south and west boundaries and an internal play ground is present. The Eastern Boundary is adjacent to a residential property and a wall with raised flower beds is present. A cut exposure of high strength sandstone was observed near the access stairs.

A rock cut is enclosed by the school buildings. The cut is accessed from the lower ground floor maintenance workshops and storage areas that are located on the western elevation at Jefferys St. The dashed line shown on figure 7 below indicates its approximate location and extents.

Figure 7 Main Campus Site and Exploratory Locations (Source Nearmap)

3.4 Site Geology

The Sydney 1:100,000 geological map Ref 9130, 1983 (presented in appendix A) for the site indicates the site to be underlain by, Wianamatta Group, Hawkesbury Sandstone, with very minor shale and laminate lenses. No faults or geological structures are recorded to be present at the site.

3.5 Soil Landscape

The government database ESpade (Accessed 23/01/18) indicates the site is underlain by the Gymea (9130) soil landscape, summarized as follows:

Landscape - undulating to rolling rises and low hills on Hawkesbury Sandstone. Local relief 20-80 m, slopes 10-25%. Rock outcrop <25%. Broad convex crests, moderately inclined side slopes with wide benches, localised rock outcrop on low broken scarps.

Soils - shallow to moderately deep (30-100 cm) Yellow Earths and Earthy Sands

Limitations - localised steep slopes, high soil erosion hazard, rock outcrop, shallow highly permeable soil, very low soil fertility.

4. Field Work Methods

The fieldwork was undertaken by Macquarie Geotechnical under the direction of Wood and Grieve Engineers. The methods of investigation are described in the Macquarie Geotechnical Report presented in Appendix A

Field work was carried out in general accordance with AS1726 – 2017 Geotechnical Site investigation, and supervised by an experienced engineering geologist or geotechnical engineer.

Due to access to the three sites, the fieldwork was undertaken in following three phases:

1. The Junior school and senior school sites - 7th and 8th of December 2017.
2. The rock mapping at the Main Campus investigation - 4th January 2018.
3. Drilling at the Main Campus - 9th January 2018.

Trial pits were excavated and reinstated with hand tools due to restricted access. All boreholes were progressed with a continuous flight auger to refusal on rock, at which point rock coring to the target depth using a water flush was carried out.

Groundwater monitoring standpipes were installed in all three boreholes drilled. The details of the installations are presented in Appendix A. Due to the drilling techniques employed, it is possible that the water flush obscured water strikes or the seepage, and ingress of groundwater into the bore. As such water strikes encountered during drilling may not have been recorded.

5. Field Work Results

5.1 Subsurface Conditions

The sub surface ground conditions encountered were generally consistent with the expected conditions and published information.

The subsurface at the sites generally comprised hardstanding, overlying fill, overlying extremely weathered Sandstone and slightly weathered medium to high strength sandstone.

5.1.1 Simplified Site Ground model

- Unit 1 – Fill (Unengineered)
- Unit 2 – Residual Soil (BH2 only)
- Unit 3 –Extremely weathered Sandstone (Class V)
- Unit 4 – Fractured Sandstone (Class III)
- Unit 5 - Slightly weathered medium to high strength Sandstone. (Class II)

The factual information for the investigation is presented in the Macquarie Geotechnical Report in Appendix A. Further discussion on the specific ground conditions is outlined below.

Junior School

The subsurface conditions at the site are indicated by boreholes (BH) 1 and 2. These show the ground model to comprise as follows:

UNIT	DESCRIPTION	DEPTH (top * m)	COMMENTS
1 - FILL	Concrete / sandy gravel / gravely sand	0m	0.4m thick (BH1); 1.8m thick (BH2)
2 – RESIDUAL SOIL	Gravely clay (low plasticity)	1.8m	BH2 only
3 – CLASS V Sandstone	Recovered as gravely sand	0.4m to 1.9m	BH1 and 2 respectively
4 – CLASS III Sandstone	Medium to high Strength Sandstone	1.1m to 2.6m	BH1 and 2 respectively
5 – CLASS II Sandstone	Medium to high strength Sandstone	5.2m to 7m	BH1 and 2 respectively

* Depth encountered to top surface

The ground conditions at the junior school site indicate that the buried natural ground profile slopes to the north, to achieve the level surface for the existing basketball court fill comprising gravelly sand has been placed (thickness increases from 0.30mbgl in BH01 to 1.80mbgl in BH02).

Hydrocarbon odours were noted during drilling, this is further discussed in the Cavvanba Consulting report ref 17066 r01 presented in appendix B

A summary of groundwater monitoring in boreholes is presented in Table 2.

Ground water monitoring carried out in January indicates that the water depths in BH1 and BH2 range between 3.5m to 4.7m and 4.1m to 5.2m bgl respectively. These depths are consistent with stained and root bearing fractures observed during drilling. We note that ground water sampling was undertaken on 15/01/18 and subsequent monitoring visits show a lower groundwater depth on the 16/01/18 and 23/01/18 in BH1 suggesting that the wells may be recharging Also the difference in depths between BH01 and BH02 is probably due to a northerly trending hydraulic gradient (i.e. in direction of topographical slope)

Table 1 Groundwater Monitoring Summary at the Junior School

Groundwater Well	Water Depths (mbgl)				
	04/01/2018	09/01/2018	15/01/2018	16/01/2018	23/1/2018
BH01 MW	3.65	3.64	3.54	4.72*	4.20*
BH02 MW	5.30	5.23	5.20	4.18*	Obstructed

Note *Well possibly recharging.

It is important to bear in mind that groundwater levels can vary; seasonally, following periods of rainfall, due to local factors (such as permeability of the rock and fractures, changes to drainage conditions, nearby underground services or basements). It is recommended that ongoing monitoring of water levels be undertaken.

Based on our understanding of the proposed development and construction activity at this site it is likely that the activity will be defined as minimal impact, and a full aquifer interference assessment is not required.

Senior School

Two hand excavated trial pits (TP01 & 02) were excavated with hand tools. The trial pits were excavated against the external wall of the structure. TP's 01 & 02 indicate the ground model for the site comprises:

Fill - to depths of 1.1m and 0.85m respectively overlying sandstone. The Fill is generally described as a gravelly SAND or clayey SAND with cobbles and boulders. A granular drainage layer was encountered in both trial pits below a geofabric layer. In TP01 the geofabric was encountered at 0.75m bgl and in TP02 at a depth of 0.55m bgl.

Sandstone – from 0.85 depth – expected to be at least Class III (based on our observations and borehole records).

Groundwater was not encountered during the investigation.

Main Campus

Ground conditions were assessed from BH03; TP's 03 & 03a and rock mapping.

BH03 was progressed to a depth of 15m bgl to characterise the rock strength and monitor groundwater for a footing to support the repurposed structure at approximately 12m bgl at the base of the rock cutting..

A ground model for the main campus based on the findings from BH03 is as follows:

Unit	Description	Depth(m)	Remarks
1 - FILL	Concrete / clayey sand	0m	0.8m thick – hydrocarbon odour
3 – CLASS V Sandstone	Recovered as sand	0.8m	Extremely weathered
4 – CLASS III Sandstone	Med to high strength Sandstone	1.2m	Fractured
5 – CLASS II Sandstone	Med to high strength Sandstone	1.9m	

Two trial pits were excavated to investigate the foundations of the structure on Jefferys St / Kirribilli Avenue. These pits were inconclusive due to the presence of obstructions.

Rock mapping was carried out of the cutting and this corroborated the ground conditions encountered in the borehole. The existing excavated rock face approximately 6 to 8m high and approximately 80m in length generally comprised of massive Sandstone, medium to high strength with moderately to widely spaced defects, horizontal to sub-horizontal. The cutting was observed from the base, rock mesh was noted near the crest suggesting that the rock quality is in a poorer condition in the top 1 to 2 m. This would be expected due to the effects of weathering. It appears the means of excavation was by drill and blast techniques and pre-splitting was not carried, resulting in a more irregular and fractured surface. Localised spot bolting has been carried out to support wedge and block failures. Tensioned wire rope has also been adopted to provide additional support to localised areas. Ground water seepage was noted from localised joints at various locations across the face.

During augering material was noted to be wet from 0.80m to 1.20m, indicated a perched water table in the clayey sand fill.

The filter pack for the borehole was specified at 9.5m bgl to 13m bgl to target the likely zone of excavation and assess the ground water conditions. Based on the monitoring results groundwater is indicated to be near the surface and was probably lowered temporarily following water sampling. We note that ground water sampling was undertaken on 15/01/18 and subsequent monitoring visits show lower groundwater levels on the 16/01/18 and 23/01/18 suggesting that the wells are recharging.

It is likely that the groundwater behaviour may be associated with flows within joints in the rock mass. Further monitoring is recommended.

	Water Level (m bgl)		
Groundwater Well	**15/01/2018**	**16/01/2018**	**23/1/2018**
BH03 MW	1.91	6.43*	1.08*

Note *Recharging well.

Olfactory odours were noted during drilling BH03, this is further discussed in the Cavvanba Consulting report ref 17066 r01 on contamination presented in appendix B.

6. Geotechnical Laboratory Testing

Geotechnical Laboratory testing is presented in Appendix A. All testing was undertaken at the Macquarie Geotechnical NATA accredited laboratory for testing. The soil and rock testing comprised the following:

- Two Sulphate Content AS1289 4.2.1
- Two pH Value AS1289 4.3.1
- Two EC Electrical Conductivity APHA 2510 & 2520-B
- Two Chloride Content RMS T1010
- Thirty Six Point Load Tests AS4133 4.1
- Four Uniaxial Compressive Strength (UCS) AS4133 4.2.2

Laboratory testing generally confirmed the expected ground conditions of good quality Hawkesbury Sandstone. These results are discussed in Section 7 in greater detail.

7. Geotechnical Discussion

7.1 Preliminary Design Parameters

Based on our investigation, and our experience in this area, we recommend the following geotechnical design parameters:

Table 2 Preliminary Geotechnical Design Parameters

Geotechnical Unit	Unit Weight γ (kN/m3)	Undrained Shear Strength cu (kPa)	Effective Shear Strength Parameters		Poisson's Ratio v	Drained Elastic Modulus E' (MPa)	Ultimate Shaft Adhesion fsult (kPa)	Ultimate End Bearing fbult (kPa)	Allowable End Bearing fbsls (kPa)
			Cohesion c' (kPa)	Friction Angle Φ' (º)					
Uncontrolled Fill	17-18	-	0	30	0.35	5-10	1)	1)	1)
Residual Soil	20	75	5	26	0.35	15	30	5003)	125
Class V Sandstone	22	500	30	35	0.3	100	150	3000	0.5 x qu (max 1000)
Class III Sandstone	24	NA	150	35	0.25	500	500	10000	0.5 x qu (max 2500)
Class II Sandstone	24	NA	300	35	0.25	1000	1000	30000	0.5 x qu (max 4000)

Note:

1) Uncontrolled fill should not be relied upon to support structures
2) Allowable end bearing pressures assume settlement magnitudes of less than about 1% of the foundation width
3) Values for footings; for piles = 9 x cu (single pile)

qu = unconfined compressive strength of rock

7.2 Junior School Partial Basement

The desired architectural finish and waterproofing for the partial basement excavation has yet to be confirmed. For the purposes of this report we have assumed the perimeter retaining structure is likely to take the form of a soldier pile wall with sprayed concrete infill panels, where the rock becomes high strength around 3m, local support with rock bolts, dentition with sprayed concrete may be considered.

Piles would likely be drilled with rotary bored methods and advice should be sought from a specialist piling contractor, who should be provided the logs for the site and should confirm that the plant selected has sufficient torque to achieve the design depth.

It is recommended that the excavation and sprayed concrete application be undertaken in lifts not exceeding 1.5 m. As the excavation proceeds, and depending on the observed performance, consideration may be given to increasing the depth of the lifts, but lifts should not exceed 2.5m. Permanent ground anchors will be required to support soldier pile retaining walls unless the lateral loads can be resisted by the building itself. The anchors/props should be installed progressively and without delay as the excavation proceeds. It is recommended that inspection and mapping of the excavated faces be carried out by an experienced engineering geologist or geotechnical engineer to check for adversely oriented jointing and/or faulting. Local support for adversely oriented jointing is likely to take the form of individual rock bolts or additional temporary ground anchors. Inspection of the excavation should be carried out for each lift of shotcrete.

The site has been altered by fill and hence, is classified as Class 'P' in accordance with AS2870-2011. We note that the underlying sandstone is considered to be Class S and the prediction of ground movements may be undertaken in accordance with the method suggested in AS2870-2011 "Residential Slabs and Footings – Construction" for footings founded in sandstone.

7.2.1 Drainage

Groundwater levels were encountered in boreholes at shallow depths and will require management during excavations.

Given the variability in groundwater levels and slow response to rise in water levels after pumping the standpipe wells dry, we believe that the water levels recorded in the boreholes may not represent a 'true' groundwater table, but rather indicate that seepage occurs through defects in the rock mass and probably along the soil bedrock interface, and these seepage flows collect in the boreholes to the levels indicated. The proposed bulk excavation would cause drainage of the water stored intermittently in the rock defects, resulting in a reduction in flows with time. Such flows would be expected to rise and fall according to prevailing weather patterns. Such seepage should be controlled by perimeter drains to a sump and pump dewatering system. The basement walls and floor slab should however be designed to cater for groundwater pressures and seepage to the levels indicted in the boreholes.

In general terms, any retaining structures around the perimeter of the basement must incorporate permanent drainage provisions and perimeter spoon drains around the basement will be required to collect seepage flows and direct them to appropriate pumping sumps. Some drainage will be required below the basement floor slabs and this may take the form of discrete drains on a grid pattern or a drainage blanket of single sized 'blue metal' gravel. A fail safe automatic pump-out system may have to be adopted to reduce the likelihood of flooding of the basement. However, based on the expected low permeability subsurface profile, we believe that seepage volumes into the basement would be of a relatively low order. We recommend that under-floor drainage or uplift resistance requirements be reviewed following inspection of the completed excavation when such issues can be more readily considered.

We do not anticipate that drainage of such flows would have a significant effect on properties in the surrounding area and that the volumes which would be pumped from the basement would not be significant.

The completed excavation should be inspected by the geotechnical and hydraulic engineers shortly after completion, in order to confirm that these assumed groundwater conditions are realistic and to identify any particular seepage flows, which require drainage measures.

7.2.2 Lateral Earth Pressures

Design of retaining walls should be carried out in accordance with the principles in Australia Standard AS 4678-2002, or other accepted methods. The lateral pressures acting on retaining walls will depend on several factors, including method of construction, rigidity of the walls, amount of ground movement behind the walls and the restraint conditions.

For multi-level propped or anchored walls that are restrained at the top, the lateral earth pressure distribution is complex and it is therefore recommended that a software package such as WALLAP or PLAXIS (or similar) be used to analyse the shoring system. These methods allow the construction sequence, stiffness of support elements and variations within the ground and groundwater conditions to be considered. Deformations of the structure and surrounding ground are also able to be assessed, where movement sensitive structures are located behind the wall.

Where excavation induced movements are not of a concern, shoring for this site could comprise soldier pile walls with reinforced shotcrete infill panels of if there are no critical structures susceptible to movement close to excavation boundary. Where it is important to reduce excavation induced movements or there are critical structures close to excavation boundaries. We recommend the use of a more rigid and closed systems of contiguous pile or secant pile walls.

The shoring pile walls should be designed to at least retain the low or weaker strength rock profile of Class V rock. The shoring piles should be socketed in to the medium to high strength rock profile of Class III or Class II rock. The underlying competent Class III and Class II sandstone bedrock may be cut vertically and unsupported.

Given the low heights of the shoring walls (~2.6m) it is possible to use a combination of toe socket and rock anchors.

The shoring pile system may terminate with sockets into the Class III or Class II sandstone bedrock of at least medium or high strength, with the sandstone below that depth being assessed to be largely self-supporting.

Where these walls do not penetrate to below the proposed basement level, it will be necessary to provide lateral support with at least one level of bracing or anchors. As the excavation extends past the toes of these piles, the rock must be carefully inspected by a geotechnical engineer to assess for any adversely oriented defects that require stabilisation to maintain the integrity of the shoring system. Suitably sized drilling rigs fitted with rock augers will be required to penetrate medium and high strength sandstone.

The reinforced shotcrete panels should be sprayed between the soldier piles progressively with the excavation such that there is no more than 1.0m of fill, or 1.8m of natural soil or weathered rock exposed between the soldier piles at any time. Prior to spraying the shotcrete, vertical lengths of strip drain should be fixed to the excavation face to aid in the

dissipation of pore pressures from behind the shotcrete. The drains must be connected to a sump for appropriate disposal.

Where temporary anchors are used to provide lateral restraint to the shoring, they should have free lengths and bond lengths of at least 4m and 3m respectively. The bond lengths must also be entirely behind a line drawn upward at 1V in 1H from the toe of the shoring. Anchors bonded into sandstone or shale/sandstone of at least low strength may be designed for an allowable bond of 100kPa, while an increased bond of 300kPa may be adopted for sandstone of at least medium strength. The adoption of higher bond values would require the completion of test anchors loaded to failure to show that increased bond values are appropriate.

It will be necessary to obtain permission from neighbouring landowners prior to installing anchors that will extend beyond the perimeter of the site. In addition, care should be taken to avoid damaging buried services, pipes, adjacent basements and other subsurface structures during anchor installation.

The 'Wallap' computer based numerical analyses can model the progressively anchored or propped shoring walls as they are constructed. The suggested design strength and material parameters given in Table 2 may be adopted for contiguous or soldier pile walls to confirm the minimum depth of embedment of the wall toe and the likely order of magnitude of wall movements and bending moments during the various phases of construction.

All appropriate hydrostatic pressures and surcharge loads should be incorporated in the design of the retaining walls. Design surcharge loads on the shoring should take account of any traffic loads, heavy crane loads, hoarding loads and vehicle impact on hoarding structure.

7.2.3 Excavation Conditions

It is understood that excavation for the basement may extend to around 10 m deep, although localised deeper excavations may be required for footings and trenches.

The materials to be excavated will comprise unconsolidated fill and extremely weathered sandstone i.e. Class V rock and more competent good quality sandstone of at least medium strength, i.e. Class III to Class II rock.

All excavated materials will need to be disposed in accordance with current DECC policies. Under the Waste Avoidance and Resource Recovery Act (NSW EPA, 2001) a waste/fill receiving site must be satisfied that materials received meet the environmental criteria for proposed land use. This includes filling and virgin excavated natural materials (VENM), such as may be removed from site. Reference should be made to the Cavvanba Consulting report ref 17066 r01 in Appendix B

7.2.4 Excavatability

The upper unconsolidated soils can be readily excavated using a large hydraulic excavators and the Class V rock may require ripping. The more competent sandstone (i.e. Class III to Class II rock) will be more difficult to excavate and is likely to present hard or heavy ripping or "very hard rock" excavation conditions.

Rippability with heavy tractors will vary according to the number of bedding partings in the rock. Experience shows that some of the material could be ripped with difficulty using a D9 tractor, but the more homogenous zones of sandstone of high strength would present difficult ripping for a D10 or D11 tractor. Excavation contractors must make their own assessment of rippability as this will be a critical factor in the excavation cost.

The alternative to ripping is the use of hydraulic rock hammers fitted to tracked excavators however the noise and vibrations generated using this method is unlikely to be acceptable. If such equipment is to be used, then we recommend that full time vibration monitoring should be set up on any buildings closest to the excavation which is being carried out at any particular time, and the equipment fitted with sirens or visual alarms, so that the contractor ceases work if safe thresholds are exceeded; work should not recommence until the cause of the exceedances has been identified and addressed.

The preferred method for excavation will be the use of a rock saw to cut the sandstone. This is likely to result in significantly reduced vibrations and a better quality face for the basement. In addition, sizeable blocks could be excavated and more easily disposed from resale from the site. An arrangement with a local contractor or stonemason could be established to reuse the blocks for landscaping or heritage structures, and increasing the sustainability of the project. Alternatively, the majority of the site won material from the rock cuttings (moderately to slightly weathered

Sandstone) is likely to be suitable for use as either a general or structural fill but is likely to require processing to meet specifications.

All excavated materials will need to be disposed in accordance with current DECC policies. Under the Waste Avoidance and Resource Recovery Act (NSW EPA, 2001) a waste/fill receiving site must be satisfied that materials received meet the environmental criteria for proposed land use. This includes filling and virgin excavated natural materials (VENM), such as may be removed from site. Reference should be made to the Cavvanba Consulting report ref 17066 r01 in Appendix B. If contamination is encountered, then substantial further testing (and associated delays) should be expected. We strongly recommend that this issue is addressed prior to the commencement of excavation on site.

Regular inspections by engineering geologists/geotechnical engineers are suggested as a means of identifying adversely oriented joints, other rock defects.

Personnel should not enter any confined excavations that are in excess of 1.5 m deep, unless the excavations are appropriately battered or shored.

7.2.5 Batter Slopes

Temporary batters through the extremely weathered sandstone should be cut at no steeper than 1 Vertical (V) in 1 Horizontal (1V in 1H), to a maximum depth of 3m, while batters in the fill should be flattened to no steeper than 1V in 1.5H. It will be necessary to keep surcharge loads well clear of the crests of such batters.

Permanent batters in these soils and weathered rock should be no steeper than 1V in 2H, and the batters should be protected such as with a dense rooted vegetative cover or with shotcrete.

Excavations in medium to high strength sandstone maybe cut vertical, however regular inspections by a experienced engineering geologist or geotechnical every 2m lift is recommended, as localised spot bolting and dentition of seams may be necessary.

It is recommended that batter slopes be inspected by a suitably experienced engineering geologist or geotechnical engineer during construction. Such inspections are of particular importance in areas where works are to be undertaken close to the toe or crest of a batter. The use of rock mesh to reduce the potential for rock fragments to fall on workers below may need to be considered depending on the particular circumstances

7.2.6 Excavation Stability

Maintaining stability of the sides of the deep excavation and of neighbouring properties will be critical for this site. The method of excavation within unconsolidated soils may consider forming the excavation sides at shallow batter slopes or by installation of a rigid retention system such as a soldier or contiguous pile shoring wall, with additional restraint using rock anchors (or internal props).

The shoring system or batters can be formed over both the fill and weathered sandstone sections of low or lesser strengths, i.e. Class V rock.

It is expected that the lower section of good quality sandstone of at least medium strength (Class III to Class II) will be self-supporting, and can be cut near vertical, subject to regular inspections as the excavation progresses.

Adversely oriented defects should be expected to result in some potentially unstable blocks and wedges of sandstone in the cut faces. Therefore excavation faces in the sandstone should be inspected by a geotechnical engineer following each 1.5m vertical lift of excavation to inspect for such defects. If such adversely oriented defects are encountered, then some stabilisation measures will be required. The options for stabilisation may include the following:

- Removal of these potentially unstable blocks, or
- The installation of rock bolts to stabilise these features.

Some treatment of seams by localised excavation and replacement with non-shrink grout may also be required.

There may well be some stabilisation or support works required in both the short and long term. The most likely stabilisation measures which may be required would involve rock bolting with bolt lengths ranging from 3m to 5m being

most probable. A moderate provision for rock bolting and shotcrete and mesh should be included in the Contract Documents for works nominated following the geotechnical inspections.

If extensive weathered seams are found, it may be necessary to provide temporary as well as permanent support in order to maintain safe working conditions; the use of shotcrete together with mesh and rock dowels are the most common means of providing this type of support. In the long term, some treatment of seams or fractured zones may also be necessary and such support may be provided either by means of retaining walls propped from the permanent structure or, in this case, by means of permanent rock bolts which can be accommodated within the site boundaries.

Permanent rock bolts would require appropriate detailing for long term corrosion protection. Design earth pressures for support of weathered and fractured zones by structural means would be determined once the problems could be assessed in the excavation.

Where these batters cannot be accommodated within the site, or where they are not preferred, it will be necessary to install a shoring system prior to commencing excavation.

7.2.7 Stress Relief

Major excavation works will inevitably cause lateral and vertical ground displacements outside of the excavation. Even though the rock is effectively shored at the boundaries, the release of stresses in rock at depth is generally accompanied by lateral movement which can give rise to observed displacement at the boundary. The amount of horizontal movement will diminish along the crest away from the midpoint, and down the excavated face away from the crest. The movement is expected to occur progressively during excavation and should be completed shortly after excavation is complete.

The amount of movement will be a function of the construction practice, earth pressure loads, and rigidity of the walls, and where critical, should be the subject of detailed analysis and modelling. As a preliminary indication, the surface settlement of a well-constructed tied back wall is anticipated to be approximately up to 0.3% H, where H is the depth of excavation, reducing to less than 0.1% H at a distance equal to H behind the excavation. Similarly, lateral displacements (into the excavation) are expected to be up to about 0.3% H at the top of the walls.

If critical, movements could be monitored by the installation of inclinometers or survey pins immediately behind the excavation or within the perimeter soldier piles.

The rock at the base of the excavation may also experience some minor vertical heave rebound (immediate) when the overburden pressure is reduced due to the deep excavation.

7.3 Main Campus and Senior School Foundations

It is considered that the proposed buildings could be supported on spread footings or bored piles. Based on the results of the investigation, we expect sandstone bedrock of medium to high strength (Class III) to be exposed at depths of around 1 mbgl.

7.3.1 Footings

We recommend for uniformity of support that all footings should be founded within sandstone bedrock of at least Class III quality, which contains 3% or less total defects in the stress influence zone of the footing. The total defect thickness is expressed as a percentage of the zone of influence which is taken to be 1.5 times the least footing width. We consider that pad or strip footings are generally suitable for this site.

Footing Design Parameters

Pad or strip footings may also be adopted to reach the Class II rock that is expected at around 2mbgl.

The following allowable bearing pressures (ABP) and shaft adhesions may be adopted for design of footings in the different rock classes of the site:

1. Class V rock: ABP of 1000kPa;
2. Class III rock: ABP of 2500kPa;
3. Class II rock: ABP of 4000kPa.
4. Pile rock socket side adhesion values (in compression) equivalent to 10% of the above ABP values may also be used in the pile footing design.

Footings designed using a maximum allowable bearing pressure (ABP) of 4,000kPa on Class II rock will be subject to a program of spoon testing and/or rock coring to check for defects such as clay seams or low strength bands. Zones of sandstone containing more than 3% allowable defects or having strengths lower than medium to high strength, may be encountered locally and it may be to lower the bearing pressure or excavate further for certain footings pending inspection and testing.

We recommend that all footing excavations be checked and approved prior to concrete being poured. At least 1 in 2 (i.e. 50%) of footing locations should be proved with rock core drilling or spoon tested in jack hammered holes, all taken from foundation level to depths of 1.5 times the footing width or 2.5m, whichever is the lesser, to confirm that no adverse defects are present below the founding levels.

During construction inspections the geotechnical engineer should nominate the testing. The presence of significant defects would require a reduction in allowable bearing capacity or an increase in footing depth.
If the ABP used for design is kept to 2,500kPa or less then the only requirement would be for visual inspection of the foundation rock at the base of footings by the geotechnical engineer, without the necessity of rock core drilling or spoon testing.

All footings should be excavated/drilled, cleaned, inspected and poured with minimal delay, (preferably on the same day as excavation and/or drilling). Water should be prevented from ponding in the base of footing excavations, as this may lead to a softening of the base, particularly in areas of more weathered bedrock. If a delay in pouring is expected, then we recommend a blinding layer of concrete be placed in the base of pad or strip footing excavations.

In accordance with Table 2 of the “Engineering Classification of Shales and Sandstones in the Sydney Region”, as revised by Pells et al 1998 ‘typical’ settlements for footings founded on bedrock with the above allowable bearing pressures would satisfy serviceability considerations; i.e. less than 1% of the minimum footing width.

7.4 Soil Aggressivity

We refer to Table 6.4.2 (c) Exposure Classification for Concrete Piles AS2159 – 2009 'Piling – Design and Installation'.

The soil condition is classified as 'Condition – A'. The test results indicate low levels of sulphates (20.6 ppm), Chlorides (35.5 ppm) and pH (7.8). Therefore we consider the soil at this site is Mild.

7.5 Working Platforms

A suitable granular working platform may be needed to support piling rigs, cranes, ancillary construction plant and the like. Comments on the design, construction and maintenance of working platforms can be addressed once the type of equipment and loads are known.

The existing fill material Unit 1 is not considered to be an engineered fill. The fill material is therefore not considered to be suitable for a working platform.

8. Recommendations

Additional monitoring and pump testing of the groundwater monitoring wells is suggested to better characterise the groundwater regime and additional ground investigation or testing maybe required as the detailed design progresses.

Further testing will be required to classify excavated materials removed from site for the purposes of waste classification and potential reuse.

It will be essential during construction that regular geotechnical inspections and testing be commissioned to check initial assumptions about excavation and foundation conditions and likely variations that may occur between borehole locations and to provide further relevant geotechnical advice. Irregular or 'milestone' inspections by a geotechnical engineer are often not adequate for excavation and foundation works. It is recommended that the Client be made aware of the need to commission a geotechnical engineer for regular frequent inspections.

9. Limitations

This report has been prepared for use of and reliance upon by St Aloysius' College ABN 46 621 313 264 (the Client) in accordance with our Proposal and Brief, and it is not intended for parties other than the Client. No responsibility or liability to any third party will be accepted. Data or opinions contained within the report may not be used in other contexts or for any other purposes without Wood & Grieve Engineers prior review and written agreement.

The opinions and recommendations in this report are based on the interpretation of the available information to meet specific financial and technical requirements of our proposal and brief, this report does not purport to completely describe all the site characteristics, conditions and properties. .

Subsurface conditions are inherently variable and can change significantly over short distances. The conditions have been and continue to be created and changed by natural processes and anthropogenic activity. For example, fill can be placed over time, ground water levels can change, floods can deposit material and materials can move down slope. Because a report is based on conditions that existed at a time of investigation. Decisions should not be made using the advice of a report that may have been affected by the passage of time.

Professional scientific and engineering judgement has been exercised by Wood and Grieve Engineers' qualified staff based on the information available for review, to provide an opinion on the overall site conditions. Actual conditions may vary from those inferred in this report. No professional no matter how qualified can reveal the exact ground conditions of foresee their behaviour. Ground conditions have been created by complex natural and anthropogenic processes, and may continue to change. For instance, boundaries between strata may be gradational, or contacts be more abrupt, unknown faults or palaeochannels (buried valleys) may be present but obscured and groundwater levels can fluctuate over time.

It is strongly recommended that any plans and specifications prepared by others and relating to the content of this report, or amendments to the original plans or specifications, are reviewed by Wood & Grieve Engineers to verify that the intent of our recommendations is properly reflected in the design. During construction or maintenance works Wood and Grieve Engineers request the opportunity to review our interpretations if the exposed site conditions are significantly different from those inferred in this report.

APPENDIX A Macquarie Geotechnical – Report on Geotechnical Investigation

MACQUARIE GEOTECH

Geotechnical Investigation Factual Report

St Aloysius College, Kirribilli – Geotechnical Investigation Factual Report

Job No.: B17550

Submitted to:
Wood & Grieve Engineers
Level 6, Building B,
207 Pacific Highway
St Leonards NSW 2065
Attn: Jonathan Durnell

Report No.: B17550

Wood & Grieve Engineers – St Aloysius College, Kirribilli

REVISION CONTROL

Revision	Date	Details	Prepared By	Reviewed By
00	23.1.2018	Draft	David Clarkson	John Boyle
01	25.1.2018	First Issue	David Clarkson	John Boyle
02	29.1.18	Final Issue	John Boyle	John Boyle

Contents

Tables

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Appendices

1 INTRODUCTION

At the request of Jonathan Durnell from Wood & Grieve Engineers, Macquarie Geotechnical (MG) has carried out a Geotechnical Investigation at St Aloysius College, Kirribilli, NSW 2061.

The objective of the investigation is to characterise the ground and groundwater conditions, develop a ground model, parameters for design purposes and investigate existing foundation conditions at the following sites;

- Junior School – Construction of an underground sports hall
- Senior School - Construction of a new single story classroom structure
- Main Campus – Construction of a new building and repurposing of adjoining structures

The comments and opinions expressed in this report are based on the ground conditions encountered during the site work and on the results of tests carried out in the field and in the laboratory. There may, however, be special conditions prevailing on the site which have not been disclosed by this investigation and which have not been taken into account by this report.

2 SCOPE OF INVESTIGATION

The scope of the ground investigation works comprised the following:

Junior School

- 2 no. rotary cored boreholes.

Senior School

- 2 no. hand excavated trial pits and associated reinstatement.

Main Campus

- 1 no. rotary cored borehole.
- 2 no. hand excavated trial pit and associated reinstatement.
- Rock Mapping

A summary of the borehole and test pits undertaken are presented Table 1 below:

Table 1: Summary of Boreholes and Test Pits

Hole ID	Eastings	Northings	RL	Depth	Structure
BH01	334779.0	6253417.0	-	10.64m	Junior School
BH02	334746.0	6253422.0	-	15.15m	Junior School
BH03	334792.0	6253182.0	-	15.10m	Main Campus
TP01	334792.0	6253247.0	-	0.93m	Senior School
TP02	334798.0	6253256.0	-	0.85m	Senior School
TP03	334758.0	6253178.0	-	0.30m	Main Campus
TP03A	334763.0	6253168.0	-	0.04m	Main Campus

Samples were taken at regular intervals and at change of strata and returned to our NATA accredited laboratory in Bathurst for testing. The soil and rock testing comprised the following:

- Two (2) Sulphate Content AS1289 4.2.1
- Two (2) pH Value AS1289 4.3.1
- Two (2) EC Electrical Conductivity APHA 2510 & 2520-B
- Two (2) Chloride Content RMS T1010
- Thirty Six (36) Point Load Tests AS4133 4.1
- Four (4) Uniaxial Compressive Strength (UCS) AS4133 4.2.2

2.1 Site Description

The project is located at St Aloysius College, Kirribilli, NSW 2061.

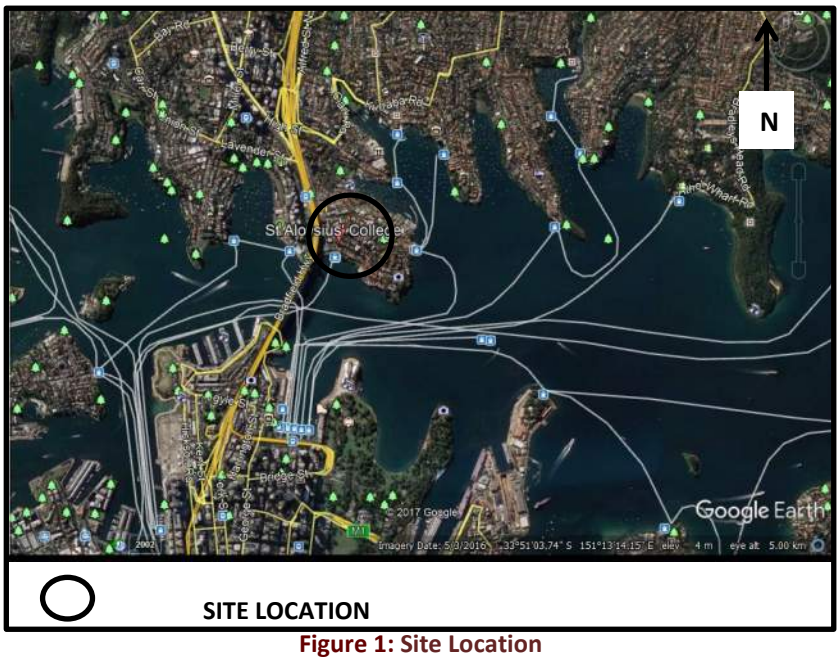

Figure 1: Site Location

2.2 Desk Study

A desk study was undertaken using readily available geological and geotechnical information and included the following:

- Sydney 1:250,000 Geological Sheet SI56-5 3rd edition
- ASRIS/CSIRO
- Google Earth
- NSW Department of Primary Industries – Groundwater Bore Data
- Naturally Occurring Asbestos Hazard Maps

2.3 Regional Geology

The Sydney 1:250,000 Geological Sheet SI56-5 3rd edition is shown in Figure 2 below:

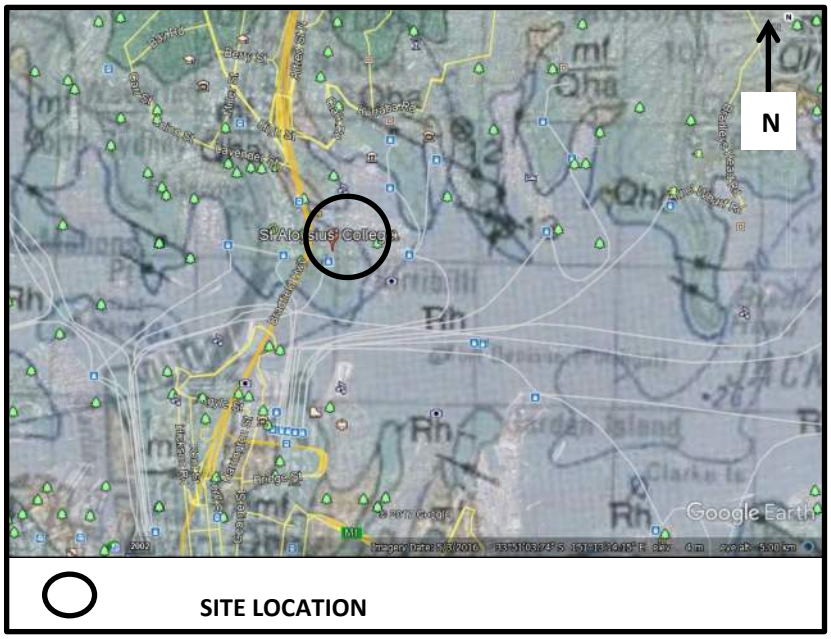

Figure 2: Site Location with Geological Map Overlay

The Sydney 1:250,000 Geological Sheet SI56-5 3rd edition indicates that the site is underlain by Wianamatta Group, Hawkesbury Sandstone – Sandstone, quartz with some shale.

2.3.1 Groundwater Bores

Review of the available groundwater data in close proximity to the site provided the following results:

Table 2: NSW Groundwater Bore Data (GW114492)

Depth (m)	Strata
0.00 – 1.30	CLAY (FILL)
1.30 – 10.00	SANDSTONE

Table 3: NSW Groundwater Bore Data (GW114494)

Depth (m)	Strata
0.00 – 0.40	SAND (FILL)
0.40 – 0.90	CLAY (FILL)
0.90 – 10.00	SANDSTONE

Table 4: NSW Groundwater Bore Data (GW114493)

Depth (m)	Strata
0.00 – 0.30	SAND (FILL)
0.30 – 0.80	CLAY (FILL)
0.80 – 10.00	SANDSTONE

2.3.2 Acid Sulphate Maps

Reference is made to the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Atlas of Australian Acid Sulphate Soils and presented in Figure 3 below:

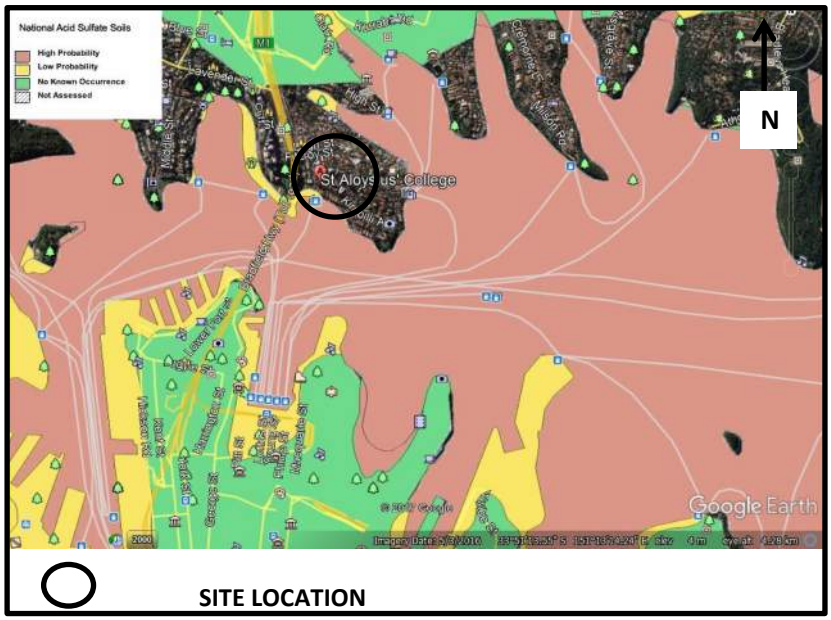

Figure 3: Site Location with Acid Sulphate Map Overlay

2.3.3 Naturally Occuring Asbestos Maps

Reference is made to the NSW Department of Primary Industry Naturally Occurring Asbestos Hazard Maps and presented in Figure 4 below:

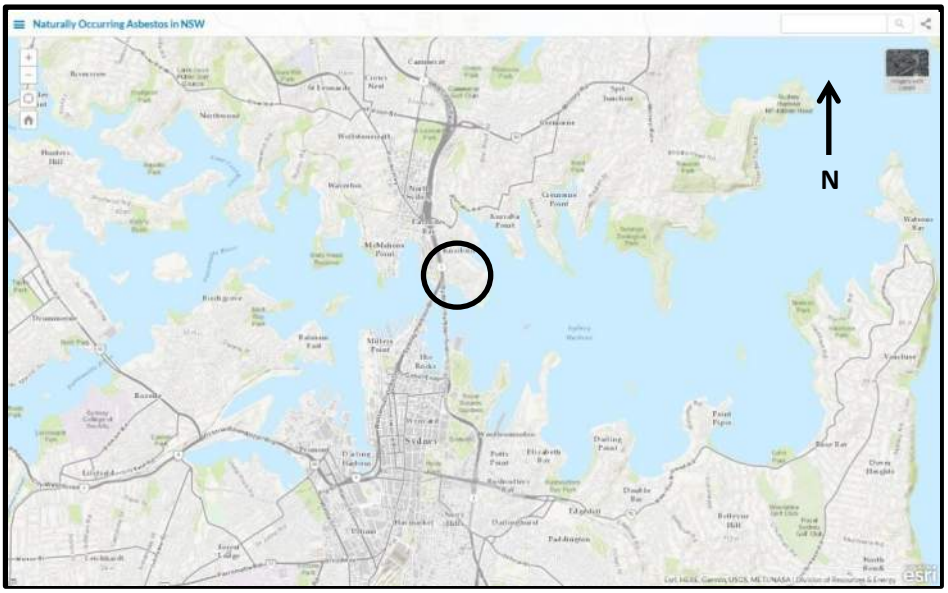

Figure 4: Naturally Occuring Asbestos Hazard Map

2.3.4 Topography

Each site of the separate schools are relatively flat areas, the overall surface topography between sites slopes to the south with elevation ranging from 35m to 11m.

2.4 Fieldwork

Fieldwork was undertaken from 7th December 2017 to 16th January 2018. The fieldwork was undertaken in accordance with our proposal dated 11th October 2017 and AS1726 Geotechnical Site Investigation.

2.4.1 Service Location

Macquarie Geotechnical obtained underground services and utility plans through 'Dial Before You Dig (DBYD)' services, and engaged Sure Search service locating to identify underground services.

2.4.2 Boreholes and Test Pits

The boreholes and test pits were undertaken at locations nominated by Wood & Grieve Engineers and are summarised in Table 1. The boreholes and test pits were backfilled with arisings on completion.

The borehole and test pit logs are presented in Appendix C.

2.5 Sampling

The sampling was undertaken in accordance with AS1289 1.2.1 and considered the engineering requirements of the investigation including the nature of the materials encountered.

2.6 In Situ Testing

Standard Penetration Tests (SPT) was carried out in borehole BH02 in order to determine the relative density and consistency of the strata encountered. The numbers of blows per 450mm penetration were recorded. The results are presented on the BH02 exploratory hole log in Appendix C.

2.7 Groundwater Monitoring

Groundwater monitoring was undertaken at weekly intervals for a period of 4 weeks.

2.8 Laboratory Testing

The samples were returned to Macquarie Geotechnical NATA accredited laboratory at Bathurst for further assessment and testing. A summary of the soil and rock laboratory tests are provided in Tables 5 and 6 below:

Table 5: Summary of Soil Laboratory Tests

Hole ID	Depth (m)	Laboratory Test
BH01	0.5-1.0	Sulphate Content AS1289 4.2.1
		pH Value AS1289 4.3.1
		Chloride Content RMS T1010
		Electrical Conductivity APHA 2510 & 2520-B
BH02	1.0-1.5	Sulphate Content AS1289 4.2.1
		pH Value AS1289 4.3.1
		Chloride Content RMS T1010
		Electrical Conductivity APHA 2510 & 2520-B

Table 6: Summary of Rock Laboratory Tests

Hole ID	Depth (m)	Laboratory Test
BH01	1.2	Point Load Tests AS4133 4.1
	2.35-2.48	Uniaxial Compressive Strength (UCS) AS4133 4.2.2
	3.4	Point Load Tests AS4133 4.1
	5.2	Point Load Tests AS4133 4.1
	7.4	Point Load Tests AS4133 4.1
	9.9	Point Load Tests AS4133 4.1
BH02	3.2	Point Load Tests AS4133 4.1
	5.4	Point Load Tests AS4133 4.1
	6.00-6.13	Uniaxial Compressive Strength (UCS) AS4133 4.2.2
	7.2	Point Load Tests AS4133 4.1
	9.2	Point Load Tests AS4133 4.1
	11.2	Point Load Tests AS4133 4.1
	13.2	Point Load Tests AS4133 4.1
BH03	1.5	Point Load Tests AS4133 4.1
	3.5	Point Load Tests AS4133 4.1
	5.2	Point Load Tests AS4133 4.1
	7.4	Point Load Tests AS4133 4.1
	8.15-8.28	Uniaxial Compressive Strength (UCS) AS4133 4.2.2
	9.4	Point Load Tests AS4133 4.1
	11.2	Point Load Tests AS4133 4.1
	13.4	Point Load Tests AS4133 4.1
	14.8-14.95	Uniaxial Compressive Strength (UCS) AS4133 4.2.2

3 EXISTING SUBSURFACE CONDITIONS

The subsurface conditions encountered in the boreholes and hand dug test pits are presented in detail in the borehole and test pit logs (refer Appendix C).

3.1 Exploratory Hole Summary

The subsurface conditions encountered in the boreholes and hand dug test pits are broadly summarised in Table 7 below:

Table 7: Exploratory Hole Summary

Material Description	BH01	BH02	BH03	TP01	TP02	TP03	TP03A
Concrete	0.00 - 0.10	0.00 - 0.10	0.00 – 0.08	-	-	-	0.00 – 0.04
Bricks (Paving)	-	-	-	0.00 – 0.05	0.00 – 0.05	-	-
Sand (Fill)	-	-	-	0.05 – 0.10	0.05 – 0.10	-	-
Sandy GRAVEL (Fill)	0.10 - 0.40	0.10 - 0.50	-	-	-	0.00 – 0.30	-
Gravelly SAND (Fill)	-	0.50 - 1.75	-	0.10 – 0.75	0.10 – 0.18	-	-
Clayey SAND (Fill)	-	-	0.08 – 0.80	-	0.18 – 0.55	-	-
Gravel (Fill)	-	-	-	0.75 – 1.10	0.55 – 0.85	-	-
Gravelly CLAY (RS)	-	1.75 – 1.90	-	-	-	-	-
Gravelly SAND (EW)	0.40 - 1.10	-	-	-	-	-	-
SAND (EW)	-	1.90 – 2.60	0.80 – 1.30	-	-	-	-
Sandy CLAY (MW)	-	2.60 – 2.85	-	-	-	-	-
SANDSTONE (MW-SW)	1.10 – 1.70 2.30 – 10.64	2.85 – 15.15	1.30 – 15.10	1.10	0.85	-	-
SILTSTONE (MW-SW)	1.70 – 2.30	-	-	-	-	-	-
Test Termination Depth (m)	10.64 (LOI)	15.15 (LOI)	15.10 (LOI)	1.10 (LOI)	0.85 (LOI)	0.30 (R)	0.04 (R)
Free Groundwater Observation (m)	3.9	2.6 3.9	NFGWO	NFGWO	NFGWO	NFGWO	NFGWO

Note: RS – Residual Soil. EW – Extremely Weathered. MW – Moderately Weathered. SW – Slightly Weathered.
LOI – Limit of Investigation.
NFGWO – No Free Ground Water Observed.

3.2 Rock Mapping

Rock mapping was undertaken on an exposure of the Hawkesbury Sandstone at the Main Campus. The exposure generally comprised of massive Sandstone, medium to coarse grained, medium to high strength with moderately to widely spaced defects, horizontal to sub-horizontal. The Rock Mass Rating (RMR) for the Sandstone is considered to be Class II, fair to good rock. Local rock support was noted to be present at the exposure.

3.3 Groundwater

The comments on groundwater are based on the observations made at the time of the investigation. Groundwater was observed in Borehole BH01 at 3.9m depth and various discrete inflows were also noted in BH02 within the sandstone bedrock. Groundwater was also observed at 2.6m depth (soil / bedrock interface) and at 3.9m depth within the sandstone bedrock. No groundwater was observed in Borehole BH03 or at the hand dug test pits.

It is possible that elevated groundwater levels during wet periods may occur. It is likely that any high groundwater would be encountered at the soil-bedrock interface, or within fractures and discontinuities of the sandstone.

Due to the drilling techniques utilised it is possible that this could have masked the discrete ingress of natural groundwater into the borehole.

Seasonal variation in ground water may be encountered and should be considered as part of the design process.

Table 8: Groundwater Well Level

		Water Level (mbgl)			
Groundwater Well	**04/01/2018**	**09/01/2018**	**15/01/2018***	**16/01/2018****	**23/01/2018**
BH01 MW	3.65	3.64	3.54	4.72	4.20
BH02 MW	5.30	5.23	5.20	4.18	Obstructed
BH03 MW	-	-	1.91	6.43	1.08

*Monitoring of groundwater by Cavvanba.
**Recharging following groundwater sampling by Cavvanba.

4 LABORATORY TEST RESULTS

A summary of soil laboratory test results are shown in Table 9 below.

Table 9: Soil Laboratory Test Results

Hole ID	Depth (m)	Sample Description	Soil Chemical Properties (SCP)			
			pH	SO_4 (ppm)	Cl (ppm)	Electrical Conductivity (uS/cm)
BH01	0.5-1.0	Silty SAND with Gravel	5.7	18.5	35.5	71.4
BH02	1.0-1.5	Silty SAND with Gravel	7.8	20.6	35.5	122.0

Note: SO_4 – Sulphate, Cl – Chloride.

A summary of rock laboratory test results are shown in Tables 10 and 11 below:

Table 10: Rock Laboratory Test Results – Point Load Index

Hole ID	Depth (m)	Sample Description	Weathering	Test Type	Point Load Index $Is_{(50)}$ (MPa)
BH01	1.2	SANDSTONE	SW	Diametral	1.32
	1.2	SANDSTONE	SW	Axial	1.53
	3.4	SANDSTONE	SW	Diametral	1.32
	3.4	SANDSTONE	SW	Axial	1.96
	5.2	SANDSTONE	SW	Diametral	2.60
	5.2	SANDSTONE	SW	Axial	5.50
	7.4	SANDSTONE	SW	Diametral	2.64
	7.4	SANDSTONE	SW	Axial	2.50
	9.9	SANDSTONE	SW	Diametral	2.42
	9.9	SANDSTONE	SW	Axial	3.37
BH02	3.2	SANDSTONE	SW	Diametral	1.73
	3.2	SANDSTONE	SW	Axial	2.27
	5.4	SANDSTONE	SW	Diametral	1.76
	5.4	SANDSTONE	SW	Axial	2.04
	7.2	SANDSTONE	SW	Diametral	1.79
	7.2	SANDSTONE	SW	Axial	3.36
	9.2	SANDSTONE	SW	Diametral	2.22
	9.2	SANDSTONE	SW	Axial	2.13
	11.2	SANDSTONE	SW	Diametral	2.05
	11.2	SANDSTONE	SW	Axial	2.20
	13.2	SANDSTONE	SW	Diametral	2.13
	13.2	SANDSTONE	SW	Axial	1.90

Table 10: Rock Laboratory Test Results – Point Load Index (Cntd)

Hole ID	Depth (m)	Sample Description	Weathering	Test Type	Point Load Index $Is_{(50)}$ (MPa)
BH03	1.5	SANDSTONE	SW-MW	Diametral	1.54
	1.5	SANDSTONE	SW-MW	Axial	2.05
	3.5	SANDSTONE	SW-MW	Diametral	1.32
	3.5	SANDSTONE	SW-MW	Axial	1.44
	5.2	SANDSTONE	SW	Diametral	1.76
	5.2	SANDSTONE	SW	Axial	2.16
	7.4	SANDSTONE	SW	Diametral	1.76
	7.4	SANDSTONE	SW	Axial	2.23
	9.4	SANDSTONE	SW	Diametral	1.67
	9.4	SANDSTONE	SW	Axial	2.24
	11.2	SANDSTONE	SW	Diametral	1.51
	11.2	SANDSTONE	SW	Axial	2.77
	13.4	SANDSTONE	SW	Diametral	1.32
	13.4	SANDSTONE	SW	Axial	2.23

Table 11: Rock Laboratory Test Results – Uniaxial Compressive Strength

Hole ID	Depth (m)	Sample Description	Weathering	Uniaxial Compressive Strength (MPa)
BH01	2.35-2.48	SANDSTONE	SW	15.1
BH02	6.00-6.13	SANDSTONE	SW	25.1
BH03	8.15-8.28	SANDSTONE	SW	18.6
BH03	14.8-14.95	SANDSTONE	SW	17.4

5 CONCLUSION

The findings of this report were based on our fieldwork, in-situ and laboratory testing for this site.

We trust the foregoing is sufficient for your present purposes, and if you have any questions please contact the undersigned.

David Clarkson
Senior Geotechnical Engineer
BEng MSc MIEAust

John Boyle
Geotechnical Manager
BSc (Hons) MEngSc (Geotechnical) Affil MIE Aust

LIMITATIONS OF GEOTECHNICAL SITE INVESTIGATION

Scope of Services

This report has been prepared for the Client in accordance with the Services Engagement Form (SEF), between the Client and Macquarie Geotechnical.

Reliance on Data

Macquarie Geotechnical has relied upon data and other information provided by the Client and other individuals. Macquarie Geotechnical has not verified the accuracy or completeness of the data, except as otherwise stated in the report. Recommendations in the report are based on the data.

Macquarie Geotechnical will not be liable in relation to incorrect recommendations should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed.

Geotechnical Investigation

Findings of Geotechnical Investigations are based extensively on judgment and experience. Geotechnical reports are prepared to meet the specific needs of individual clients. This report was prepared expressly for the Client and expressly for the Clients purposes.

This report is based on a subsurface investigation, which was designed for project-specific factors. Unless further geotechnical advice is obtained this report cannot be applied to an adjacent site nor can it be used when the nature of any proposed development is changed.

Limitations of Site investigation

As a result of the limited number of sub-surface excavations or boreholes there is the possibility that variations may occur between test locations. The investigation undertaken is an estimate of the general profile of the subsurface conditions. The data derived from the investigation and laboratory testing are extrapolated across the site to form a geological model. This geological model infers the subsurface conditions and their likely behavior with regard to the proposed development.

The actual conditions at the site might differ from those inferred to exist.

No subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

Time Dependence

This report is based on conditions, which existed at the time of subsurface exploration. Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report.

Macquarie Geotechnical should be kept appraised of any such events, and should be consulted for further geotechnical advice if any changes are noted.

Avoid Misinterpretation

A geotechnical engineer or engineering geologist should be retained to work with other design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

No part of this report should be separated from the Final Report.

Sub-surface Logs

Sub-surface logs are developed by geoscientific professionals based upon their interpretation of field logs and laboratory evaluation of field samples. These logs should not under any circumstances be redrawn for inclusion in any drawings.

Geotechnical Involvement During Construction

During construction, excavation frequently exposes subsurface conditions. Geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendations and should make their own enquiries and obtain independent advice in relation to such matters

Macquarie Geotechnical assumes no responsibility and will not be liable to any other person or organisations for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisations arising from matters dealt with or conclusions expressed in the report.

Other limitations

Macquarie Geotechnical will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Other Information

For further information reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, 1987.

Appendix A – Geotechnical Explanatory Notes

MACQUARIE GEOTECH

Geotechnical Explanatory Notes

Soil Description

In engineering terms soil includes every type of uncemented or partially cemented inorganic material found in the ground. In practice, if the material can be remoulded by hand in its field condition or in water it is described as a soil. The dominant soil constituent is given in capital letters, with secondary textures in lower case. The dominant feature is assessed from the Unified Soil Classification system and a soil symbol is used to define a soil layer as follows:

UNIFIED SOIL CLASSIFICATION

The appropriate symbols are selected on the result of visual examination, field tests and available laboratory tests, such as, sieve analysis, liquid limit and plasticity index.

USC Symbol	Description
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand
ML	Silt of low plasticity
CL	Clay of low plasticity
OL	Organic soil of low plasticity
MH	Silt of high plasticity
CH	Clay of high plasticity
OH	Organic soil of high plasticity
Pt	Peaty Soil

MOISTURE CONDITION

Dry – Cohesive soils are friable or powdery
Cohesionless soil grains are free-running

Moist – Soil feels cool, darkened in colour
Cohesive soils can be moulded
Cohesionless soil grains tend to adhere

Wet – Cohesive soils usually weakened
Free water forms on hands when handling

For cohesive soils the following codes may also be used:

MC>PL Moisture Content greater than the Plastic Limit.
MC~PL Moisture Content near the Plastic Limit.
MC<PL Moisture Content less than the Plastic Limit.

PLASTICITY

The potential for soil to undergo change in volume with moisture change is assessed from its degree of plasticity. The classification of the degree of plasticity in terms of the Liquid Limit (LL) is as follows:

Description of Plasticity	LL (%)
Low	<35
Medium	35 to 50
High	>50

COHESIVE SOILS – CONSISTENCY

The consistency of a cohesive soil is defined by descriptive terminology such as very soft, soft, firm, stiff, very stiff and hard. These terms are assessed by the shear strength of the soil as observed visually, by the pocket penetrometer values and by resistance to deformation to hand moulding.

A Pocket Penetrometer may be used in the field or the laboratory to provide approximate assessment of unconfined compressive strength of cohesive soils. The values are recorded in kPa, as follows:

Strength	Symbol	Pocket Penetrometer Reading (kPa)
Very Soft	VS	< 25
Soft	S	20 to 50
Firm	F	50 to 100
Stiff	St	100 to 200
Very Stiff	VSt	200 to 400
Hard	H	> 400

MACQUARIE GEOTECH

COHESIONLESS SOILS – RELATIVE DENSITY

Relative density terms such as very loose, loose, medium, dense and very dense are used to describe silty and sandy material, and these are usually based on resistance to drilling penetration or the Standard Penetration Test (SPT) 'N' values. Other condition terms, such as friable, powdery or crumbly may also be used.

The Standard Penetration Test (SPT) is carried out in accordance with AS 1289, 6.3.1. For completed tests the number of blows required to drive the split spoon sampler 300 mm are recorded as the N value. For incomplete tests the number of blows and the penetration beyond the seating depth of 150 mm are recorded. If the 150 mm seating penetration is not achieved the number of blows to achieve the measured penetration is recorded. SPT correlations may be subject to corrections for overburden pressure and equipment type.

Term	Symbol	Density Index	N Value (blows/0.3 m)
Very Loose	VL	0 to 15	0 to 4
Loose	L	15 to 35	4 to 10
Medium Dense	MD	35 to 65	10 to 30
Dense	D	65 to 85	30 to 50
Very Dense	VD	>85	>50

COHESIONLESS SOILS PARTICLE SIZE DESCRIPTIVE TERMS

Name	Subdivision	Size
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μm to 2.36 mm
	medium	200 μm to 600 μm
	fine	75 μm to 200 μm

Rock Description

The rock is described with strength and weathering symbols as shown below. Other features such as bedding and dip angle are given.

ROCK QUALITY

The fracture spacing is shown where applicable and the Rock Quality Designation (RQD) or Total Core Recovery (TCR) is given where:

$$\text{RQD (\%)} = \frac{\text{Sum of Axial lengths of core > 100mm long}}{\text{total length considered}}$$

$$\text{TCR (\%)} = \frac{\text{length of core recovered}}{\text{length of core run}}$$

ROCK STRENGTH

Rock strength is described using AS1726 and ISRM – Commission on Standardisation of Laboratory and Field Tests, "Suggested method of determining the Uniaxial Compressive Strength of Rock materials and the Point Load Index", as follows:

Term	Symbol	Point Load Index $Is_{(50)}$ (MPa)
Extremely Low	EL	<0.03
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	H	1 to 3
Very High	VH	3 to 10
Extremely High	EH	>10

ROCK MATERIAL WEATHERING

Rock weathering is described using the following abbreviation and definitions used in AS1726:

Abbreviation	Term
RS	Residual soil
XW	Extremely weathered
DW	Distinctly weathered
SW	Slightly weathered
FR	Fresh

MACQUARIE GEOTECH

DEFECT SPACING/BEDDING THICKNESS

Measured at right angles to defects of same set or bedding.

Term	Defect Spacing	Bedding
Extremely closely spaced	<6 mm	Thinly Laminated
	6 to 20 mm	Laminated
Very closely spaced	20 to 60 mm	Very Thin
Closely spaced	0.06 to 0.2 m	Thin
Moderately widely spaced	0.2 to 0.6 m	Medium
Widely spaced	0.6 to 2 m	Thick
Very widely spaced	>2 m	Very Thick

DEFECT DESCRIPTION

Type:	Description
B	Bedding
F	Fault
C	Cleavage
J	Joint
S	Shear Zone
D	Drill break

Planarity/Roughness:

Class	Description
I	rough or irregular, stepped
II	smooth, stepped
III	slickensided, stepped
IV	rough or irregular, undulating
V	smooth, undulating
VI	slickensided, undulating
VII	rough or irregular, planar
VIII	smooth, planar
IX	slickensided, planar

The inclination if defects are measured from perpendicular to the core axis.

WATER


Water level at date shown


Partial water loss


Water inflow


Complete water loss

Groundwater not observed: The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

Groundwater not encountered: The borehole/test pit was dry soon after excavation, however groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

MACQUARIE GEOTECH

Graphic Symbols for Soils and Rocks

Typical symbols for soils and rocks are as follows. Combinations of these symbols may be used to indicated mixed materials such as clayey sand.

Soil Symbols

Main components


CLAY - CL


CLAY - CH


SAND


GRAVEL


BOULDERS / COBBLES


TOPSOIL


SILT

Minor Components


Clayey


Silty


Sandy


Gravelly

Other


FILL


BITUMEN


CONCRETE

Rock Symbols

Sedimentary Rocks


SANDSTONE


SILTSTONE


CLAYSTONE, MUDSTONE


SHALE


LAMINITE


ASPHALT


LIMESTONE


CONGLOMERATE

Igneous Rocks


GRANITE


BASALT


UNDIFFERENTIATED IGNEOUS

Metamorphic Rocks


SLATE, PHYLLITE, SCHIST


GNEISS

QUARTZITE

MACQUARIE GEOTECH

Engineering Classification of Shales and Sandstones in the Sydney Region – A Summary Guide

The Sydney Rock Class classification system is based on rock strength, defect spacing and allowable seams as set out below. All three factors must be satisfied.

CLASSIFICATION FOR SANDSTONE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)
I	>24	>600	<1.5
II	>12	>600	<3
III	>7	>200	<5
IV	>2	>60	<10
V	>1	N.A.	N.A.

CLASSIFICATION FOR SHALE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)
I	>16	>600	<2
II	>7	>200	<4
III	>2	>60	<8
IV	>1	>20	<25
V	>1	N.A.	N.A.

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UNIAXIAL COMPRESSIVE STRENGTH (UCS)

For expedience in field/construction situations the uniaxial (unconfined) compressive strength of the rock is often inferred, or assessed using the point load strength index (Is_{50}) test (AS 4133.4.1 – 1993). For Sydney Basin sedimentary rocks the uniaxial compressive strength is typically about 20 x (Is_{50}) but the multiplier may range from about 10 to 30 depending on the rock type and characteristics. In the absence of UCS tests, the assigned Sydney Rock Class classification may therefore include rock strengths outside the nominated UCS range.

DEFECT SPACING

The terms relate to spacing of natural fractures in NMLC, NQ and HQ diamond drill cores and have the following definitions:

Defect Spacing (mm)	Terms Used to Describe Defect Spacing[1]
>2000	Very widely spaced
600 – 2000	Widely spaced
200 – 600	Moderately spaced
60 – 200	Closely spaced
20 – 60	Very closely spaced
<20	Extremely closely spaced

[1]After ISO/CD14689 and ISRM.

ALLOWABLE SEAMS

Seams include clay, fragmented, highly weathered or similar zones, usually sub-parallel to the loaded surface. The limits suggested in the tables relate to a defined zone of influence. For pad footings, the zone of influence is defined as 1.5 times the least footing dimension. For socketed footings, the zone includes the length of the socket plus a further depth equal to the width of the footing. For tunnel or excavation assessment purposes the defects are assessed over a length of core of similar characteristics.

Source: Based on Pells et al (1978), as revised by Pells et al (1998).
Pells, P.J.N, Mostyn, G. and Walker, B.F. – Foundations on Sandstone and Shale in the Sydney Region. Australian Geomechanics Journal, No 33 Part 3, December 1998.

MACQUARIE GEOTECH

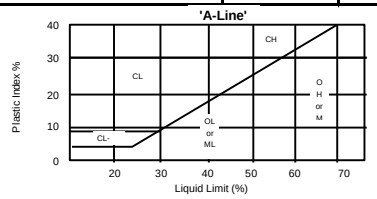
Summary of Soil Logging Procedures

Coarse Material: grain size - colour - particle shape - secondary components - minor constituents - moisture condition - relative density - origin - additional observations.

Fine Material: plasticity - colour - secondary components - minor constituents - moisture w.r.t. plasticity - consistency - origin - additional observations.

Guide to the Description, Identification and Classification of Soils

Major Divisions				SYMBOL	Typical Names
> 200mm		BOULDERS			
60 to 200mm		COBBLES			
COARSE GRAINED SOILS	More than 50% by dry mass less than 60mm is greater that 0.076mm	GRAVEL	More than 50% of coarse fraction > 2.36mm	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels.
		Gravelly Soils		GM	Silty gravels, gravel-sand-silt mixtures.
				GC	Clayey gravels, gravel-sand-clay mixtures
		SANDS	More than 50% of coarse fraction < 2.36mm	SW	Well-graded sands, gravelly sands, little or no fines.
				SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
		Sandy Soils		SM	Silty sands, sand-silt mixtures.
				SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	More than 50% by dry mass less than 60mm is less than 0.076mm	Liquid Limit < 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
				OL	Organic silts and organic silty clays of low plasticity.
		Liquid Limit > 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
				CH	Inorganic clays of high plasticity, fat clays.
				OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS				Pt	Peat and other highly organic soils.



Grain sizes			
Gravel		Sand	
Coarse -	63 to 20mm	Coarse -	2.36 to 0.6mm
Medium -	20 to 6 mm	Medium -	0.6 to 0.2mm
Fine -	6 to 2.36mm	Fine -	0.2 to 0.075mm

GEOLOGICAL ORIGIN:-

Fill - artificial soils / deposits
Alluvial - soils deposited by the action of water
Aeolian - soils deposited by the action of wind
Topsoil - soils supporting plant life containing significant organic content
Residual - soils derived from insitu weathering of parent rock.
Colluvial - transported debris usually unsorted, loose and deposited

Field Identification of Fine Grained Soils - Silt or Clay?

Dry Strength - Allow the soil to dry completely and then test its strength by breaking and crumbling between the fingers.
High dry strength - Clays; Very slight dry strength - Silts.

Toughness Test - the soil is rolled by hand into a thread about 3mm in diameter. The thread is then folded and re-rolled repeatedly until it has dried sufficiently to break into lumps. In this condition inorganic clays are fairly stiff and tough while inorganic silts produce a weak and often soft thread which may be difficult to form and readily breaks and crumbles.

Dilatancy Test - Add sufficient water to the soil, held in the palm of the hand, to make it soft but not sticky. Shake horizontally, striking vigorously against the other hand several times. Dilatancy is indicated by the appearance of a shiny film on the surface of the soil. If the soil is then squeezed or pressed with the fingers, the surface becomes dull as the soil stiffens and eventually crumbles. These reactions are pronounced only for predominantly silt size material. Plastic clays give no reaction.

Descriptive Terms for Material Portions

COARSE GRAINED SOILS		FINE GRAINED SOILS	
% Fines	*Term/Modifier*	*% Coarse*	*Term/Modifier*
< 5	Omit, or use "trace"	< 15	Omit, or use "trace"
> 5, < 12	"with clay/silt" as applicable	> 15, < 30	"with sand/gravel" as applicable
> 12	Prefix soil as "silty/clayey"	> 30	Prefix as "sandy/gravelly"

Moisture Condition

for non-cohesive soils:

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.

for cohesive soils:

MC > PL	Moisture content estimated to be greater than the plastic limit.
MC ~ PL	Moisture content estimated to be approximately equal to the plastic limit. The soil can be moulded
MC < PL	Moisture content estimated to be less than the plastic limit. The soil is hard and friable, or powdery.

The plastic limit (PL) is defined as the moisture content (percentage) at which the soil crumbles when rolled into threads of 3mm dia.

Consistency - For Clays & Silts

Description	*UCS(kPa)*	*Field guide to consistency*
Very soft	< 25	Exudes between the fingers when squeezed in hand
Soft	25 - 50	Can be moulded by light finger pressure
Firm	50 - 100	Can be moulded by strong finger pressure
Stiff	100 - 200	Cannot be moulded by fingers. Can be indented by thumb.
Very stiff	200 - 400	Can be indented by thumb nail
Hard	> 400	Can be indented with difficulty by thumb nail
Friable	-	Crumbles or powders when scraped by thumbnail

Relative Density for Gravels and Sands

Description	*SPT "N" Value*	*Density Index (ID) Range %*
Very loose	0 - 4	< 15
Loose	4 - 10	15 - 35
Medium dense	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very dense	> 50	> 85

MACQUARIE GEOTECH

Summary of Rock Logging Procedures

Description order: constituents - rock name - grain size - colour - weathering - strength - minor constituents - additional observations.

· minor constituents - moisture w.r.t. plasticity - consistency - origin - additional observations.

Definition - Sedimentary Rock

Conglomerate	more than 50% of the rock consists of gravel (>2mm) sized fragments
Sandstone	more than 50% of the rock consists of sand (0.06 to 2mm) sized grains
Siltstone	more than 50% of the rock consists of silt sized granular particles and the rock is not laminated
Claystone	more than 50% of the rock consists of clay or mica material and the rock is not laminated
Shale	more than 50% of the rock consists of clay or silt sized particles and the rock is laminated

Weathering

Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a change in volume but the soil has not significantly transported.
Extremely Weathered	EW	Rock is weathered to such an extent that it has 'soil' properties; ie. it either disintegrates or can be remoulded, in water
Distinctly Weathered	DW	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.
Slightly Weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition or staining.

Stratification

thinly laminated	<6mm	medium bedded	0.2 - 0.6m
laminated	6 - 20mm	thickly bedded	0.6 - 2m
very thinly bedded	20 - 60mm	very thickly bedded	>2m
thinly bedded	60mm - 0.2m		

Discontinuities

order of description: depth - type - orientation - spacing - roughness / planarity - thickness - coating

	Type	Class	Roughness/Planarity	Class	Roughness/Planarity
B	Bedding	I	rough or irregular, stepped	VI	slickensided, undulating
F	Fault	II	smooth, stepped	VII	rough or irregular, planar
C	Cleavage	III	slickensided, stepped	VIII	smooth, planar
J	Joint	IV	rough or irregular, undulating	IX	slickensided, planar
S	Shear Zone	V	smooth, undulating		
D	Drill break				

Rock Strength

Term		Is (50)	Field Guide
Extremely Low	EL		Easily remoulded by hand to a material with soil properties.
		0.03	
Very low	VL		May be crumbled in the hand. Sandstone is "sugary" and friable
		0.1	
Low	L		A piece of core 150 mm long x 50 mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
		0.3	
Medium	M		A piece of core 150 mm long x 50 mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.
		1	
High	H		A piece of core 150 mm long x 50 mm dia. core cannot be broken by unaided hands, can be slightly scratched or scored with knife.
		3	
Very High	VH		A piece of core 150 mm long x 50 mm dia. May be broken readily with hand held hammer. Cannot be scratched with pen knife.
		10	
Extremely High	EH		A piece of core 150 mm long x 50 mm dia. Is difficult to break with hand held hammer. Rings when struck with a hammer.

* - rock strength defined by point load strength (Is 50) in direction normal to bedding

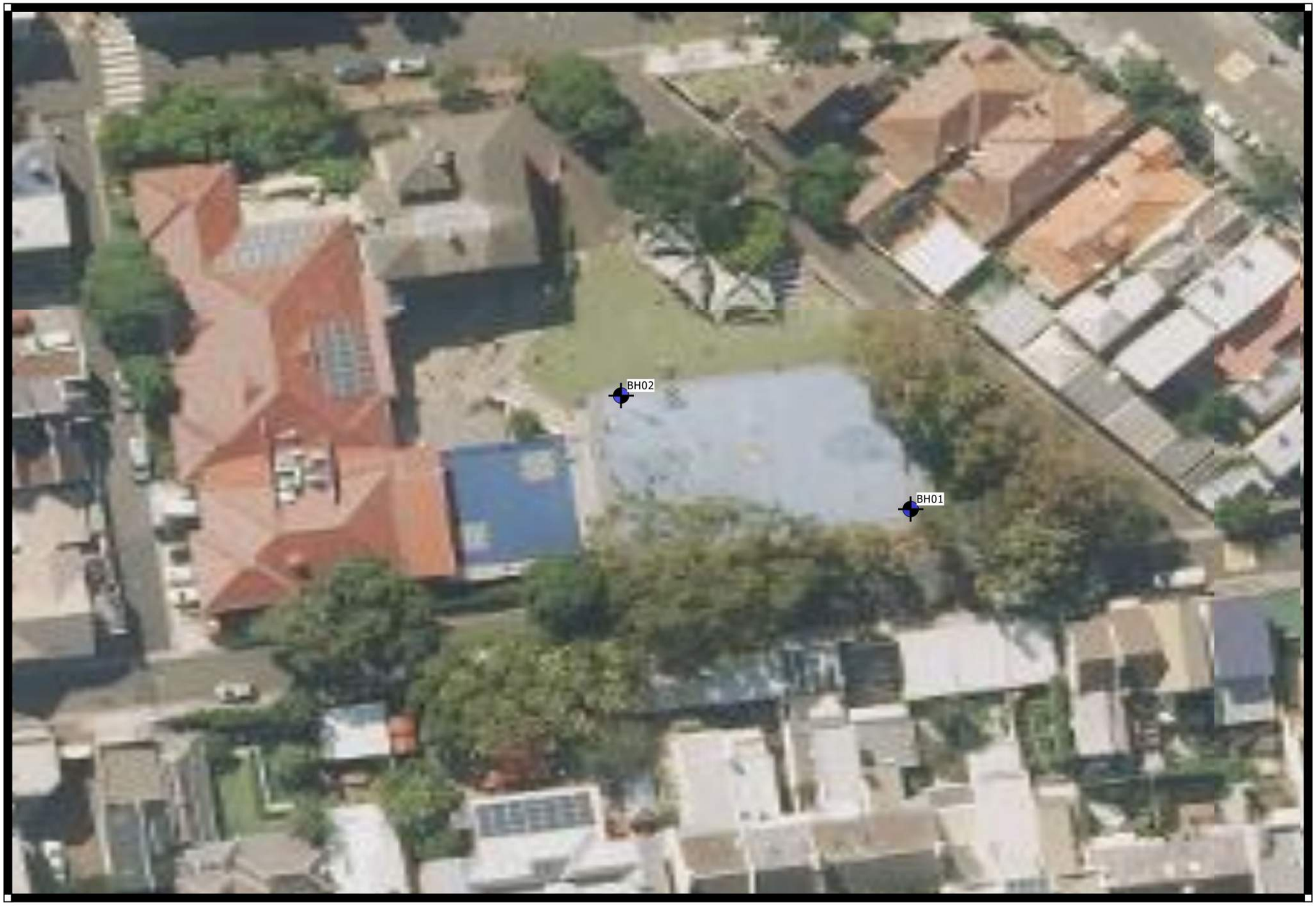
Degree of fracturing

fragmented	The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than the core diameter
highly fractured	Core lengths are generally less than 20mm - 40mm with occasional fragments.
fractured	Core lengths are mainly 30mm - 100mm with occasional shorter and longer lengths
slightly fractured	Core lengths are generally 300mm - 1000mm with occasional longer sections and shorter sections of 100mm -- 300mm.
unbroken	The core does not contain any fracture.

- spacing of all types of natural fractures, but not artificial breaks, in cored bores.

The fracture spacing is shown where applicable and the Rock Quality Designation is given by: RQD (%) = sum of unbroken core pieces 100 mm or longer

Appendix B – Site Plan & Borehole Locations



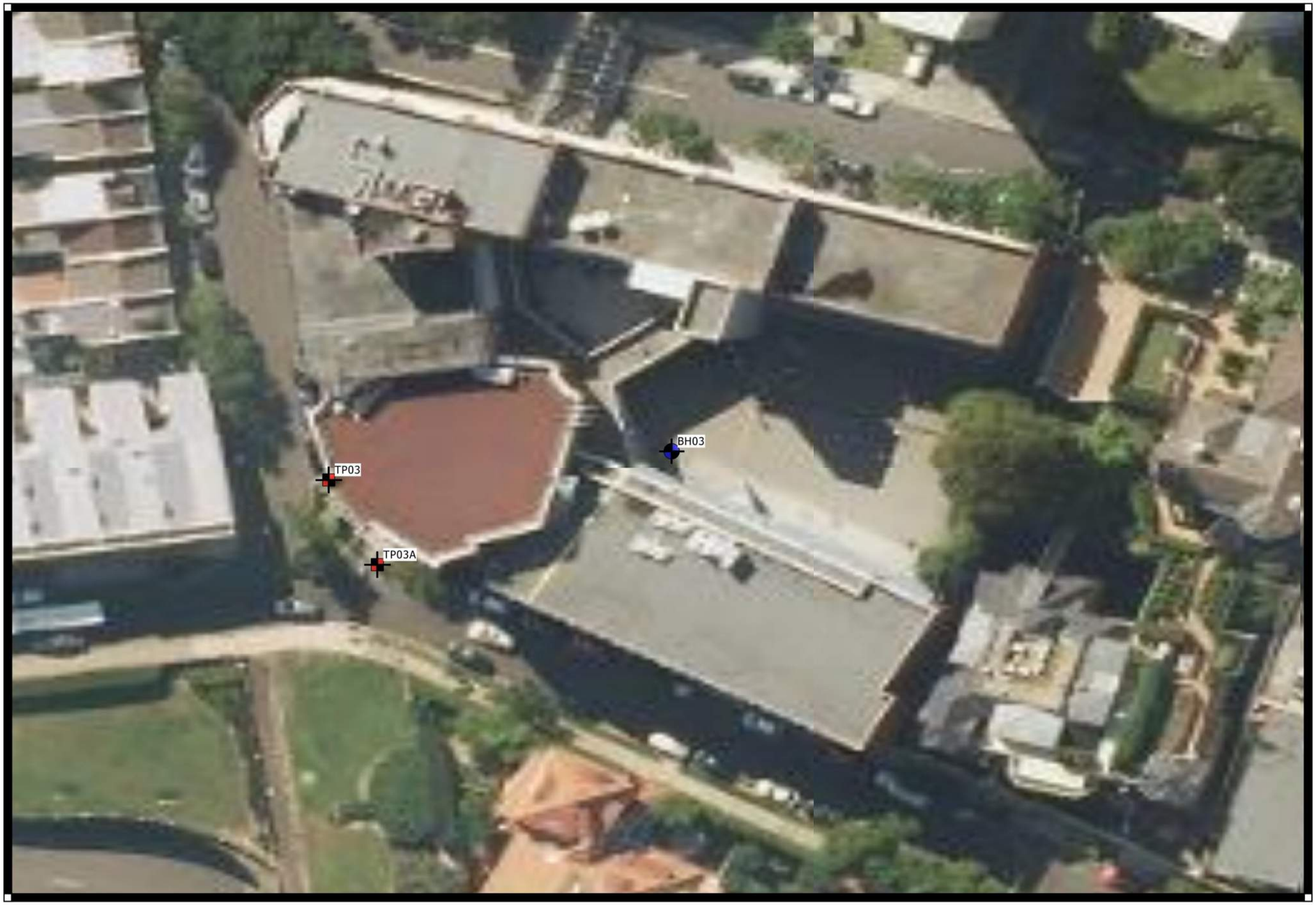
N

Legend

Test Locations

Borehole

MACQUARIE GEOTECH 3 Watt Drive, Bathurst NSW 2795 P: 02 6332 2011 F: 02 6334 4213 E: macgeo@macgeo.com.au	Client: Wood And Grieve Engineers			0 5 10 15 20 25 Metres - Scale 1:250	**JOB NO** B17550
	Project: St Aloysius College Geotechnical Investigation - Junior Campus				
	Location: Kirribilli NSW			Vertical to Horizontal Scale 1 : 1 Co-ordinate Reference System - EPSG: 4326 WGS: 84	Macquarie Geotechnical Ltd Geotechnical Investigation Locality Map
	Drawn: C. Green	Checked: J. Boyle	Date: 22/01/2018		Drawing Number: B17550 St Aloysius College Geotechnical Investigation REV0



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Legend

Test Locations

- Borehole
- Test Pit

MACQUARIE GEOTECH

3 Watt Drive, Bathurst NSW 2795
P: 02 6332 2011 F: 02 6334 4213 E: macgeo@macgeo.com.au

Client: Wood And Grieve Engineers

Project: St Aloysius College Geotechnical Investigation - Main Campus

Location: Kirribilli NSW

Drawn: C. Green | Checked: J. Boyle | Date: 22/01/2018

0 5 10 15 20 25

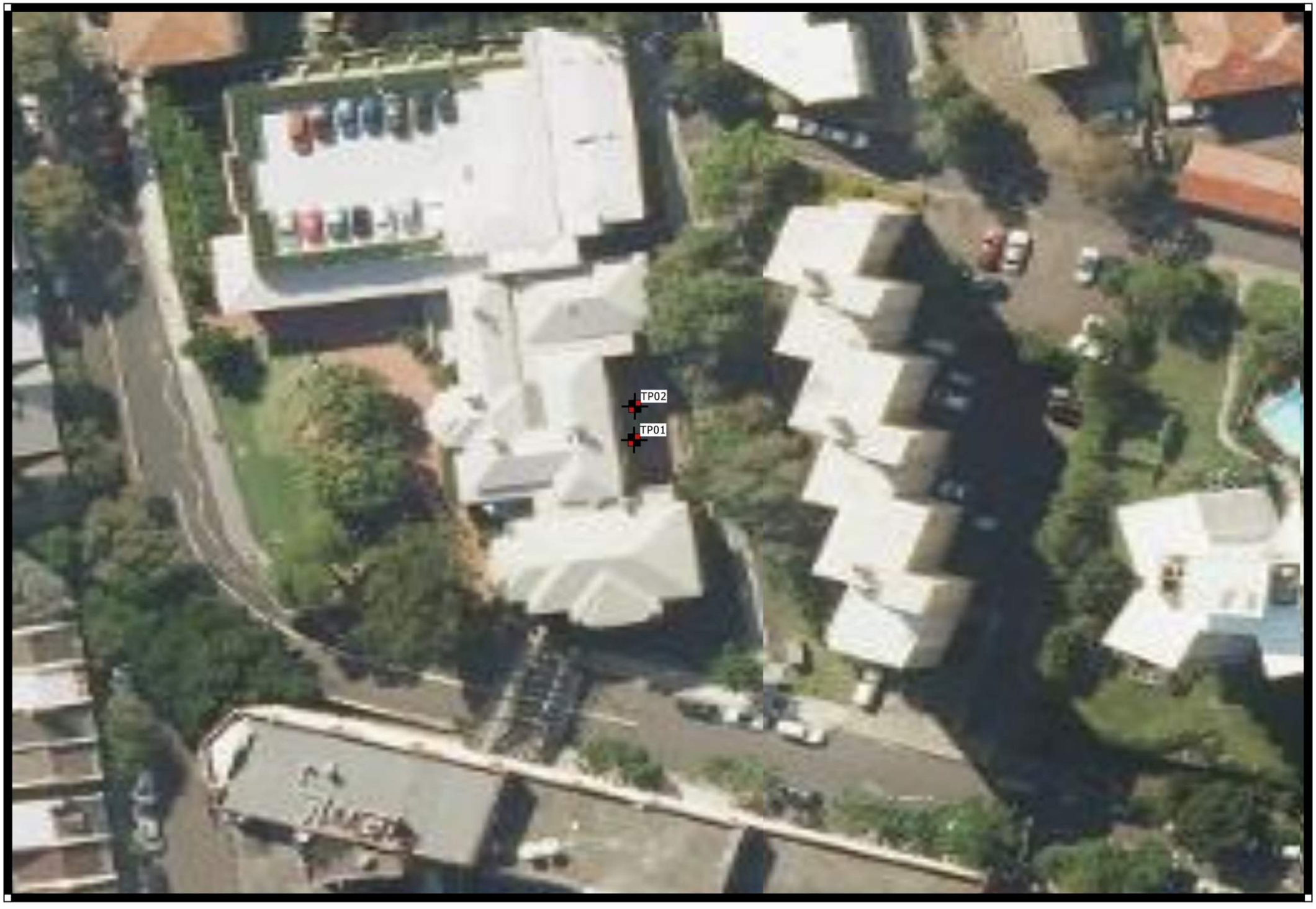
Metres - Scale 1:250

Vertical to Horizontal Scale 1 : 1
Co-ordinate Reference System - EPSG: 4326 WGS: 84

JOB NO B17550

Macquarie Geotechnical Ltd
Geotechnical Investigation Locality Map

Drawing Number: B17550 St Aloysius College Geotechnical Investigation REV0



N

Legend

Test Locations

Test Pit

MACQUARIE GEOTECH 3 Watt Drive, Bathurst NSW 2795 P: 02 6332 2011 F: 02 6334 4213 E: macgeo@macgeo.com.au	Client: Wood And Grieve Engineers			0 5 10 15 20 25 Metres - Scale 1:250	**JOB NO** B17550
	Project: St Aloysius College Geotechnical Investigation - Senior Campus				
	Location: Kirribilli NSW			Vertical to Horizontal Scale 1 : 1 Co-ordinate Reference System - EPSG: 4326 WGS: 84	Macquarie Geotechnical Ltd Geotechnical Investigation Locality Map
	Drawn: C. Green	Checked: J. Boyle	Date: 22/01/2018		Drawing Number: B17550 St Aloysius College Geotechnical Investigation REV0

Appendix C – Borehole Logs

MACQUARIE GEOTECH

Borehole No.
BH01
Page 1 of 5

Engineering Log - Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	07-12-2017
Project Name:	St Aloysius College	Completed:	07-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334779.0 m E 6253417.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Hole Diameter:	115 mm	Bearing:		Datum:	AHD	Operator:	CD

Drilling Information									Soil Description				Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	DCP Blows/100mm 5 10 15 20 / Pocket Penetrometer UCS (kPa) 100 200 300 400 500		Structure and Additional Observations
AD/T				ES 0.40-0.50 m D 0.50-1.00 m			0			CONCRETE: grey and brown					ROAD SURFACE
										SANDY GRAVEL: fine to medium gravel, sub-angular, brown and red, fine to coarse sand, trace low plasticity clay	D	MD			FILL
									SP	GRAVELLY SAND: fine to coarse grained sand, orange brown, fine to medium, sub-angular gravel, trace low plasticity clay (Extremely Weathered Sandstone)	D	MD			EXTREMELY WEATHERED MATERIAL BH01_0.4_0.5 PID 2.5ppm
							1			Continued on cored borehole sheet					
							2								
							3								
							4								
							5								

Method
AS - Auger Screwing
RR - Rock Roller
WB - Washbore

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Support
C - Casing

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Plastic Limit
< PL
= PL
< PL

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	07-12-2017
Project Name:	St Aloysius College	Completed:	07-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334779.0 m E 6253417.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	NMLC 1.5 m	Bearing:		Datum:	AHD	Operator:	CD

Drilling Information								Rock Substance			Rock Mass Defects	
Method	Support	Water	TCR (%)	SCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength Is(50) ● - Axial ○ - Diametral EL VL L M H VH EH	Defect Spacing (mm) 30 100 300 1000 3000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling Particular / General
							1		Continued from non-cored borehole sheet				
NMLC			100		100		2		SANDSTONE: fine to coarse grained, layered, brown	SW			JT, 0°, Clay SN, PR, S, greysih brown JT, 0°, Clay SN, PR, S, orange brown JT, 0°, Clay SN, PR, S, orange brown JT, 5°, Clay SN, PR, S, orange brown JT, 0°, Clay SN, PR, S, orange brown JT, 0°, Clay SN, PR, S, orange brown HB
			100		52				SILTSTONE: layered, red and brown 1.96-2.07m: Sandstone; fine to medium grained	MW			
							3		SANDSTONE: fine to medium grained, brown and grey 3.14-4.00m: brownish grey	SW			JT, 0°, Clay SN, PR, S, orange brown JT, 0°, Clay SN, UN, RF, orange brown JT, 0°, Clay SN, UN, RF, orange brown JT, 0°, Clay SN, UN, RF, orange brown JT, 0°, Clay SN, UN, RF, grey brown HB
			100		99		4		3.79m: rootlets observed in the joint 4.00-5.22m: Golden brown and grey 4.01-5.22m: Beddings between every 10-30mm at 0 to 10 degrees				JT, 35°, Clay SN, UN, RF, orange brown JT, 0°, Clay SN, UN, RF, orange brown JT, 0°, Clay SN, UN, RF, orange brown HB HB JT, 0°, UN, RF, orange brown rootlets observed HB
			100		99		5		5.22-7.40m: Beddings between every 10-40mm at 0 to 10 degrees 5.23-10.64m: browinsh grey				JT, 0°, Clay SN, UN, RF, orange brown HB HB HB
			100		100					SW			

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
T - Timbering

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
DW - Distinctly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
(indirect tensile strength)
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

MACQUARIE GEOTECH

Cored Borehole No.

BH01

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	07-12-2017
Project Name:	St Aloysius College	Completed:	07-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334779.0 m E 6253417.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	NMLC 1.5 m	Bearing:		Datum:	AHD	Operator:	CD

Drilling Information								***Rock Substance***				***Rock Mass Defects***		
Method	Support	Water	TCR (%)	SCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength Is(50) ● - Axial ○ - Diametral (EL VL L M H VH EH)	Defect Spacing (mm) (30 100 300 1000 3000)	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling — Particular	General
NMLC			100		100		7		SANDSTONE: fine to medium grained, brown and grey*(continued)*	SW			HB	
													DB	
													HB	
			100		100		8		7.64-9.00m: Beddings between every 10-30mm at 0 to 15 degrees				HB	
													HB	
													HB	
													HB	
			100		100		9		9.60-10.60m: Beddings between every 10-30mm at 0 to 10 degrees				HB	
													HB	
							10						HB	
			100		71								JT, 0°, CA SN, UN, RF, grey brown	
									Hole Terminated at 10.64 m Target depth					
							11							

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Support
T - Timbering

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
DW - Distinctly Weathered
XW - Extremely Weathered
RS - Residual Soil

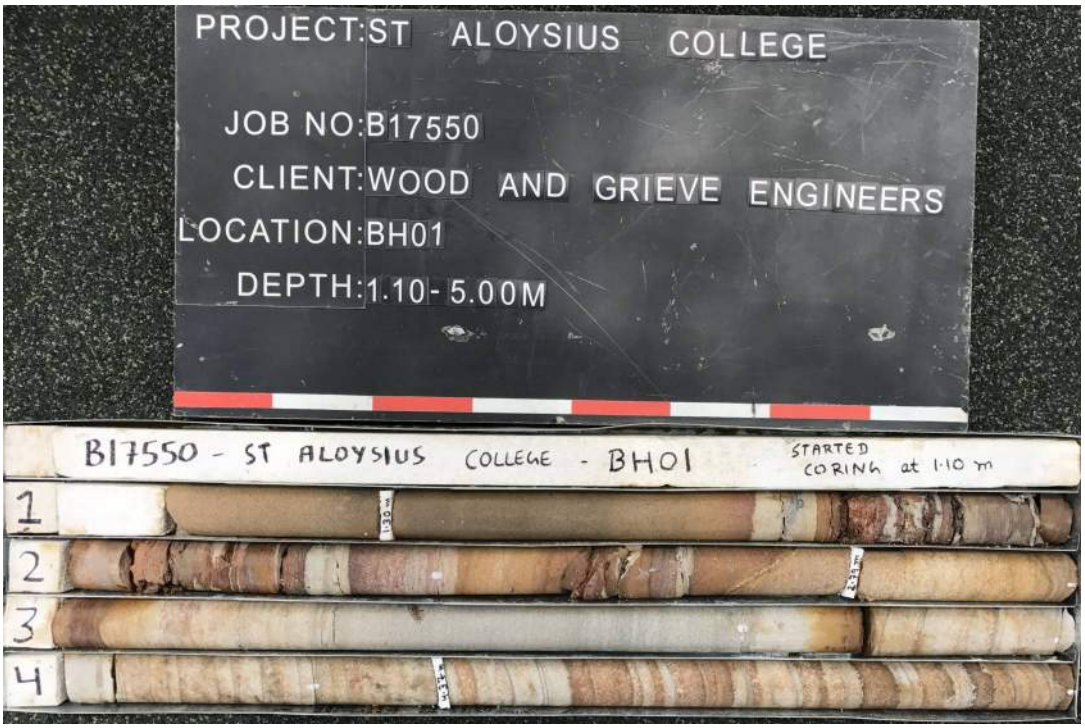
Strength
(indirect tensile strength)
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	07-12-2017
Project Name:	St Aloysius College	Completed:	07-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334779.0 m E 6253417.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	NMLC 1.5 m	Bearing:		Datum:	AHD	Operator:	CD



PointID : BH01 Depth Range: 1.10 - 5.00 m

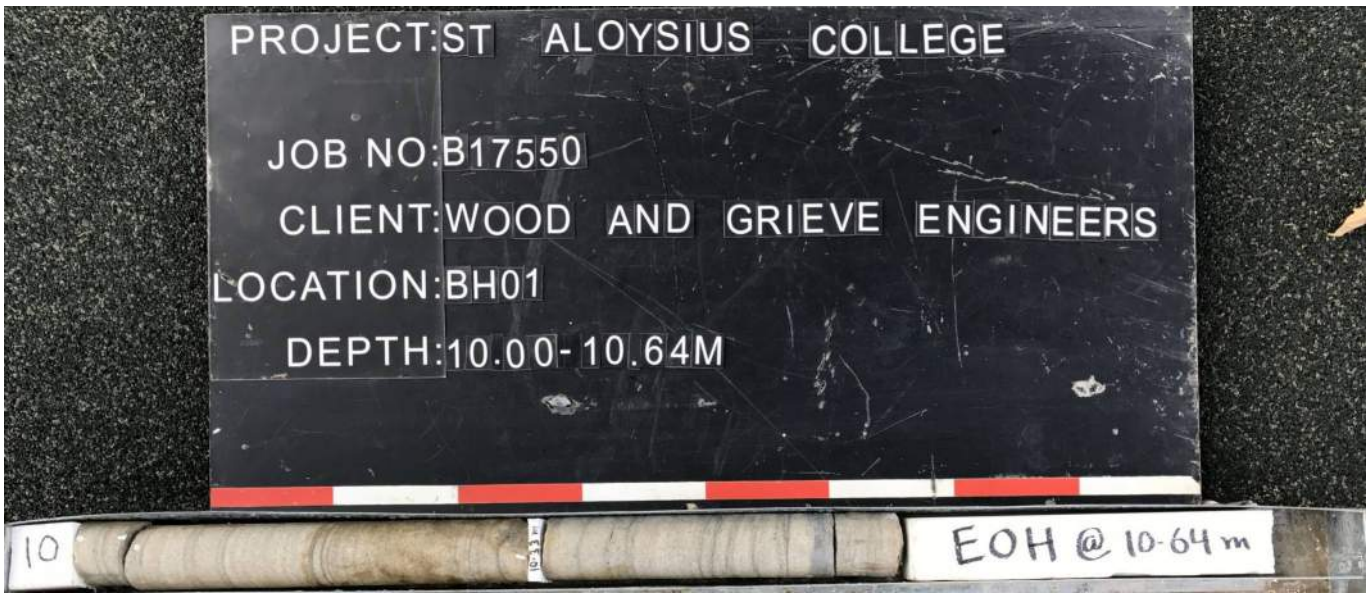
PointID : BH01 Depth Range: 5.00 - 10.00 m

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	07-12-2017
Project Name:	St Aloysius College	Completed:	07-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334779.0 m E 6253417.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	NMLC 1.5 m	Bearing:		Datum:	AHD	Operator:	CD



PointID : BH01 Depth Range: 10.00 - 10.64 m

MACQUARIE GEOTECH

GROUNDWATER LOG BH01

PROJECT NUMBER B17550	**DRILLING DATE** 7/12/17	**COORDINATES** 334779, 6253417
PROJECT NAME St Aloysius College	**TOTAL DEPTH** 10.64	**COORD SYS** MGA94 Zone 56
CLIENT Wood and Grieve Engineers	**DIAMETER** 115mm	**COMPLETION**
ADDRESS Level 6, Building B, 207 Pacific Highway, St Leonards	**CASING** uPVC	**SURFACE ELEVATION**
	SCREEN uPVC Factory Slotted	**WELL TOC**
LICENCE NO.		

COMMENTS

LOGGED BY JB
CHECKED BY JB

PID	Samples	Analysed	% Recovery	Depth (m)	Graphic Log	Moisture	Material Description	Well Diagram	Elevation (m)
				0		D	CONCRETE: grey	concrete	0
							Sandy GRAVEL: brown and red	cement grout	
							Gravelly SAND: orange brown	backfill	
				1			SANDSTONE	bentonite	1
				2			SILTSTONE		2
							SANDSTONE		
				3				filter pack	3
				4					4
				5				bentonite	5
				6					6
				7					7
				8				backfill	8
				9					9
				10					10
				11			Termination Depth at:10.64 m		11
				12					12
				13					13
				14					14
				15					15

MACQUARIE GEOTECH

Borehole No.
BH02
Page 1 of 6

Engineering Log - Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	08-12-2017
Project Name:	St Aloysius College	Completed:	08-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334746.0 m E 6253422.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Hole Diameter:	115 mm	Bearing:		Datum:	AHD	Operator:	CD

Drilling Information							Soil Description				Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	DCP Blows/100mm 5 10 15 20	Pocket Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T				D 0.10-0.50 m ES 0.20 m ES 0.40 m D 0.50-1.00 m ES 0.55 m D 1.00-1.50 m ES 1.00 m D 1.50-2.00 m ES 1.50 m SPT 1.50-1.95 m 3,6,10 N=16 ES 1.90 m D 2.00-2.60 m			1 2		CL SP	CONCRETE: grey and brown SANDY GRAVEL: fine to coarse gravel, sub-angular, brown and grey, fine to coarse sand GRAVELLY SAND: fine to coarse grained sand, grey and brown, fine to coarse, sub-angular gravel GRAVELLY CLAY: low plasticity, red and brown, fine to medium, sub-angular gravel SAND: fine to coarse grained sand, orange brown and grey, with fine to course, sub-angular gravel (Extremely Weathered Sandstone)	M M M D	MD MD St MD			ROAD SURFACE FILL BH01_0.2 PID 5.8ppm BH01_0.4 PID 7.1ppm BH01_0.55 PID 1.7pm BH01_1.0 PID 5.8ppm BH01_1.5 PID 11.5ppm RESIDUAL SOIL EXTREMELY WEATHERED MATERIAL
							3 4 5			Continued on cored borehole sheet					

Method
AS - Auger Screwing
RR - Rock Roller
WB - Washbore

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Support
C - Casing

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Plastic Limit
< PL
= PL
< PL

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	08-12-2017
Project Name:	St Aloysius College	Completed:	08-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334746.0 m E 6253422.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD Operator: CD

Drilling Information								***Rock Substance***				***Rock Mass Defects***		
Method	Support	Water	TCR (%)	SCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength Is(50) ● - Axial ○ - Diametral EL VL L M H VH EH	Defect Spacing (mm) 30 100 300 1000 3000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling Particular	General
							1							
							2		Continued from non-cored borehole sheet					
NMLC		▶	100		83		3		Recovered as Sandy CLAY with gravel: medium plasticity clay, brown and red, fine to coarse sand, fine to medium, sub-angular gravel.	MW			DB	
									SANDSTONE: medium to coarse grained, layered, orange brown and grey 2.85-3.84m: Beddings between every 10-30mm at 0 to 10 degrees	SW			JT, 0°, PR, RF, stained orange brown JT, 5°, PR, RF, stained grey brown	
		▶					4		Water strike between 3.91-3.93m 4.00-4.22m: Red brown 4.00-5.00m: Beddings between every 10-25mm at 0 to 15 degrees 4.22-6.40m: Orange brown and grey				JT, 0°, Clay FILLED, PR, S, orange brown JT, 0°, Fe SN, PR, RF, orange brown JT, 0°, Fe SN, UN, RF, orange brown JT, 0°, PR, RF, stained red brown JT, 10°, Clay SN, PR, RF, grey brown HB HB	
			100		100		5		5.00-5.55m: Beddings between every 10-30mm at 0 to 10 degrees	SW			HB HB JT, 0°, Clay SN, PR, RF, orange brown	
			100		89									

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
DW - Distinctly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
(indirect tensile strength)
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	08-12-2017
Project Name:	St Aloysius College	Completed:	08-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334746.0 m E 6253422.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD	Operator:	CD

Drilling Information								***Rock Substance***				***Rock Mass Defects***		
Method	Support	Water	TCR (%)	SCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength Is(50) ● - Axial ○ - Diametral EL VL L M H VH EH	Defect Spacing (mm) 30 100 300 1000 3000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling Particular	General
NMLC			100		89		7		SANDSTONE: medium to coarse grained, layered, orange brown and grey*(continued)* 6.00-6.60m: Beddings between every 10-20mm at 0 to 10 degrees 6.40-8.92m: Grey and black brown 7.05-7.25m: Beddings between every 20-30mm at 0 to 10 degrees 7.25-8.00m: Beddings between every 10-30mm at 0 to 15 degrees	SW		HB JT, 0°, Clay SN, PR, S, orange brown HB HB HB HB HB JT, 0°, Clay SN, PR, S, grey brown JT, 5°, Clay SN, PR, S, grey brown JT, 5°, Clay SN, PR, S, grey brown	
			100		100		8		8.00-8.50m: Beddings between every 10-30mm at 0 to 15 degrees 8.50-9.00m: Beddings between every 10-25mm at 0 to 10 degrees				JT, 5°, Clay SN, PR, RF, grey brown JT, 5°, Clay SN, PR, RF, grey brown JT, 0°, Clay SN, PR, RF, grey brown DB HB JT, 0°, Clay SN, PR, RF, grey brown HB	
			100		100		9		9.00-9.24m: Beddings between every 10-30mm at 0 to 5 degrees				HB HB JT	
			100		100		10		10.00-10.18m: Beddings between every 20-30mm at 0 to 10 degrees	SW			HB HB HB	
			100		100		11		11.05-12.00m: Beddings between every 20-40mm at 0 to 10 degrees				HB	

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
DW - Distinctly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
(indirect tensile strength)
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	08-12-2017
Project Name:	St Aloysius College	Completed:	08-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334746.0 m E 6253422.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD	Operator:	CD

Drilling Information								*Rock Substance*					*Rock Mass Defects*		
Method	Support	Water	TCR (%)	SCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength Is(50) ● - Axial ○ - Diametral EL VL L M H VH EH	Defect Spacing (mm) 30 100 300 1000 3000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling Particular	General
NMLC			100		85		13		SANDSTONE: medium to coarse grained, layered, orange brown and grey*(continued)* 12.00-12.37m: Beddings between every 10-30mm at 0 to 30 degrees 12.37m: 1 number coal infilled <2mm thick	SW			HB JT, 0°, Coal FILLED, PR, RF, black JT HB HB HB	
			100		100		14		13.68-14.52m: Beddigs between every 10-30mm at 0 to 25 degrees				HB HB	
			100		100		15		15.00-15.15m: Beddings between every 10-30mm at 0 to 25 degrees				HB	
									Hole Terminated at 15.15 m Target depth					
							16							
							17							

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
DW - Distinctly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
(indirect tensile strength)
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	08-12-2017
Project Name:	St Aloysius College	Completed:	08-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334746.0 m E 6253422.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD	Operator:	CD

PointID : BH02 Depth Range: 2.60 - 7.00 m

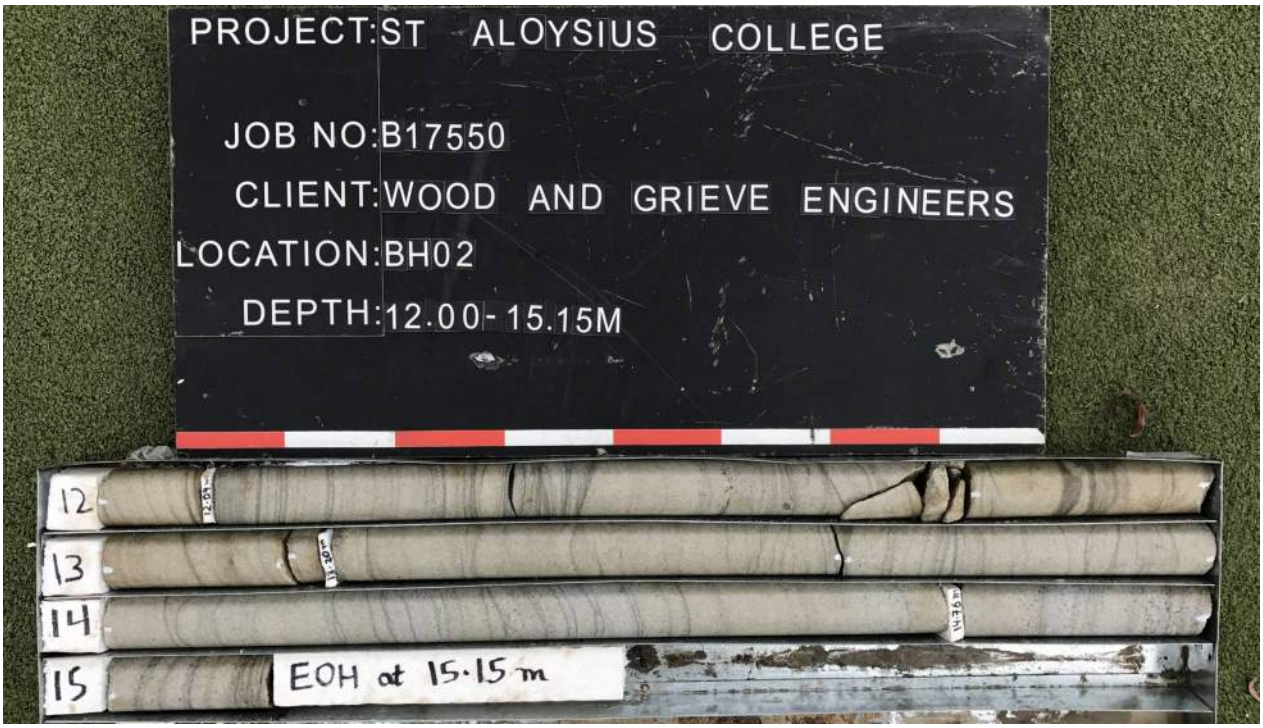
PointID : BH02 Depth Range: 7.00 - 12.00 m

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	08-12-2017
Project Name:	St Aloysius College	Completed:	08-12-2017
Hole Location:	Junior School Basketball Court	Logged By:	GC
Hole Position:	334746.0 m E 6253422.0 m N MGA94 Zone 56	Checked By:	JB

Drill Model and Mounting:	Drill Rig E50	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD	Operator:	CD



PointID : BH02 Depth Range: 12.00 - 15.15 m

GROUNDWATER LOG BH02

PROJECT NUMBER B17550
PROJECT NAME St Aloysius College
CLIENT Wood and Grieve Engineers
ADDRESS Level 6, Building B, 207 Pacific Highway, St Leonards
LICENCE NO.

DRILLING DATE 8/12/17
TOTAL DEPTH 15.15
DIAMETER 115mm
CASING uPVC
SCREEN uPVC Factory Slotted

COORDINATES 334779, 6253417
COORD SYS MGA94 Zone 56
COMPLETION
SURFACE ELEVATION
WELL TOC

COMMENTS

LOGGED BY JB
CHECKED BY JB

PID	Samples	Analysed	% Recovery	Depth (m)	Graphic Log	Moisture	Material Description	Well Diagram	Elevation (m)
				0		M	CONCRETE: grey	cement grout	0
				1			Sandy GRAVEL: brown and red Gravelly SAND: orange brown		1
				2			Gravelly CLAY: orange brown		2
						D	SAND: orange brown and grey (Extremely Weathered Sandstone)		
				3			SANDSTONE	backfill	3
				4					4
				5					5
				6				bentonite	6
				7					7
				8					8
				9					9
				10					10
				11				filter pack	11
				12					12
				13					13
				14					14
				15					15
							Termination Depth at:15.15 m		

MACQUARIE GEOTECH

Borehole No.
BH03
Page 1 of 6

Engineering Log - Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	09-01-2018
Project Name:	St Aloysius College	Completed:	09-01-2018
Hole Location:	Junior School Basketball Court	Logged By:	JB
Hole Position:		Checked By:	JB

Drill Model and Mounting:	Drill Rig	Inclination:	-90°	RL Surface:	No survey		
Hole Diameter:	100 mm	Bearing:		Datum:	AHD	Operator:	BG Drilling

Drilling Information										Soil Description			Observations
Method	Penetration	Support	Water	Samples Tests Remarks	Recovery	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description Fraction, Colour, Structure, Bedding, Plasticity, Sensitivity, Additional	Moisture Condition	Consistency Relative Density	DCP Blows/100mm 5 10 15 20 / Pocket Penetrometer UCS (kPa) 100 200 300 400 500	Structure and Additional Observations
AD/T			Not Observed	ES 0.25 m ES 0.45 m ES 1.00 m ES 1.20 m			1		SP	CONCRETE: fine to medium, rounded to sub-angular, grey, matrix supported 1 No. 6mm reinforcement 2 No. 14mm reinforcement 1 No. 6mm reinforcement CLAYEY SAND: fine to coarse grained sand, yellow brown, low plasticty clay CLAYEY SAND: fine to coarse grained sand, grey brown and orange, low plasticty clay, (Slight hydrocarbon odour) SAND: yellow brown, with low plasticity clay Continued on cored borehole sheet	M W	MD		FILL EXTREMELY WEATHERED MATERIAL

Method
AS - Auger Screwing
RR - Rock Roller
WB - Washbore

Penetration
No resistance ranging to refusal

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Samples and Tests
U - Undisturbed Sample
D - Disturbed Sample
SPT - Standard Penetration Test

Moisture Condition
D - Dry
M - Moist
W - Wet

Consistency/Relative Density
VS - Very Soft
S - Soft
F - Firm
VSt - Very Stiff
H - Hard
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

Support
C - Casing

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Classification Symbols and Soil Descriptions
Based on Unified Soil Classification System

Plastic Limit
< PL
= PL
< PL

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	09/01/2018
Project Name:	St Aloysius College	Completed:	09/01/2018
Hole Location:	Junior School Basketball Court	Logged By:	JB
Hole Position:		Checked By:	JB

Drill Model and Mounting:	Drill Rig	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD	Operator:	BG Drilling

Drilling Information | **Rock Substance** | **Rock Mass Defects**

Method	Support	Water	TCR (%)	SCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description: rock type: grain characteristics, colour, structure, minor components	Weathering	Strength Is(50) ● - Axial ○ - Diametral (EL VL L M H VH EH)	Defect Spacing (mm) (30 100 300 1000 3000)	Defect Description: thickness, type, inclination, planarity, roughness, coating/infilling — Particular	General
							1		Continued from non-cored borehole sheet					
NMLC		Not Observed	100		65		2		SANDSTONE: medium to coarse grained, grey and orange	SW to MW			5°, Fe, PR, S 5°, Fe, PR, S 5°, Fe, PR, S 5°, Fe, UN, S	
			100		100		3						5°, Fe, UN, S	
			100		100		4		SANDSTONE: medium to coarse grained, grey, with dark grey laminations closely spaced	SW			5°, X, UN, S	
			100		100		5							

Method
AS - Auger Screwing
WB - Washbore
HQ3 HQ3 Core Barrel
NQ3 NQ3 Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
DW - Distinctly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
(indirect tensile strength)
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

MACQUARIE GEOTECH

Cored Borehole No.
BH03
Page 3 of 6

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	09/01/2018
Project Name:	St Aloysius College	Completed:	09/01/2018
Hole Location:	Junior School Basketball Court	Logged By:	JB
Hole Position:		Checked By:	JB

Drill Model and Mounting:	Drill Rig	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD	Operator:	BG Drilling

Drilling Information								***Rock Substance***				***Rock Mass Defects***		
Method	Support	Water	TCR (%)	SCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength Is(50) ● - Axial ○ - Diametral (EL VL L M H VH EH)	Defect Spacing (mm) (30 100 300 1000 3000)	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling — Particular	General
NMLC		Not Observed	100		100		7		SANDSTONE: medium to coarse grained, grey, with dark grey laminations closely spaced*(continued)*					
			100		100		8							
			100		100		9			SW				
			100		100		10						5°, UN, S	
			100		100		11						5°, UN, S	

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
DW - Distinctly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
(indirect tensile strength)
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	09/01/2018
Project Name:	St Aloysius College	Completed:	09/01/2018
Hole Location:	Junior School Basketball Court	Logged By:	JB
Hole Position:		Checked By:	JB

Drill Model and Mounting:	Drill Rig	Inclination:	-90°	RL Surface:	No survey
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD

Operator: BG Drilling

Drilling Information								Rock Substance				Rock Mass Defects		
Method	Support	Water	TCR (%)	SCR (%)	RQD (%)	RL (m)	Depth (m)	Graphic Log	Material Description rock type: grain characteristics, colour, structure, minor components	Weathering	Strength Is(50) ● - Axial ○ - Diametral EL VL L M H VH EH	Defect Spacing (mm) 30 100 300 1000 3000	Defect Description thickness, type, inclination, planarity, roughness, coating/infilling Particular	General
NMLC		Not Observed	100		100		13		SANDSTONE: medium to coarse grained, grey, with dark grey laminations closely spaced*(continued)*	SW				
			100		100		14		From 13.61m to 13.66 3 No. thin beds of red brown claystone From 13.85m to 13.81 1 No. thin beds of red brown claystone				5°, Clay, UN, S 15°, UN, S	
			100		100		15						5°, UN, S	
							16		Hole Terminated at 15.10 m Target depth					
							17							

Method
AS - Auger Screwing
WB - Washbore
HQ3 - HQ3 Core Barrel
NQ3 - NQ3 Core Barrel

Water
Level (Date)
Inflow
Partial Loss
Complete Loss

Graphic Log/Core Loss
Core recovered (hatching indicates material)
Core loss

Weathering
FR - Fresh
SW - Slightly Weathered
DW - Distinctly Weathered
XW - Extremely Weathered
RS - Residual Soil

Strength
(indirect tensile strength)
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High
EH - Extremely High

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	09/01/2018
Project Name:	St Aloysius College	Completed:	09/01/2018
Hole Location:	Junior School Basketball Court	Logged By:	JB
Hole Position:		Checked By:	JB

Drill Model and Mounting:	Drill Rig	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD	Operator:	BG Drilling

PointID : BH03 Depth Range: 1.30 - 6.00 m

PointID : BH03 Depth Range: 6.00 - 11.00 m

Engineering Log - Cored Borehole

Project No.: B17550

Client:	Wood and Grieve Engineers	Commenced:	09/01/2018
Project Name:	St Aloysius College	Completed:	09/01/2018
Hole Location:	Junior School Basketball Court	Logged By:	JB
Hole Position:		Checked By:	JB

Drill Model and Mounting:	Drill Rig	Inclination:	-90°	RL Surface:	No survey		
Barrel Type and Length:	1.5 m	Bearing:		Datum:	AHD	Operator:	BG Drilling

PointID : BH03 Depth Range: 11.00 - 15.10 m

MACQUARIE GEOTECH

GROUNDWATER LOG

PROJECT NUMBER B17550
PROJECT NAME St Aloysius College
CLIENT Wood and Grieve Engineers
ADDRESS Leve 6, Building B, 207 Pacific Highway, St Leonards

DRILLING DATE 9/1/18
TOTAL DEPTH 15.1
DIAMETER 115mm
CASING uPVC
SCREEN uPVC Factory Slotted

COORDINATES 334792, 6253182
COORD SYS MGA94 Zone 56
COMPLETION
SURFACE ELEVATION
WELL TOC

COMMENTS

LOGGED BY JB
CHECKED BY JB

PID	Samples	Analysed	% Recovery	Depth (m)	Graphic Log	Moisture	Material Description	Well Diagram	Elevation (m)
				0		M	CONCRETE: grey	concrete cement grout	0
				1			Clayey SAND: yellow brown		1
							Clayey SAND: grey brown and orange		
						W	SAND with clay: yellow brown (Extremely Weathered Sandstone)		
				2			SANDSTONE		2
				3					3
				4					4
				5				backfill	5
				6					6
				7					7
				8				bentonite	8
				9					9
				10				filter pack	10
				11					11
				12				bentonite	12
				13					13
				14				backfill	14
				15					15
							Termination Depth at:15.1 m		

EXCAVATION - GEOLOGICAL LOG

MACQUARIE GEOTECH

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

PIT NO : TP01
FILE / JOB NO : B17550
SHEET : 1 OF 3

POSITION : E: 334792.0, N: 6253247.0 (MGA94 Zone 56) SURFACE ELEVATION :
EQUIPMENT TYPE : METHOD : Hand Dug
DATE EXCAVATED : 07-12-2017 LOGGED BY : DP CHECKED BY : JB
EXCAVATION DIMENSIONS : 1.62 m LONG 0.63 m WIDE

EXCAVATION INFORMATION | MATERIAL

VE / PENETRATION / F / H	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	ELEVATION (RL) DEPTH (M)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	DCP Blows/100mm 5 10 15 20	POCKET PENETRO-METER kPa 100 200 300 400	STRUCTURE & Other Observations
		0.05m D	0.0			Red brown Bricks (PAVING)	D	VD			FILL
		0.10m D ES			0.05m	SAND: fine to coarse grained sand, dark grey, with low plasticity clay, trace roots <2mm diameter		L			
					0.10m	GRAVELLY SAND: fine to coarse grained sand, dark grey, fine to coarse, sub-rounded to sub-angular gravel, trace low plasticity clay		MD			TP01_0.1 PID 46.7ppm
			0.2		0.15m	GRAVELLY SAND: fine to coarse grained sand, pale orange brown, fine to coarse, sub-angular gravel, with low plasticity clay, trace cobbles and boulders upto 300mm diameter					
		0.30m ES									TP01_0.3 PID 2.0ppm
		0.40m D	0.4		0.40m	GRAVELLY CLAYEY SAND: fine to coarse grained sand, pale brown and pale grey brown, low plasticity clay, fine to coarse, sub-angular gravel, with cobbles, trace sub-angular boulders upto 300mm diameter	SM	D - VD			
	Not Observed	0.50m ES									TP01_0.5 PID 1.7ppm
			0.6								
		0.75m ES			0.75m	0.75m: geofabric cloth					TP01_0.75 PID 2.1ppm
		0.80m	0.8			GRAVEL: medium to coarse gravel, sub-angular, grey, (DRAINAGE LAYER)					
						0.93m: concrete footing	D / SM	VD			
			1.0			0.96m: 1 no of 100mm diameter pipe , 1.10m from wall 1 no of white plastic pipe , 1.20m from wall (foundation level at pipe is 1.04m deep)					
					1.10m	Hole Terminated at 1.10 m Sandstone encountered at 1.10m					
			1.2								
			1.4								

PHOTOGRAPHS NOTES [Y] Excavated perpendicular to external wall.

METHOD
N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper

SUPPORT
T Timbering

PENETRATION
VE E F H VH — No Resistance

WATER
10 Oct., 73 Water Level on Date shown
water inflow
water outflow

SAMPLES & FIELD TESTS
U - Undisturbed Sample
D - Disturbed Sample
B - Bulk Disturbed Sample
MC - Moisture Content
PP - Pocket Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
PBT - Plate Bearing Test

CLASSIFICATION SYMBOLS & SOIL DESCRIPTION
Based on Unified Classification System

MOISTURE
D - Dry
M - Moist
W - Wet

CONSISTENCY/ RELATIVE DENSITY
VS - Very Soft
S - Soft
F - Firm
St - Stiff
VSt - Very Stiff
H - Hard
VL - Very Loose
L - Loose
MD - Medium Dense
D - Dense
VD - Very Dense

See Explanatory Notes for details of abbreviations & basis of descriptions.

EXCAVATION - GEOLOGICAL LOG

PIT NO : TP01

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

FILE / JOB NO : B17550
SHEET : 2 OF 3

POSITION : E: 334792.0, N: 6253247.0 (MGA94 Zone 56)	SURFACE ELEVATION :	
EQUIPMENT TYPE :	METHOD : Hand Dug	
DATE EXCAVATED : 07-12-2017	LOGGED BY : DP	CHECKED BY : JB
EXCAVATION DIMENSIONS : 1.62 m LONG 0.63 m WIDE		

TP01 - 1 Depth Range: 0.00 - 0.93 m

TP01 - 2 Depth Range: 0.00 - 0.93 m

EXCAVATION - GEOLOGICAL LOG

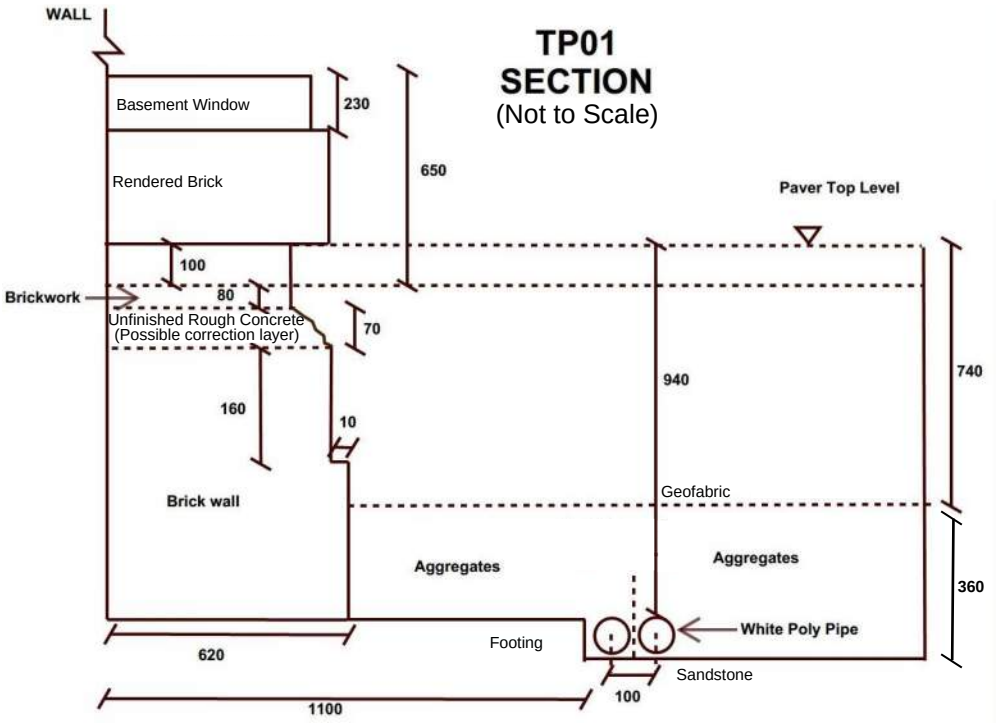
MACQUARIE GEOTECH

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

PIT NO : TP01
FILE / JOB NO : B17550
SHEET : 3 OF 3

POSITION : E: 334792.0, N: 6253247.0 (MGA94 Zone 56)	SURFACE ELEVATION :	
EQUIPMENT TYPE :	METHOD : Hand Dug	
DATE EXCAVATED : 07-12-2017	LOGGED BY : DP	CHECKED BY : JB
EXCAVATION DIMENSIONS : 1.62 m LONG 0.63 m WIDE		

TP01 - 3 Depth Range: 0.00 - 0.93 m



TP01 - 4 Depth Range: 0.00 - 0.93 m

EXCAVATION - GEOLOGICAL LOG

MACQUARIE GEOTECH

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

PIT NO : TP02
FILE / JOB NO : B17550
SHEET : 1 OF 3

POSITION : E: 334798.0, N: 6253256.0 (MGA94 Zone 56) SURFACE ELEVATION :
EQUIPMENT TYPE : METHOD : Hand Dug
DATE EXCAVATED : 08-12-2017 LOGGED BY : DP CHECKED BY : JB
EXCAVATION DIMENSIONS : 1.10 m LONG 0.68 m WIDE

EXCAVATION INFORMATION | MATERIAL

VE E PENETRATION F H	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	ELEVATION (RL) DEPTH (M)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	DCP Blows/100mm 5 10 15 20	POCKET PENETRO-METER kPa 100 200 300 400	STRUCTURE & Other Observations
		0.05m D	0.0			0.05m Brown brick (PAVING)		VD			FILL
		0.08m ES				SAND: fine to coarse grained sand, dark grey, with clay		L			
		0.10m D				0.10m GRAVELLY SAND: fine to coarse grained sand, dark grey, fine to coarse, sub-rounded to sub-angular gravel, trace low plasticity clay					TP02_0.08 PID 4.8ppm
		0.15m ES				0.15m GRAVELLY SAND: fine to coarse grained sand, orange brown, fine to coarse, sub-rounded gravel, with low plasticity clay		MD - D			TP02_0.15 PID 8.5ppm
		0.20m D	0.2			0.18m CLAYEY SAND: fine to coarse grained sand, brown and grey, brown mottled pale grey, low plasticity clay, with fine to coarse, angular to sub-angular gravel, with sub-angular cobbles, trace sandy clay pockets <50mm, gravel - mixture of sandstone, glass, plastic fragments, brick 0.25-0.40m: 3 nos of sub-angular boulders up to 300mm diameter	SM				
		0.30m ES									TP02_0.30 PID 11.9ppm
	Not Observed	0.40m D	0.4			Becoming sandy GRAVEL with depth		D - VD			
						0.55m 0.55m: black geofabric					FILL
		0.60m D	0.6			GRAVEL: medium to coarse gravel, sub-angular, grey, trace fine to coarse sand					
							SM - W	VD			
		0.80m	0.8			0.75m: top of footing 2 nos pipes beside footing					
						0.85m 0.85m: top of sandstone Hole Terminated at 0.85 m					
			1.0								
			1.2								
			1.4								

PHOTOGRAPHS NOTES [Y] Excavated perpendicular to external wall.

METHOD
N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper

SUPPORT
T Timbering

PENETRATION
VE E F H VH — No Resistance

WATER
10 Oct., 73 Water Level on Date shown
water inflow
water outflow

SAMPLES & FIELD TESTS
U - Undisturbed Sample
D - Disturbed Sample
B - Bulk Disturbed Sample
MC - Moisture Content
PP - Pocket Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
PBT - Plate Bearing Test

CLASSIFICATION SYMBOLS & SOIL DESCRIPTION
Based on Unified Classification System

MOISTURE
D - Dry
M - Moist
W - Wet

CONSISTENCY/ RELATIVE DENSITY

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

See Explanatory Notes for details of abbreviations & basis of descriptions.

EXCAVATION - GEOLOGICAL LOG

MACQUARIE GEOTECH

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

PIT NO : TP02
FILE / JOB NO : B17550
SHEET : 2 OF 3

POSITION : E: 334798.0, N: 6253256.0 (MGA94 Zone 56)	SURFACE ELEVATION :	
EQUIPMENT TYPE :	METHOD : Hand Dug	
DATE EXCAVATED : 08-12-2017	LOGGED BY : DP	CHECKED BY : JB
EXCAVATION DIMENSIONS : 1.10 m LONG 0.68 m WIDE		

TP02 - 1 Depth Range: 0.00 - 0.85 m

TP02 - 2 Depth Range: 0.00 - 0.85 m

EXCAVATION - GEOLOGICAL LOG

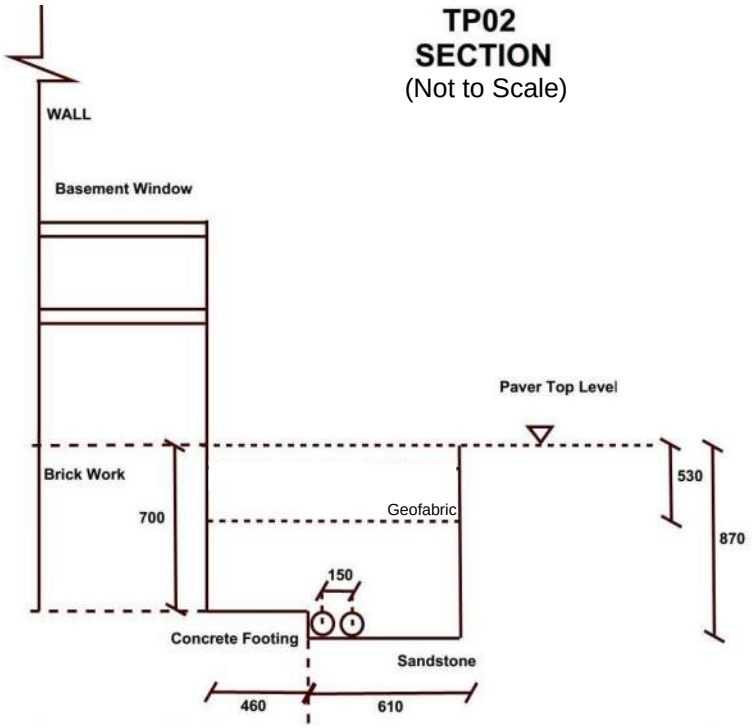
MACQUARIE GEOTECH

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

PIT NO : TP02
FILE / JOB NO : B17550
SHEET : 3 OF 3

POSITION : E: 334798.0, N: 6253256.0 (MGA94 Zone 56)	SURFACE ELEVATION :	
EQUIPMENT TYPE :	METHOD : Hand Dug	
DATE EXCAVATED : 08-12-2017	LOGGED BY : DP	CHECKED BY : JB
EXCAVATION DIMENSIONS : 1.10 m LONG 0.68 m WIDE		

TP02 - 3 Depth Range: 0.00 - 0.85 m



TP02 - 4 Depth Range: 0.00 - 0.85 m

EXCAVATION - GEOLOGICAL LOG

MACQUARIE GEOTECH

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

PIT NO : TP03
FILE / JOB NO : B17550
SHEET : 1 OF 2

POSITION : E: 334758.0, N: 6253178.0 (MGA94 Zone 56) SURFACE ELEVATION :
EQUIPMENT TYPE : METHOD : Hand Dug
DATE EXCAVATED : 16/01/2017 LOGGED BY : JB CHECKED BY : JB
EXCAVATION DIMENSIONS : 0.30 m LONG 0.30 m WIDE

EXCAVATION INFORMATION | MATERIAL

VE / PENETRATION E F H	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	ELEVATION (RL) DEPTH (M)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	DCP Blows/100mm 5 10 15 20	POCKET PENETRO-METER kPa 100 200 300 400	STRUCTURE & Other Observations
	Not Observed		0.0			0.04m Mulch					TOPSOIL - REWORKED
						0.10m SAND: fine grained sand, Dark brown, with low plasticity clay, with fine to medium subangular gravel					
			0.2			GRAVELLY SAND: fine to coarse grained sand, Brown, fine to medium subangular gravel, trace subangular cobbles, trace sandy clay pockets <50mm, gravel - mixture of sandstone, glass, plastic fragments, brick					FILL
						0.30m Hole Terminated at 0.30 m Refusal on Concrete					
			0.4								
			0.6								
			0.8								
			1.0								
			1.2								
			1.4								

PHOTOGRAPHS NOTES [Y]

METHOD
N Natural Exposure
X Existing Excavation
BH Backhoe Bucket
B Bulldozer Blade
R Ripper

SUPPORT
T Timbering

PENETRATION
VE E F H VH — No Resistance

WATER
10 Oct., 73 Water Level on Date shown
water inflow
water outflow

SAMPLES & FIELD TESTS
U - Undisturbed Sample
D - Disturbed Sample
B - Bulk Disturbed Sample
MC - Moisture Content
PP - Pocket Penetrometer (UCS kPa)
VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
PBT - Plate Bearing Test

CLASSIFICATION SYMBOLS & SOIL DESCRIPTION
Based on Unified Classification System

MOISTURE
D - Dry
M - Moist
W - Wet

CONSISTENCY/ RELATIVE DENSITY

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

See Explanatory Notes for details of abbreviations & basis of descriptions.

EXCAVATION - GEOLOGICAL LOG

MACQUARIE GEOTECH

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

PIT NO : TP03
FILE / JOB NO : B17550
SHEET : 2 OF 2

POSITION : E: 334758.0, N: 6253178.0 (MGA94 Zone 56)	SURFACE ELEVATION :	
EQUIPMENT TYPE :	METHOD : Hand Dug	
DATE EXCAVATED : 16/01/2017	LOGGED BY : JB	CHECKED BY : JB
EXCAVATION DIMENSIONS : 0.30 m LONG 0.30 m WIDE		

TP03 Depth Range: 0.00 - 0.30 m

MACQUARIE GEOTECH

EXCAVATION - GEOLOGICAL LOG

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

PIT NO : TP03A
FILE / JOB NO : B17550
SHEET : 1 OF 2

POSITION : E: 334763.0, N: 6253168.0 (MGA94 Zone 56)	SURFACE ELEVATION :
EQUIPMENT TYPE :	METHOD : Hand Dug
DATE EXCAVATED : 16/01/2017	LOGGED BY : JB CHECKED BY : JB
EXCAVATION DIMENSIONS : 0.30 m LONG 0.30 m WIDE	

EXCAVATION INFORMATION | MATERIAL

VE / PENETRATION E F H	GROUND WATER LEVELS	SAMPLES & FIELD TESTS	ELEVATION (RL) DEPTH (M)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION Soil Type, Colour, Plasticity or Particle Characteristic Secondary and Minor Components	MOISTURE CONDITION	CONSISTENCY RELATIVE DENSITY	DCP Blows/100mm 5 10 15 20	POCKET PENETRO-METER kPa 100 200 300 400	STRUCTURE & Other Observations
	Not Observed		0.0			CONCRETE: grey					FILL
			0.04m			Hole Terminated at 0.04 m Refusal on Concrete					
			0.2								
			0.4								
			0.6								
			0.8								
			1.0								
			1.2								
			1.4								

PHOTOGRAPHS Y
NOTES

METHOD
- N Natural Exposure
- X Existing Excavation
- BH Backhoe Bucket
- B Bulldozer Blade
- R Ripper

SUPPORT
- T Timbering

PENETRATION
VE E F H VH — No Resistance

WATER
10 Oct., 73 Water Level on Date shown
water inflow
water outflow

SAMPLES & FIELD TESTS
- U - Undisturbed Sample
- D - Disturbed Sample
- B - Bulk Disturbed Sample
- MC - Moisture Content
- PP - Pocket Penetrometer (UCS kPa)
- VS - Vane Shear; P-Peak, R-Remouded (uncorrected kPa)
- PBT - Plate Bearing Test

CLASSIFICATION SYMBOLS & SOIL DESCRIPTION
Based on Unified Classification System

MOISTURE
- D - Dry
- M - Moist
- W - Wet

CONSISTENCY/ RELATIVE DENSITY

VS	- Very Soft
S	- Soft
F	- Firm
St	- Stiff
VSt	- Very Stiff
H	- Hard
VL	- Very Loose
L	- Loose
MD	- Medium Dense
D	- Dense
VD	- Very Dense

See Explanatory Notes for details of abbreviations & basis of descriptions.

MACQUARIE GEOTECH

EXCAVATION - GEOLOGICAL LOG

CLIENT : Wood and Grieve Engineers PROJECT : St Aloysius College
LOCATION : Junior School Basketball Court

PIT NO : TP03A
FILE / JOB NO : B17550
SHEET : 2 OF 2

POSITION : E: 334763.0, N: 6253168.0 (MGA94 Zone 56)	SURFACE ELEVATION :	
EQUIPMENT TYPE :	METHOD : Hand Dug	
DATE EXCAVATED : 16/01/2017	LOGGED BY : JB	CHECKED BY : JB
EXCAVATION DIMENSIONS : 0.30 m LONG 0.30 m WIDE		

TP03A Depth Range: 0.00 - 0.04 m

Appendix D – Laboratory Test Results

SOIL CHEMICAL PROPERTIES REPORT

Client:	Wood and Grieve Engineers	**Source:**	BH01 0.50-1.00m
Address:	Lvl 6, Building B, 207 Pacific Highway St Leonards 2065	**Sample Description:**	Silty SAND with Gravel
Project:	St Aloysius College, Kirribilli	**Report No:**	B44864-SCP
Job No:	B17550	**Lab No:**	B44864

Test Procedure:

☑	AS1289 4.2.1	Soil Chemical Tests - Determination of a sulfate content of a natural soil and the sulfate content of the groundwater - Normal Method
☑	AS1289 4.3.1	Soil Chemical Tests - Determination of the pH value of a soil - Electrometric method
☐	AS 1289 4.4.1	Soil Chemical Tests - Determination of the electrical resistivity of a soil - Method for sands and granular material
☐	AS 1012.20	Chloride and sulphate
☐	RMS T123	pH value of a soil (electrometric method)
☐	RMS T185	Resistivity of sands and granular road construction materials
☐	RMS T200	Chloride content of roadbase
☑	RMS T1010	Quantitative determination of chlorides in soil
☐	RMS T1011	Quantitative determination of sulphates in soil
☐	BS1377(1990 pt.3)	Water soluble sulphate content
☐	APHA 4500 H+B	pH
☐	APHA 4500 SO4 2-B	Sulphate
☐	APHA 4500 Cl-B	Chloride
☑	APHA 2510 & 2520-B	Electrical Conductivity
☐	TAI B117	Sulphides Present (This service Not Covered by NATA Accreditation)

Sampling:	Sampled by Macquarie Geotechnical Staff in accordance with AS1289 1.1	**Date Sampled:**	7/12/2017
Preparation:	Prepared in accordance with the test method		

Sulphides Present	-
Sulphur Peroxide (%)	-
Sulphate content (ppm)	18.5
Sulphate content (%)	0.00
Chloride ion content (ppm)	35.5
Chloride ion content (%)	0.00
pH	5.7
Electrical Conductivity (uS/cm)	71.4
Mean Resistivity Ω.m	-
(Resisitivity) Density ratio (R_D)	-
(Resisitivity) Density index (I_D)	-

NATA

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

JABoye

John Boye

23/01/2018

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

SOIL CHEMICAL PROPERTIES REPORT

Client:	Wood and Grieve Engineers	**Source:**	BH02 1.00-1.50m
Address:	Lvl 6, Building B, 207 Pacific Highway St Leonards 2065	**Sample Description:**	Silty SAND with Gravel
Project:	St Aloysius College, Kirribilli	**Report No:**	B44871-SCP
Job No:	B17550	**Lab No:**	B44871

Test Procedure:

☑	AS1289 4.2.1	Soil Chemical Tests - Determination of a sulfate content of a natural soil and the sulfate content of the groundwater - Normal Method
☑	AS1289 4.3.1	Soil Chemical Tests - Determination of the pH value of a soil - Electrometric method
☐	AS 1289 4.4.1	Soil Chemical Tests - Determination of the electrical resistivity of a soil - Method for sands and granular material
☐	AS 1012.20	Chloride and sulphate
☐	RMS T123	pH value of a soil (electrometric method)
☐	RMS T185	Resistivity of sands and granular road construction materials
☐	RMS T200	Chloride content of roadbase
☑	RMS T1010	Quantitative determination of chlorides in soil
☐	RMS T1011	Quantitative determination of sulphates in soil
☐	BS1377(1990 pt.3)	Water soluble sulphate content
☐	APHA 4500 H+B	pH
☐	APHA 4500 SO4 2-B	Sulphate
☐	APHA 4500 Cl-B	Chloride
☑	APHA 2510 & 2520-B	Electrical Conductivity
☐	TAI B117	Sulphides Present (This service Not Covered by NATA Accreditation)

Sampling:	Sampled by Macquarie Geotechnical Staff in accordance with AS1289 1.1	**Date Sampled:**	7/12/2017
Preparation:	Prepared in accordance with the test method		

Sulphides Present	-
Sulphur Peroxide (%)	-
Sulphate content (ppm)	20.6
Sulphate content (%)	0.00
Chloride ion content (ppm)	35.5
Chloride ion content (%)	0.00
pH	7.8
Electrical Conductivity (uS/cm)	122.0
Mean Resistivity Ω.m	-
(Resisitivity) Density ratio (R_D)	-
(Resisitivity) Density index (I_D)	-

Authorised Signatory:

JABoye

John Boye

23/01/2018

Date:

NATA Accredited Laboratory Number: 14874

MACQUARIE GEOTECH

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Bathurst NSW 2795

POINT LOAD INDEX REPORT

Client:	Wood and Grieve Engineers	**Sampling Method:**	NA
Address:	Lvl 6, Building B, 207 Pacific Highway St Leonards 2065	**Storage History:**	Core Box
Project:	St Aloysius College, Kirribilli	**Report No.:**	B44865-PL
Job No.:	B17550	**Date of Test**	20/01/2018

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 7/12/2017

Preparation: Prepared in accordance with the test method

Sample Number	Borehole ID	Depth (m)	Sample Description	Moisture Condition	Test Type	Average Width (mm)	Platen Seperation (mm)	Failure Load (KN)	Point Load Index Is (mPa)	Point Load Index Is50 (mPa)	Notes
B44865	BH01	1.2	SANDSTONE	As Receive	Diametria	52.00	47.00	3.00	1.36	1.32	
B44865	BH01	1.2	SANDSTONE	As Receive	Axial	34.00	25.00	2.00	1.85	1.53	
B44867	BH01	3.4	SANDSTONE	As Receive	Diametria	52.00	47.00	3.00	1.36	1.32	
B44867	BH01	3.4	SANDSTONE	As Receive	Axial	34.00	28.00	2.80	2.31	1.96	
B44868	BH01	5.2	SANDSTONE	As Receive	Diametria	52.00	50.00	6.50	2.60	2.60	
B44868	BH01	5.2	SANDSTONE	As Receive	Axial	28.00	19.00	5.00	7.38	5.50	
B44869	BH01	7.4	SANDSTONE	As Receive	Diametria	52.00	47.00	6.00	2.72	2.64	
B44869	BH01	7.4	SANDSTONE	As Receive	Axial	38.00	29.00	4.00	2.85	2.50	
B44870	BH01	9.9	SANDSTONE	As Receive	Diametria	52.00	47.00	5.50	2.49	2.42	
B44870	BH01	9.9	SANDSTONE	As Receive	Axial	31.00	25.00	4.10	4.16	3.37	
B44872	BH02	3.2	SANDSTONE	As Receive	Diametria	52.00	49.00	4.20	1.75	1.73	
B44872	BH02	3.2	SANDSTONE	As Receive	Axial	39.00	32.00	4.00	2.52	2.27	
B44873	BH02	5.4	SANDSTONE	As Receive	Diametria	52.00	47.00	4.00	1.81	1.76	
B44873	BH02	5.4	SANDSTONE	As Receive	Axial	39.00	31.00	3.50	2.27	2.04	
B44875	BH02	7.2	SANDSTONE	As Receive	Diametria	52.00	48.00	4.20	1.82	1.79	
B44875	BH02	7.2	SANDSTONE	As Receive	Axial	26.00	20.00	3.00	4.53	3.36	
B44876	BH02	9.2	SANDSTONE	As Receive	Diametria	52.00	48.00	5.20	2.26	2.22	
B44876	BH02	9.2	SANDSTONE	As Receive	Axial	40.00	34.00	4.00	2.31	2.13	
B44877	BH02	11.2	SANDSTONE	As Receive	Diametria	52.00	48.00	4.80	2.08	2.05	
B44877	BH02	11.2	SANDSTONE	As Receive	Axial	37.00	33.00	3.80	2.44	2.20	

Comments:

NATA

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Authorised Signatory:

JABoyle

John Boyle

20/01/2018

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
3 Watt Drive
Bathurst NSW 2795

POINT LOAD INDEX REPORT

Client:	Wood and Grieve Engineers	**Sampling Method:**	NA
Address:	Lvl 6, Building B, 207 Pacific Highway St Leonards 2065	**Storage History:**	Core Box
Project:	St Aloysius College, Kirribilli	**Report No.:**	B44868-PL
Job No.:	B17550	**Date of Test**	20/01/2018

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 7/12/2017

Preparation: Prepared in accordance with the test method

Sample Number	Borehole ID	Depth (m)	Sample Description	Moisture Condition	Test Type	Average Width (mm)	Platen Seperation (mm)	Failure Load (KN)	Point Load Index Is (mPa)	Point Load Index Is50 (mPa)	Notes
B44878	BH02	13.2	SANDSTONE	As Receive	Diametria	52.00	48.00	5.00	2.17	2.13	
B44878	BH02	13.2	SANDSTONE	As Receive	Axial	35.00	31.00	3.00	2.17	1.90	
B44879	BH03	1.5	SANDSTONE	As Receive	Diametria	52.00	47.00	3.50	1.58	1.54	
B44879	BH03	1.5	SANDSTONE	As Receive	Axial	34.00	29.00	3.00	2.39	2.05	
B44880	BH03	3.5	SANDSTONE	As Receive	Diametria	52.00	47.00	3.00	1.36	1.32	
B44880	BH03	3.5	SANDSTONE	As Receive	Axial	34.00	27.00	2.00	1.71	1.44	
B44881	BH03	5.2	SANDSTONE	As Receive	Diametria	52.00	47.00	4.00	1.81	1.76	
B44881	BH03	5.2	SANDSTONE	As Receive	Axial	33.00	29.00	3.10	2.54	2.16	
B44882	BH03	7.4	SANDSTONE	As Receive	Diametria	52.00	47.00	4.00	1.81	1.76	
B44882	BH03	7.4	SANDSTONE	As Receive	Axial	34.00	26.00	3.00	2.67	2.23	
B44884	BH03	9.4	SANDSTONE	As Receive	Diametria	52.00	47.00	3.80	1.72	1.67	
B44884	BH03	9.4	SANDSTONE	As Receive	Axial	34.00	28.00	3.20	2.64	2.24	
B44885	BH03	11.2	SANDSTONE	As Receive	Diametria	52.00	45.00	3.20	1.58	1.51	
B44885	BH03	11.2	SANDSTONE	As Receive	Axial	29.00	24.00	3.10	3.50	2.77	
B44886	BH03	13.4	SANDSTONE	As Receive	Diametria	52.00	47.00	3.00	1.36	1.32	
B44886	BH03	13.4	SANDSTONE	As Receive	Axial	31.00	26.00	2.80	2.73	2.23	

Comments:

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

JABoyle

John Boyle

20/01/2018

Date:

MACQUARIE GEOTECH

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Bathurst NSW 2795

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK REPORT

Client:	Wood and Grieve Engineers	**Source:**	BH01 2.35-2.48m
Address:	Lvl 6, Building B, 207 Pacific Highway St Leonards 2065	**Sample Description:**	SANDSTONE
Project:	St Aloysius College, Kirribilli	**Report No.:**	B44866-UCS
Job No.:	B17550	**Lab No.:**	B44866

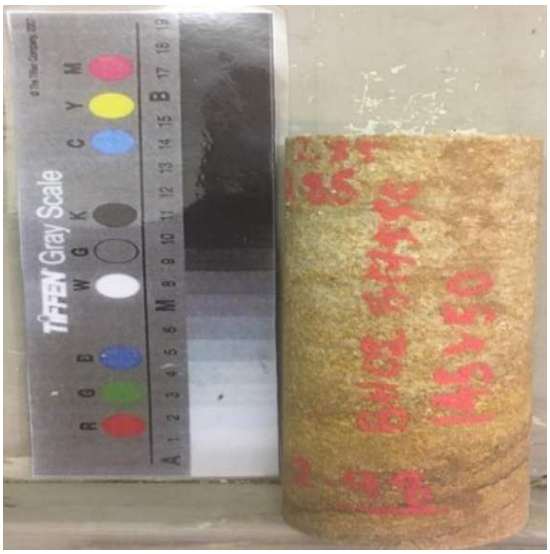
Test Procedure:

☑ AS4133 4.2.1 Rock strength tests - Determination of uniaxial compressive strength - Rock Strength >50MPa

☐ AS4133 4.2.2 Rock strength tests - Determination of uniaxial compressive strength - Rock Strength < 50 Mpa

Sampling:	Sampled by Client	**Date Sampled:**	7/12/2017
Preparation:	Prepared in accordance with the test method		

Date Tested	20/01/2018	**Machine Type**	ELE	**Sample Storage Conditions**	CORE BOX



Before Test

After Test

TEST RESULTS

Average Diameter (mm)	Specimen Height (mm)	Length/ Diameter Ratio	Specimen Condition	Description of Failure	Duration of Test (Sec)	Load at Fracture (kN)	Moisture Content at Time of Test (%)	Compressive Strength (MPa)
52.00	145	2.79	Moist	Shear	300	32	0.8	**15.1**

Notes:

NATA Accredited Laboratory Number: 14874

Authorised Signatory:

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21/01/2018

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UNIAXIAL COMPRESSIVE STRENGTH OF ROCK REPORT

Client:	Wood and Grieve Engineers	**Source:**	BH02 6.00-6.13m
Address:	Lvl 6, Building B, 207 Pacific Highway St Leonards 2065	**Sample Description:**	SANDSTONE
Project:	St Aloysius College, Kirribilli	**Report No.:**	B44874-UCS
Job No.:	B17550	**Lab No.:**	B44874

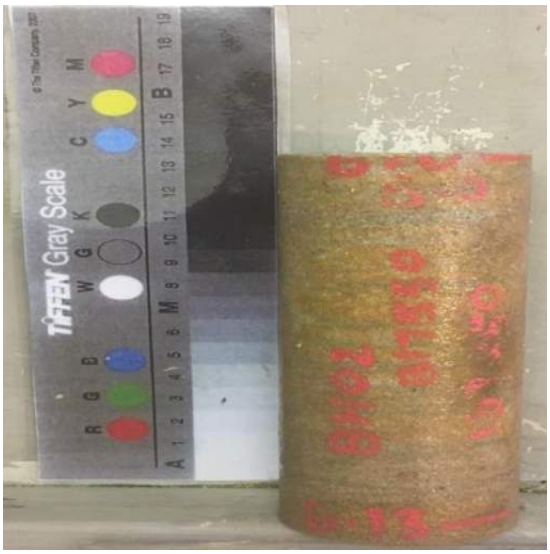
Test Procedure:

☐ AS4133 4.2.1 Rock strength tests - Determination of uniaxial compressive strength - Rock Strength >50MPa

☑ AS4133 4.2.2 Rock strength tests - Determination of uniaxial compressive strength - Rock Strength < 50 Mpa

Sampling:	Sampled by Client	**Date Sampled:**	7/12/2017
Preparation:	Prepared in accordance with the test method		

Date Tested	20/01/2018	**Machine Type**	ELE	**Sample Storage Conditions**	CORE BOX



Before Test

After Test

TEST RESULTS

Average Diameter (mm)	Specimen Height (mm)	Length/ Diameter Ratio	Specimen Condition	Description of Failure	Duration of Test (Sec)	Load at Fracture (kN)	Moisture Content at Time of Test (%)	Compressive Strength (MPa)
52.00	140	2.69	Moist	Shear	342	53	5.2	**25.1**

Notes:

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21/01/2018

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UNIAXIAL COMPRESSIVE STRENGTH OF ROCK REPORT

Client:	Wood and Grieve Engineers	**Source:**	BH03 8.15-8.28m
Address:	Lvl 6, Building B, 207 Pacific Highway St Leonards 2065	**Sample Description:**	SANDSTONE
Project:	St Aloysius College, Kirribilli	**Report No.:**	B44883-UCS
Job No.:	B17550	**Lab No.:**	B44883

Test Procedure:

☐ AS4133 4.2.1 Rock strength tests - Determination of uniaxial compressive strength - Rock Strength >50MPa

☑ AS4133 4.2.2 Rock strength tests - Determination of uniaxial compressive strength - Rock Strength < 50 Mpa

Sampling:	Sampled by Client	**Date Sampled:**	9/1/18
Preparation:	Prepared in accordance with the test method		

Date Tested	20/01/2018	**Machine Type**	ELE	**Sample Storage Conditions**	CORE BOX

Before Test

After Test

TEST RESULTS

Average Diameter (mm)	Specimen Height (mm)	Length/ Diameter Ratio	Specimen Condition	Description of Failure	Duration of Test (Sec)	Load at Fracture (kN)	Moisture Content at Time of Test (%)	Compressive Strength (MPa)
52.00	140	2.69	Moist	Shear	320	39	3.9	**18.6**

Notes:

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Authorised Signatory:

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21/01/2018

Date:

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UNIAXIAL COMPRESSIVE STRENGTH OF ROCK REPORT

Client:	Wood and Grieve Engineers	**Source:**	BH03 14.8-14.95m
Address:	Lvl 6, Building B, 207 Pacific Highway St Leonards 2065	**Sample Description:**	SANDSTONE
Project:	St Aloysius College, Kirribilli	**Report No.:**	B44887-UCS
Job No.:	B17550	**Lab No.:**	B44887

Test Procedure:

☐ AS4133 4.2.1 Rock strength tests - Determination of uniaxial compressive strength - Rock Strength >50MPa

☑ AS4133 4.2.2 Rock strength tests - Determination of uniaxial compressive strength - Rock Strength < 50 Mpa

Sampling:	Sampled by Client	**Date Sampled:**	9/01/2018
Preparation:	Prepared in accordance with the test method		

Date Tested	20/01/2018	**Machine Type**	ELE	**Sample Storage Conditions**	CORE BOX

Before Test

After Test

TEST RESULTS

Average Diameter (mm)	Specimen Height (mm)	Length/ Diameter Ratio	Specimen Condition	Description of Failure	Duration of Test (Sec)	Load at Fracture (kN)	Moisture Content at Time of Test (%)	Compressive Strength (MPa)
52.00	150	2.88	Moist	Shear	310	37	6.1	**17.4**

Notes:

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21/01/2018

Date:

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APPENDIX B Cavvanba Consulting –Contamination

Preliminary Site Investigation

Wood and Grieve Engineers Pty Ltd

St Aloysius College,
Kirribilli NSW 2061

January 2018

Ref. 17066 R01

CAVVANBA
consulting

Cavvanba Consulting Pty Ltd
ABN: 37 929 679 095

1/66 Centennial Circuit
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Byron Bay NSW 2481

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Report Details

Report:

Preliminary Site Investigation

St Aloysius College, Kirribilli, New South Wales 2061

Ref: 17066 R01

for

Wood & Grieve Engineers Pty Ltd

Distribution:

Deliverables	Status	Date	Recipient
1	17066 R01	25/01/2018	Jonathan Durnell, Wood & Grieve Engineers Pty Ltd
1	17066 R01	25/01/2018	Cavvanba Project File
1	17066 R01	25/01/2018	Cavvanba Library

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Ross Nicolson
Senior Environmental Scientist

Date: 25 January 2018

Ben Wackett
Principal Environmental Scientist

Date: 25 January 2018

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Figures

Tables

Appendices

Executive Summary

Cavvanba Consulting Pty Ltd was commissioned by Wood & Grieve Engineers Pty Ltd to undertake a Preliminary Site Investigation (PSI) at three parcels of land located in Kirribilli, New South Wales 2061 (herein known as the sites). The site is proposed to be developed and an environmental site assessment is required to be submitted with the development application (DA). The site consists of:

- *Junior School;*
- *Senior School; and*
- *Main Campus.*

The objective of the PSI was to identify all past and present potentially contaminating activities, identify potential contaminant types, discuss the site conditions, provide a preliminary assessment of site contamination; and assess the need for further investigations.

The limited soil investigation objectives were to provide additional information to supplement the PSI information obtained. The intrusive investigation focussed on the areas of the site proposed to be disturbed by the works outlined in the DA.

To meet the project objectives, the scope of work completed included a desktop review of background information and undertaking a limited intrusive investigation which included the advancement of six soil bores across the three properties, installation of three monitoring wells and sampling of soil and groundwater.

The site is currently a school, located within a SP2 – Educational Establishment zoning. There are limited areas of open space and are mostly concrete surfaced.

The sources of potential on-site contamination were identified to include fill material, underground fuel storage, demolition waste and asbestos in buildings as well as off-site sources including a dry-cleaners.

The soil profile identified across the site was observed to consist of fill material to varying depths depending on the property, followed by the natural sandstone profile. Field indicators, including hydrocarbon odours were noted in the fill material. Potential asbestos containing material fragments were not observed on surface soils or within the soil profile on-site.

Soil analytical results exceeded adopted health-based residential screening criteria in samples collected and analysed from fill material from all three properties. As the sites are largely sealed, complete exposure pathways to the impacted fill material are limited at this stage.

Groundwater analytical results from the installed monitoring wells exceeded site criteria for metals and benzo(a)pyrene, as well as detections for TRH and BTEXN.

Based on the findings of this preliminary site investigation and the limited intrusive investigation undertaken, the risk of exposure to the contaminated fill material will need to be managed during the proposed works as complete exposure pathways exist during excavation. In addition, waste classification will need to be considered if off-site disposal is proposed.

More detailed environmental investigation works are required to characterise contamination at the site, evaluate if there are unacceptable risks to human health or the environment and to determine site suitability.

1.0 Introduction

Cavvanba Consulting Pty Ltd (Cavvanba) was commissioned by Wood & Grieve Engineers Pty Ltd (W&G) to undertake a Preliminary Site Investigation (PSI) of St Aloysius College located in Kirribilli NSW 2061.

The scope of work was detailed in Cavvanba's proposal to W&G, and associated acceptance of engagement on 28 November 2017. This report should be read in conjunction with Cavvanba's *General Limitations*, included as Section 1.4.

1.1 Background

The college (the site) consists of three discrete campuses, located in close proximity off Humphrey Place as detailed below from north to south:
- Junior School;
- Senior School; and
- Main Campus.

The site is proposed to be developed and an environmental site assessment is required to be submitted with the development application (DA). The development proposed for the site is detailed below:
- Junior School: construction of an underground sports hall;
- Senior School: construction of a new single-story classroom structure; and
- Main Campus: construction of a new building and repurposing of adjoining structures.

It is likely that as part of these works, subsurface disturbance with occur including excavation of soil and potential off-site disposal.

A site locality and site features plan are provided as Figure 1 and Figures 2-4, respectively. These Figures also show the areas proposed to be disturbed by the works.

1.2 Objectives

The PSI objectives are based on those described by the Environment Protection Authority (EPA) formerly (*Office of Environment and Heritage) Guidelines for Consultants Reporting on Contaminated Sites, 2011*, which describe that the objectives of a preliminary site investigation are to:
- identify all past and present potentially contaminating activities;
- identify potential contaminant types;
- discuss the site conditions;
- provide a preliminary assessment of site contamination; and
- assess the need for further investigations.

The limited soil investigation objectives were to provide additional information to supplement the PSI information obtained. The intrusive investigation focussed on the areas of the site proposed to be disturbed by the works outlined in the DA.

1.3 Scope of work

The scope of work included:

- Review of historical environmental reports applicable to the site.
- Review information held by North Sydney Council.
- Search of the certificates of land titles.
- Review of historical aerial photographs.

- Groundwater bore/monitoring well search of Department of Primary Industries licensed groundwater bores within a 1 km radius of the site.
- Dangerous Goods search of Safe Work NSW records.
- Review of public registers including contaminated land records, Protection of the Environment Operations (POEO), cattle dip site locater, unexploded ordinance (UXO), and Environmental Protection Authority (EPA) notified sites.
- Completion of a comprehensive site walkover and visual inspection for key features to identify potential areas of environmental concern on- and off-site.
- Review of available published information regarding site conditions, e.g. geology sheet, soil maps and notes, etc.
- Incorporate the findings of these activities into a report.

In addition to the above scope, a limited intrusive investigation was conducted during the geotechnical works, consisting of:

- Observation of the excavation of six geotechnical holes advanced in the areas of the site proposed to be disturbed, and appraisal of environmental conditions.
- Soil samples were collected and analysed for total recoverable hydrocarbons (TRH), benzene, toluene, ethylbenzene, xylene, naphthalene (BTEXN), polycyclic aromatic hydrocarbons (PAHs), heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury), and limited samples for asbestos and volatile organic compounds (VOCs).
- Monitoring wells were installed by Macquarie Geotech. Cavvanba collected samples for analysis for TRH, BTEXN, PAHs, heavy metals, organochloride pesticides (OCPs), organophosphorus pesticides (OPPs) and polychlorinated biphenyls (PCBs).
- Inclusion of the results in the PSI report.

Guidance considered in preparing a PSI includes:

- NSW EPA (formerly Office of Environment and Heritage (OEH)) (2011) *Guidelines for Consultants Reporting on Contaminated Sites*.
- NSW EPA (2017) *Guidelines for the NSW Site Auditor Scheme (3rd edition)*.
- National Environment Protection Council (NEPC) *National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM (2013)) – Schedule B2: Guideline on Site Characterisation* (2013).

1.4 Limitations

The findings of this report are based on the objectives and scope of work outlined above. Cavvanba performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession. No warranties or guarantees, express or implied, are made. Subject to the scope of work, Cavvanba's assessment is limited strictly to identifying typical environmental conditions associated with the subject property, and does not include evaluation of any other issues. This report does not comment on any regulatory obligations based on the findings, for which a legal opinion should be sought. This report relates only to the objectives and scope of work stated, and does not relate to any other works undertaken for the Client.

The report and conclusions are based on the information obtained at the time of the assessment. Changes to the subsurface conditions may occur subsequent to the investigation described herein, through natural processes or through the intentional or accidental addition of contaminants, and these conditions may change with space and time.

The site history, and associated uses, areas of use, and potential contaminants, were determined based on the activities described in the scope of work. Additional site history information held by the Client, regulatory authorities, or in the public domain, which was not provided to Cavvanba or was not sourced by Cavvanba under the scope of work, may identify additional uses, areas of use and/or potential contaminants. The information sources referenced have been used to determine site history and desktop information regarding local subsurface conditions. While Cavvanba has used reasonable care to avoid reliance on data and information that is inaccurate or unsuitable, Cavvanba is not able to verify the accuracy or completeness of all information and data made available.

Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history, and which may not be expected at the site. The absence of any identified hazardous or toxic materials on the subject property, should not be interpreted as a warranty or guarantee that such materials do not exist on the site. If additional certainty is required, additional site history or desktop studies, or environmental sampling and analysis, should be commissioned.

The results of this assessment are based upon site inspection and fieldwork conducted by Cavvanba personnel and information provided by the Client. All conclusions regarding the property area are the professional opinions of the Cavvanba personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, Cavvanba assumes no responsibility or liability for errors in any data obtained from regulatory agencies, information from sources outside of Cavvanba, or developments resulting from situations outside the scope of this project.

2.0 Site Setting

2.1 Site Identification

The college consists of three discrete campuses, located in close proximity off Humphrey Place as detailed below from north to south:
- Junior School;
- Senior School; and
- Main Campus.

The Junior School is situated approximately 80 m (one street block) to the north of the Senior School. The legal property description of the site is referred to as Lot 1 DP830667.

The Senior School is described as Lot 101 in DP1108496.

The Main Campus is located off Jefferey's Street, Kirribilli NSW 2061, approximately 100 metres (m) east of the Bradfield Highway. The legal property description of the site is referred to as Lot 10 in Deposited Plan (DP) 880841.

Specific site details are presented in Sections 2.1.1 – 2.1.3, below. A site locality map is provided as Figure 1.

2.1.1 Junior School Identification

The Junior School site location is shown on Figure 1. The site identification and landuse details are:

Owner:	The Trustees of The Jesuit Fathers.
Site Address:	29 Burton Street, Milsons Point, 2061, NSW
Legal Property Description:	Lot 1 in DP830667
Property area:	Approximately 4,300m^2.
Co-ordinates:	Latitude: -33.846545536 Longitude: 151.213584165
Local Government Authority:	North Sydney Council.
Elevation:	Approximately 30 metres (m) above mean sea level.
Landuse – Existing:	Junior School.
Landuse – Proposed:	Junior School.
Zoning – Existing:	SP2 – Educational Establishment.
Zoning – Proposed:	SP2 – Educational Establishment.

2.1.2 Senior School Identification

The senior school site location is shown on Figure 1. The site identification and landuse details are:

Registered Proprietor:	The Trustees of the Jesuit Fathers.

Site Address:	47 Upper Pitt Street, Milsons Point, 2061, NSW
Legal Property Description:	Lot 101 of DP1108496
Property area:	3,400 m^2
Co-ordinates:	Latitude: -33.847878851 Longitude: 151.214116498
Local Government Authority:	North Sydney Council.
Elevation:	Approximately 30 metres (m) above mean sea level.
Landuse – Existing:	Senior School
Landuse – Proposed:	Senior School
Zoning – Existing:	SP2 – Educational Establishment.
Zoning – Proposed:	SP2 – Educational Establishment.

2.1.3 Main Campus Identification

Owner:	The Trustees of the Jesuit Fathers.
Site Address:	47 Upper Pitt Street, Milsons Point, 2061, NSW
Legal Property Description:	Lot 10 of DP880841.
Property area:	Approximately 3,800 m^2.
Co-ordinates:	Latitude: -28.550873 Longitude: 153.503748
Local Government Authority:	North Sydney Council.
Elevation:	Approximately 20 - 30 metres (m) above mean sea level.
Landuse – Existing:	College
Landuse – Proposed:	College
Zoning – Existing:	SP2 – Educational Establishment.
Zoning – Proposed:	SP2 – Educational Establishment.

2.2 Surrounding Land Uses

The sites are located in mixed residential and commercial/industrial area. The boundaries of all sites are roads, excluding the northern portion of the Senior School. Land use features surrounding the three sites are summarised below.

2.2.1 Junior School

North: Burton Street is situated immediately to the north of the site; beyond this, industrial and residential properties extend over a number of streets.

East: Residential properties are located to the east of the site beyond Crescent Place.

South: Bligh Street is situated directly to the South, residential and commercial buildings occupy the block beyond this point including a dry cleaners.

West: Residential properties are located to the east beyond Humphrey Place.

2.2.2 Senior School

North: Fitzroy Street is located to the North; residential dwellings occupy the area immediately beyond this.

East: Residential and apartment block buildings occupy the east.

South: Upper Pitt Street runs adjacent to the southern boundary of the site; beyond this is St Aloysius's Main Campus site.

West: Jeffery Street is situated to the west; apartment buildings appear to occupy the block beyond.

2.2.3 Main Campus

North: Upper Pitt Street runs along the northern boundary of the site. The St Aloysius Senior School is situated approximately 30 m to the north.

East: Apartment buildings occupy the neighbouring land to the east.

South: The site is bordered by Kirribilli Avenue to the south, followed by residential buildings.

West: The site is bordered with Jefferys Street to the west, followed by residential buildings.

3.0 Environmental setting

3.1 Local meteorology

A summary of the climatic data for the nearby Sydney Observatory Hill is shown in Table 3.1.

Table 3.1: Climatic summary

	Temperature ^{0}C		Rainfall mm		Mean number of raindays
	Minimum	Maximum	Average monthly	Highest recorded	
January	18.7	26.0	102.2	387.1	8.6
February	18.8	25.8	117.6	630.6	9.0
March	17.6	24.8	130.9	521.4	9.8
April	14.7	22.5	128.5	622.1	12.9
May	11.6	19.5	118.6	585.0	13.0
June	9.3	17.0	132.2	642.7	12.5
July	8.1	16.4	96.6	336.1	11.1
August	9.0	17.9	80.7	482.6	10.3
September	11.1	20.1	67.9	355.8	10.5
October	13.6	22.2	76.4	285.0	11.6
November	15.7	23.7	83.6	517.2	11.7
December	17.6	25.2	77.5	401.9	11.5

Notes: Data from 1858 to 2017 from Sydney Observatory Hill (Bureau of Meteorology Climate data website). A rain day occurs when a daily rainfall of at least >1 mm is recorded.

3.2 Topography and hydrology

3.2.1 Junior School

The Junior School is situated at approximately 29 metres above mean sea level forming the topmost portion of the ridge to the Kirrbilli Peninsula. The site slopes from the Bligh Street entrance at its highest point with a gradual fall of approximately 4 metres toward the Burton Street entrance to the north. It is anticipated that surface water would be directed over land to the north of the site towards the municipal stormwater drainage system, eventually discharging to Sydney Harbour.

3.2.2 Senior School

The Senior School is situated at approximately 28 metres above mean sea level, which also forms part of the ridge to the Kirribilli Peninsula. The site is predominantly occupied by buildings, however the open, south-western portion of the site is relatively flat with a gradual fall to the southwest towards Sydney Harbour. It is anticipated that surface water would be directed within the on-site stormwater drainage system to the southwest, eventually discharging to Sydney Harbour.

3.2.3 Main Campus

The Main Campus is situated at approximately 24 metres above mean sea level, forming part of the Kirribilli Peninsula ridge line. The site is occupied completely by buildings with the exception of a level, concrete open space area in the central – eastern portion of the site. The general area within the immediate vicinity of the Main Campus slopes from the

Upper Pitt Street entrance at its highest point with a fall of approximately 6 metres towards Kirribilli Avenue to the south. Similar to the Senior School site, it is anticipated that surface water would be directed within the on-site stormwater drainage system to the southwest, eventually discharging to Sydney Harbour. Sydney Harbour is located approximately 100 m to the south of the Main Campus.

3.3 Geology and soils

3.3.1 Geology

Based on the Sydney Area Coastal Quaternary Geology Map (Geological Survey of New South Wales, 2008), the site lies on Hawkesbury Sandstone, consisting of cross-bedded to massive quartz sandstone with mudstone lenses.

3.3.2 Acid sulfate soils

The NSW Environment & Heritage online Soil and Land Information (eSPADE) shows the sites are located in an area where acid sulfate soils are not known to be present.

3.4 Hydrogeology

Based on the height of the site, relative to the Harbour, as well as the fractured aquifer within the sandstone, groundwater is likely to be encountered within 10 m of the ground surface. Groundwater is expected to be within the fractures and porous lenses within the bedrock. Regional groundwater is anticipated to flow to the south towards Sydney Harbour.

A search of NSW Department of Primary Industries Office of Water licensed bores within a 500 m radius of the senior school site identified one registered bore, which is located 450 m east of the site. This bore is considered to be across-gradient assuming the groundwater is flowing towards Sydney Harbour to the south.

The results of the groundwater bore search are provided in full in Appendix A, and summarised in Table 3.2 below.

Table 3.2: Licensed bore summary

Bore ID	Registered use	Distance from site	Geology	Depth (m)	Water bearing zone (m)
GW114492	Monitoring bore	~ 450 m east	0 – 0.3 m fill dark brown, silty sandy clay. 0.3 – 1.3 m fill dark brown, silty sandy clay, sandstones. 1.3 – 1.7 m Sandstone, low strength, yellow brown. 1.7 – 10.0 m Sandstone, medium strength, grey.	10.0	1.2 m

4.0 Site History and Regulatory Information

4.1 Site history summary

A history of the school was present on a plaque on-site, which has been summarised in Table 4.1 below.

To summarise, the college was present previously in East Sydney before moving to Surry Hills and then to the current site in 1903. The school opened in 1908, initially as a Junior School in the location of the current Main Campus.

The Senior School property was purchased in 1916. Major redevelopment of the college occurred during the 1960.

The Junior School property was opened in 1993. Prior to this, this was residential properties.

Table 4.1: School history

Year	Description
Previous locations	
1879	St. Aloysius' College was opened in St. Kilda House, Palmer Street, East Sydney (i.e. not the current location).
1882	Transferred to Bourke Street, Surry Hills (present St. Margaret's Hospital) (i.e. not the current location).
Main Campus only	
1903	College transferred to Kirribilli (Main Campus).
1908	Junior School opened (Main Campus).
1915	Additions to old residence.
Main Campus and Senior School	
1916	Wyalla Purchased (Senior School).
1954	Science Block added to Wyalla (Senior School).
1961	Redevelopment of the college began.
1963	Stage One (Great Hall, Classrooms, Offices) opened.
1965	Stage Two (Foyer, Gymnasium, Chapel) opened.
1967	Stage Three (Completion of Hall, Garage, Offices, Classrooms) opened.
Main Campus, Senior School and Junior School	
1993	Opening of Junior School Burton Street, Milson's Point.
1997	Opening of Wyalla as new Senior School (Years 11 & 12).
2011	Opening of Dalton Hall (Senior School).

4.1.1 Title Deed Information

The historical title search and cadastral layout is provided in full in Appendix B. The three sites consist of the following:

- Junior School;
- Senior School; and
- Main Campus.

A summary provided by Advance Legal Searchers Pty Ltd is displayed in Tables 4.2, 4.3 and 4.4 below.

Junior School

A summary for the Junior School is provided below in Table 4.2 below.

The title search information shows that the site was acquired as multiple Lots between 1959 – 1971 for development of the Junior School which was opened in 1993. This correlates with the known site history included in Table 4.1.

Prior to this, there appear to be multiple Lots which were owned by individuals. No business names were present, but the occupations of the owners were noted. Reviewing this information with the aerial photographs suggests it was high density residential land use.

Table 4.2: Junior School land title search summary

Year	Proprietor description
(Lot 1 DP 830667)	
1993 – to date	The Trustees of the Jesuit Fathers
Lots 11 to 21 Section B DP 1537, Lots 1 to 4 DP 120180, Lots 1 to 2 DP 120181, Lots 1 to 3 DP 120182, Lots 1 & 2 DP 121439, Lot A DP 378862, Lot B DP 378862, Lot A DP 382298, Lot B DP 382298	
1991 – 1993	The Trustees of the Jesuit Fathers
1989 – 1991	Minister for School Education and Youth Affairs
All Lots	
(~1959 – 1971) – 1989 Date of acquisition varies depending on lot.	Her Most Gracious Majesty Queen Elizabeth the Second
Prior to 1959 – 1971	Multiple owners. Refer to Appendix B for more information.

Senior School

A summary for the main Lot of the Senior School is provided below in Table 4.3 below.

The title search information shows that the site was acquired in 1916 for use as a school, which correlates with the known site history.

Prior to this time period, there appear to be multiple Lots which were owned by individuals. No business names were present, but the occupations of the owners were noted. Reviewing this information suggests it was a residential land use.

Table 4.3: Senior School land title search summary

Year	Proprietor description
(Lot 101 DP 1108496)	
2007 – to date	The Trustees of the Jesuit Fathers
(Part Lot 2 DP 55414 – Area 2 Roods 8 Perches – CTVol 2682 Fol 192)	

Year	Proprietor description
1951 - 2007	The Trustees of the Jesuit Fathers
1931 – 1951	John Corcoan, clerk in holy orders John Lynch Forster, clerk in holy orders Austin Kelly, clerk in holy orders
1922 – 1931	John Corcoan, clerk in holy orders Dominic Connell, clerk in holy orders John Lynch Forster, clerk in holy orders
1916 – 1922	Patrick Joseph McCurtin, clerk in holy orders John Lynch Forster, clerk in holy orders George Byrne, clerk in holy orders
1916 – 1916	Annie Wilson Hardwick Hutton, wife of George Hutton, gentleman.
Prior - 1916	Multiple owners. Refer to Appendix B for more information.

Main Campus

A summary for the Main Campus is provided below in Table 4.4 below.

The title search information shows that the site was owned by the Jesuit Fathers since at least 1906 and has likely been associated with the school since then.

Table 4.4: Main Campus land title search summary

Year	Proprietor description
(Lot 10 DP 880841)	
1998 – to date	The Trustees of the Jesuit Fathers
(Lot 5 DP 115496)	
1996 - 1998	The Trustees of the Jesuit Fathers
(Note (a) Part Portion 356 Parish Willoughby – Area 1 Rood 30 Perches – CTVol 1722 Fol 122)	
1951 – 1996	The Trustees of the Jesuit Fathers
1931 – 1951	John Corcoan, clerk in holy orders John Lynch Forster, clerk in holy orders Austin Kelly, clerk in holy orders
1922 – 1931	John Corcoan, clerk in holy orders Dominic Connell, clerk in holy orders John Lynch Forster, clerk in holy orders
1906 – 1922	John Ryan, clerk in holy orders Thomas Fay, clerk in holy orders Charles Delaney, clerk in holy orders Thomas Gartlan, clerk in holy orders Luke Murphy, clerk in holy orders
(Note (b) Allotment 4 of Mr. John Campbell's subdivision Parish Willoughby – Area 2 Roods – Conv Bk 1623 No. 528)	
1931 – 1996	Reverend John Forster Reverend Wilfred Ryan Reverend Austin Kelly *(trustees of the Jesuit Fathers)*
Prior – 1931	Reverend George Byrne Reverend John Forster Reverend Wilfred Ryan

Year	Proprietor description
	(trustees of the Jesuit Fathers)

4.1.2 Historical Aerial Photographs

Aerial photographs dated between 1943 and 2017 were reviewed as part of this investigation, and are included as Appendix B. A summary of each photograph is provided in Tables 4.5 – 4.7, below.

Junior School

Between the 1970 and 1982 aerial photograph, there appears to have been demolition of the six residential properties in the southern portion of the property.

Table 4.5: Junior School Aerial Photograph Summary

Photograph	Interpretation
1943	The layout and alignment of the wider Kirribilli area appears to be similar to what we see to date. – six residential buildings are situated in the southern portion of the site; – a large building is situated in the northern portion of the site; – a large tree occupies the north-eastern corner of the site; – the highway is present approximately 100 m to the west of the site; – immediately to the north appears to be occupied by one large industrial building, beyond this, residential properties extend over a number of blocks; – residential properties appear to be located to the east of the site, across the road, currently known as Carabella Street; – a small road, currently known as Bligh Street, runs from east to west directly to the South, residential buildings occupy the block beyond this point; and – residential properties are located to the west of the site, beyond the road currently known as Humphrey Place.
1951	The site and immediate surrounding area appears to be consistent with the previous aerial photograph.
1961	The site and immediate surrounding area appears to be consistent with the previous aerial photograph.
1970	The most eastern residential buildings appear to have been demolished. The remaining features of the site and surrounding area appear consistent with the previous aerial photograph.
1982	A large sports field now occupies the southern portion of the site, previously where the six residential buildings were first identified in 1943. The remaining features of the site and surrounding area appear consistent with the previous aerial photograph.
1991	The site and immediate surrounding area appears to be consistent with the previous aerial photograph.

Photograph	Interpretation
2005	The large building in the northern portion of the site is no longer present. A large building now occupies the western boundary of the site, presumed to be the Junior School. A portion of the sports field appears to have been sealed, presumably for recreational use in the location of the current basketball court. The remaining features of the site and surrounding area appear consistent with the previous aerial photograph.
2017	The building in the western portion has had an extension added onto its southern side, bordering Bligh Street. Another sealed area is present adjacent to this extension. The remaining features of the site and surrounding area appear consistent with the previous aerial photograph.

Senior School

Minimal changes are evident from the historical aerial photographs for the Senior School.

Table 4.6: Senior School Aerial Photograph Summary

Photograph	Interpretation
1943	The layout and alignment of the wider Kirribilli area appears to be similar to what we see to date. – The site appears to be developed with buildings occupying a significant portion of the site area; – the highway is present approximately 100 m to the west of the site; – immediately to the north appears to be occupied by a row of large buildings, beyond this, residential properties extend over a number of blocks; – industrial buildings appear to be present to the east of the site; – the road, currently known as Upper Pitt Street, runs from east to west directly to the south, the main school campus occupies the block beyond this point; – apartment blocks are located to the west of the site, beyond the road currently known as Jeffrey's Street.
1951, 1961, 1970, 1982, 1991, 2005, 2017	The site and immediate surrounding area appears to be consistent with the aerial photograph dated 1943.

Main Campus

Between the 1970 and 1982 aerial photograph, there appears to have been demolition of the smaller properties located in the northern section of the Main Campus.

Table 4.7: Main Campus Aerial Photograph Summary

Photograph	Interpretation
1943	The layout and alignment of the wider Kirribilli area appears to be similar to what we see to date. – Approximately five buildings were located in the northern portion of the site; – A concrete pad was located in the southern portion of the site as well as some large trees; – The highway is present approximately 100 m to the west of the site; – immediately to the north, across the road currently known as Upper Pitt Street, is occupied by the Senior School; – industrial buildings appear to be present to the east of the site; – the road, currently known as Kirribilli Avenue, runs from east to west directly to the south, apartment blocks occupy the area beyond this point; – apartment blocks are located to the west of the site, beyond the road currently known as Jeffrey's Street.
1951, 1961	The site and immediate surrounding area appears to be consistent with the aerial photograph dated 1943.
1970	The large southern building appears to have been developed on the remaining area of the site. The remaining features of the site and surrounding area appear consistent with the previous aerial photograph.
1982	The buildings in the northern portion of the site appear to have been demolished and replaced by one a larger building. The remaining features of the site and surrounding area appear consistent with the previous aerial photograph.
1991, 2005 and 2017	The site and immediate surrounding area appears to be consistent with the aerial photograph dated 1982.

4.2 Desktop regulatory records search

4.2.1 Chemical handling and storage

Site occupiers are required to notify SafeWork NSW if they store, handle or process hazardous chemicals that exceed quantities specified in the relevant legislation. A search of SafeWork NSW dangerous goods licences database has identified no records held for this site (refer to Appendix D).

4.2.2 North Sydney Local Environmental Plan 2013

According to the North Sydney Local Environmental Plan (LEP) 2013, the following key information for the site and immediate surrounding area is noted:

- All three sites (Junior School, Senior School and Main Campus) are located within a SP2 – Infrastructure (Educational Establishment) zoning as presented on the land zoning map. The objectives of the *SP2 – Infrastructure* zoning are generally to:
  - provide for infrastructure and related uses; and
  - prevent development that is not compatible with, or that may detract from the provision of infrastructure.

- The Junior School and Senior School (Wyalla) properties are listed as being Heritage properties (I0188 and I0242 respectively), as presented on the Heritage Map, included as Appendix E.

- The sites are not within the foreshore area.

4.2.3 Regulatory agency search – licences, permits and notices

A summary of licenses, permits and notices, accessed 23 January 2018 is provided in Table 4.8 below, and included in Appendix F in full.

Table 4.8: Online search results for licences, permits and notices

Search	Description	Result
Protection of the Environment Operations (POEO) Public register	Environment protection licences, applications and notices.	None.
Contaminated Land Management (CLM) Records	Notices for: – Declaration of significantly Contaminated Land; – Approved Voluntary Management Proposals; Management orders; – Ongoing maintenance orders; – Repeal, revocation or variation notices; – Site audit statements.	None.
The Department of Defence	UXO risk.	None.
Department of Primary Industries	Naturally occurring asbestos in NSW	None.

4.3 Surrounding landuses

4.3.1 Neutral Bay Gasworks

The North Shore Gas Company began operations at the HMAS Platypus site in 1884, adjacent to Neutral Harbour, located approximately 300 m north-east of the site. These gasworks operated for over 50 years, expanding facilities as demand for gas increased. By 1937, the ageing gasworks infrastructure at Neutral Bay had become inefficient and costly to operate resulting in closure of the facility in favour of a new more efficient gasworks at Oyster Cove.

Based on Cavvanba's experience, wastes from gasworks that can be used as filling material, such as ash and spent oxides were often transported locally to sites for filling and levelling of land.

4.3.2 Other surrounding landuses

The other sites identified in the EPA contaminated sites register (included in Appendix F) are not really considered to be an issue. It is noted however that there is a dry cleaner located to the south of the Junior School.

4.4 Services and stormwater

Underground assets such as gas, electricity and water provide preferential pathways for contaminant migration. A dial before you dig search was conducted that showed a large number of assets in close proximity to the site, with some leading onto the site.

Underground service plans are provided in Appendix G.

4.5 Previous environmental investigations

No previous environmental investigations have been provided to Cavvanba for the properties.

4.6 Integrity assessment

The site history information documented above is generally consistent with the aerial photographs, and the physical condition of the site.

Based on the above, Cavvanba considers that sufficient historical information and site condition information has been obtained to allow for a thorough investigation of the site's environmental condition.

5.0 Site Interview and Inspection

A site inspection was undertaken to incorporate anecdotal evidence and consolidate the findings of the information review through physical inspection of potential contaminant sources, pathways and receptors.

5.1 Site interview

An interview was conducted with Brian Hartley, the caretaker for St Aloysius college on 8 December 2017, who had worked at the site for 28 years. Brian's understanding of the site history was similar to that described in Section 4.1.

An underground storage tank (UST) was known to be on the main campus, associated with the boiler. Brian was uncertain of the volume of the UST but believed it remained in-situ but stopped being used prior to 1982.

Asbestos was understood to have been present on-site in certain areas but has been managed by an asbestos contractor.

Small-scale use of chemicals associated with the science laboratory were believed to have been used on-site but were understood to have been periodically appropriately disposed of off-site.

Small-scale fuel and solvent storage is located on-site in a designated dangerous goods storage area.

An underground storage tank exists on the Senior School site, used for storage of grey water which is recycled for toilets and urinals.

5.2 Site observations

A site inspection was undertaken by Mr Drew Wood of Cavvanba on 7 December 2017. A photographic log has been provided as Appendix H. The following key observations were made during the site inspection:

Junior School

- The site is an operational junior school, located atop of the Kirribilli Peninsula ridge line.

- The western portion of the site is covered completely by buildings, forming approximately 40% of the total site area. Whilst access to the building was restricted in areas, it is understood that these buildings were generally made up of classrooms, offices and assembly areas.

- The open space areas within the central and eastern portion of the site comprised of the following:
  - an open space assembly area, covered by a concrete hardstand;
  - a concrete basketball court;
  - artificial turf cricket nets and open space area; and
  - asphalt open space area.

- With the exception of landscaped garden areas intermittently occupying the southern, eastern and northern site boundaries, the entire site area was completely covered by buildings, concrete, artificial turf or asphalt.

Senior School

- The site is an operational senior school forming part of the Kirribilli Peninsula ridgeline.

- The northern and eastern portion of the site is predominantly covered by buildings and/or small paved courtyards areas, which forms approximately 70% of the total site area. The senior school vehicle parking area is located atop of the double storey building in the northern portion of the site, with access from Robertson Lane. Whilst access to the building was restricted in areas, it is understood that these buildings were generally made up of classrooms, offices and assembly areas.

- The open space area in the south-western portion of the site comprised of a paved and grassed area with sporadic, mature trees. The grassed area was observed to be patchy in areas.

Main Campus

- The site is an operational school that forms part of the Kirribilli Peninsula ridgeline.

- Approximately 80% of the total site area is covered by buildings, with the remaining area comprising a concrete open space area. Whilst access to the building was restricted in areas, it is understood that these buildings were generally made up of classrooms, offices and assembly areas.

- With the exception of a raised, landscaped garden in the central – eastern portion of the site, the entire site was completely covered by buildings or concrete.

- A small workshop and general maintenance area was observed on the western boundary of the site, with access from Jeffrey Street, which generally comprised the following:
  - small quantity dangerous goods storage consisting of fuels, solvents, paints etc as presented on Photographs 19 and 20 of Appendix H;
  - an underground storage tank of approximately 4,000 L in volume (assumed 1,015 gallons), assumed to formerly contain kerosene as presented on Photographs 17 and 18 of Appendix H; and
  - general small-scale maintenance activities.

- Whilst access to school laboratories was restricted, all chemicals used by staff in science laboratories are understood to be appropriately stored and where required, disposed of off-site.

It should be noted that during the site inspection, access was not available to all portions of the three sites.

5.2.1 Above-ground and underground infrastructure

While the SafeWork NSW report did not include any details of dangerous goods, based on conversations on-site and observations, an underground storage tank exists on the Main Campus.

5.2.2 Evidence of filling

Filling was evident associated with levelling of the site prior to construction.

5.3 Visual and olfactory signs of contamination

Potential contamination was limited to fill material used for site levelling prior to construction, as well as the UST identified.

5.4 Issues identified

A summary of the potential contamination sources identified are detailed below for each site.

Junior School

Potential contamination sources consist of:
- demolition waste associated with the six former residential properties in the southern portion of the site. Poor demolition practices were common during this time-period, so there is a high potential of contamination associated with asbestos, lead paint etc in this portion of the site;
- imported fill used for site levelling;
- adjacent dry cleaners (located downgradient); and
- asbestos in current site buildings.

Senior School

Potential contamination sources consist of:
- imported fill used for site levelling;
- adjacent dry cleaners (located upgradient); and
- asbestos in current site buildings.

Main Campus

Potential contamination sources consist of:
- demolition waste associated with the former buildings in the northern portion of the site. Poor demolition practices were common during this time-period, so there is a high potential of contamination associated with asbestos, lead paint etc in this portion of the site;
- imported fill used for site levelling;
- former UST, currently not decommissioned; and
- asbestos in current site buildings.

6.0 Soil and groundwater assessment

The contaminants, media and environmental criteria are summarised below.

6.1 Contaminants of concern

Potential contaminants of concern are detailed in Table 6.1 below and are associated with the presence of fill material as well as fuel storage.

Table 6.1: PCOCs and summary of areas of concern

PCOCs	Description and common relationship
Heavy Metals	arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn). Fuels/oils, fill, metal working, buildings, fences, urban runoff, electrical components, pest control, fertilisers, etc.
TRHs	Total recoverable hydrocarbons including volatile fractions (C_6 – C_9 TRHs) and semi-volatile fractions (C_{10} – C_{36} TRHs). Fuels, oils and grease, fill material, solvents.
BTEXN	Benzene, toluene, ethyl benzene, xylenes and naphthalene. Volatile hydrocarbons. Fuel constituents, fill materials, solvents.
PAHs	Polycyclic aromatic hydrocarbons. Semi-volatile hydrocarbons. Constituents in bitumen, tar, asphalt, fuel constituents, oil, grease, ash.
Asbestos	Asbestos in the form of free fibres and asbestos containing materials (ACMs). Commonly used in pipework, buildings (fibro), etc.

6.2 Relevant environmental media

The environmental media considered relevant for the investigation consisted of fill, site soils, and groundwater.

6.3 Relevant environmental criteria

6.3.1 Soil

For soil, the appropriate criteria are based on the *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM) (2013) and in particular the health investigation levels (HILs), environmental investigation levels (EILs), environmental screening levels (ESLs) and health screening levels (HSLs) applicable for residential landuse.

The open space scenario in NEPM, 2013 includes secondary schools, but not primary schools. Therefore, for conservative purposes, "Residential A" criteria was used to take into account the Junior School.

HSLs and ESLs – soil type

Due to the presence of fill on-site, sandy soil criteria have been used as the soil type for deriving the HSLs and ESLs.

Asbestos

The guideline summarises typical asbestos contamination into three groups, being:

- **ACM** is asbestos containing materials, bonded in a matrix such as cladding, fencing or vinyl tiles, that will not pass through as 7 mm x 7 mm sieve. ACM can usually be detected visually.

- **FA** is fibrous asbestos, including friable or severely weathered ACM. FA can usually be detected visually.

- **AF** is asbestos fines, including free fibres, small FA bundles, and ACMs that can pass through a 7 mm x 7mm sieve.

If suspected ACMs are observed during the investigation, then confirmation testing of the materials and/or the soil may be required.

6.3.2 Groundwater

For waters, the appropriate criteria are based on the *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM) (2013) and in particular those applicable for the protection of marine water ecosystems. It is specified that the 95% species protection levels are to be applied for slightly to moderately-disturbed ecosystems (most urban catchments), and the 99% species protection levels for pristine or vulnerable ecosystems, or where the contaminants are intractable (e.g. bioaccumulative).

The drinking water criteria from *NHMRC/NRMMC* (2011) and *NHMRC* (2008) with respect to recreational water use will be adopted in this assessment for comparison purposes.

The Guidelines on the Duty to Report Contamination under the Contaminated Land Management (CLM) *Act 1997* (EPA, September 2015) describes where contamination is considered *significant enough to warrant regulation*, and requires reporting to EPA. This includes scenarios where groundwater concentrations exceed the drinking water criteria (in combination with other factors).

7.0 Limited investigation

The field work was completed on 7 and 8 December 2017 and 9 and 15 January 2018 by Drew Wood of Cavvanba Consulting. Drew has over 10 years of experience in conducting contaminated land investigations.

The sampling was conducted at pre-selected locations which were chosen for geotechnical purposes. Cavvanba's role was as observers only, and were not involved in the design of the sampling plan or selection of soil boring or monitoring well locations.

The scope is summarised as:
- Junior School – two boreholes, converted into monitoring wells;
- Senior School – two testpits, no access for monitoring wells; and
- Main Campus – one borehole, converted into a monitoring well.

The sampling and analytical strategy and methodology are described below. The results of the assessment are provided in Section 8. Soil sample locations are shown on Figures 2 - 4.

7.1 Sampling strategy

7.1.1 Soil investigation

Objective

To provide additional information to supplement the PSI information obtained, focussing on the areas of the site proposed to be disturbed by the works outlined in the DA. The objective was not to target sources or to characterise the site systematically.

The intrusive investigation was preliminary in nature and was conducted in conjunction with the geotechnical works therefore uncertainties remain.

Strategy

Locations were not targeted at potential sources of contamination. It is noted that the proposed sampling strategy was not intended to meet the definition of a systematic approach or meet the minimum sampling requirements in accordance with *Sampling Design Guidelines* (NSW EPA, 1995). A total of six locations were advanced across the three sites, focussing on the areas of the site which are proposed to be disturbed by the works in the DA. These locations are shown on Figures 2 - 4.

Table 7.1: Rationale for sampling design

Location ID	Rationale
BH01, BH02	Junior School, beneath basketball court, targeting fill material.
TP01, TP02	Secondary School, targeting fill material.
BH03	Main Campus, targeting fill material.

7.1.2 Groundwater investigation

Objective

To collect samples from groundwater monitoring wells installed on-site for geotechnical purposes, and to provide a preliminary environmental assessment of conditions on-site.

Strategy

Three groundwater monitoring wells were installed at the site during the PSI by Macquarie Geotech. Monitoring well locations were chosen for geotechnical purposes.

The monitoring well locations are detailed in Table 7.2 and shown on Figures 2 - 4.

Table 7.2: Groundwater sampling and analytical strategy

Well location	Strategy	Groundwater Monitoring Event
MW01 and MW02	Senior School	TRHs, BTEXN, PAHs, Phenols, OCs, OPs, PCBs, 8 metals.
MW03	Main Campus	TRHs, BTEXN, PAHs, Phenols, OCs, OPs, PCBs, 8 metals.

7.2 Methodology

7.2.1 Soil

Soil samples were collected using hand tools (stainless steel) or directly from the solid flight augers, ensuring that soil sampled had not been in direct contact with the hand tool. During sampling, a photo-ionisation detector (PID) was used to screen soil samples for volatile organic compounds (VOCs), to aid in the selection process for samples to be analysed. PID calibration records are included in Appendix I, and geological logs are included in Appendix J.

Due to limited access in the Senior School, only test pits using hand tools were advanced on this property.

All soil samples were collected into laboratory supplied glass jars and placed directly into chilled eskies and transported to the laboratory under chain of custody documentation, in accordance with Cavvanba fieldwork procedures.

Overburden was placed alongside the sample location sequentially during excavation, and backfilled in the same sequence it was excavated.

7.2.2 Groundwater

Monitoring wells were installed using a truck-mounted drill rig with a solid flight auger, followed by rock coring. Monitoring well installation was managed by Macquarie Geotech. Cavvanba understands it was consistent with the *Minimum Construction Requirements for Water Bores in Australia* (Land and Water Biodiversity Committee, 2003). Monitoring wells were installed to a maximum depth of 15.15 m, and screened across the maximum length of the bedrock rather than a discrete sampling depth. All wells were constructed of 50 mm diameter Class 18 uPCV casing and screen, with a bentonite seal above the screen. Groundwater wells were developed following installation. A new bailer was used for each well.

Groundwater sampling was conducted on 15 January 2018, by Drew Wood of Cavvanba Consulting, using a disposable plastic bailer in accordance with *Cavvanba Fieldwork Procedures for Groundwater sampling*, which generally meets NEPM requirements. All wells were gauged and sampled.

To ensure representative samples were collected:

- water was collected for the collection of water quality parameters, including pH, temperature, conductivity, redox and dissolved oxygen (DO), which were measured using a calibrated YSI water quality meter; and
- water quality parameters recorded consecutive readings within 10% prior to sampling.

Groundwater parameter probe calibration records are included in Appendix I, monitoring well installation logs are included in Appendix J, and groundwater sampling sheets are included in Appendix K.

Samples were collected directly from the bailer into appropriately preserved laboratory prepared and supplied sample bottles and quickly capped with no headspace remaining to minimise the loss of any volatiles.

A pair of disposal gloves was worn during collection and all groundwater samples were collected into laboratory supplied bottles, in accordance with Cavvanba fieldwork procedures. All samples were placed directly into chilled eskies and transported to the laboratory under chain of custody documentation.

7.3 Data usability

A background to data usability is provided in Appendix L. All site work was completed in accordance with standard Cavvanba sampling protocols, including a QA/QC programme and fieldwork procedures.

A data usability assessment has been performed for the sampling undertaken during this investigation, as summarised in Appendix L and includes:
- summary of field quality assurance/quality control;
- field quality control soil samples summary; and
- summary of laboratory quality assurance/quality control.

Overall, the data usability assessment shows that the data is of suitable quality to support the conclusions made in this report.

8.0 Conditions encountered

The subsurface conditions encountered are summarised below. For descriptions of the subsurface conditions at specific locations, refer to the geological logs in Appendix J, and for specific samples, refer to Table 1, attached. A photo log is provided as Appendix H.

8.1 Soil

8.1.1 Junior School

Two soil borings were advanced beneath the basketball court of the Junior School. The profile consisted of the following:
- fill consisting of black sandy gravel to depths of 1.7 m (BH02) and 0.4 m (BH01);
- gravelly clay to 1.9 m;
- weathered sandstone to 1.1 - 2.6 m; followed by
- sandstone to the maximum explored depth of 15.15 m.

The basketball court was noted to be raised approximately 1-2 metres above the remainder of the site, and it is likely that this material is imported fill sourced from off-site. The fill material was noted to have a slight hydrocarbon odour. PID readings of less than 15 ppm were noted during sampling this material.

8.1.2 Senior School

Two test pits were advanced in the Senior School and the profile consisted of the following:
- fill consisting of sand to clayey gravelly sandy gravel or clayey sand black sandy gravel to depths of 0.75 m;
- geofabric layer;
- fill consisting of blue gravel to 1.1 m; followed by
- sandstone to the maximum explored depth of 1.1 m.

The geofabric layer was understood to be associated with underground services located in close proximity.

A PID reading of 46.7 ppm was identified in TP01 at 0.1 m in the fill material. The remainder of the fill had PID readings less than 15 ppm. No hydrocarbon odours or staining were noted.

8.1.3 Main Campus

The profile beneath the Main Campus consisted of the following:
- fill consisting of light brown sand to depths of 0.8 m;
- brown and black clayey sand to depths of 1.3 m;
- sandstone to the maximum explored depth of 15.10 m.

The fill material present to depths of 0.8 m was noted to have a slight hydrocarbon odour. PID readings of less than 15 ppm were recorded during sampling this material.

8.2 Asbestos

Potential asbestos containing material fragments were not observed on surface soils or within the soil profile.

8.3 Groundwater

Cavvanba's role consisted of observing the installation of the wells followed by sampling. Groundwater was encountered at depths of approximately 4 - 5 m below the natural

ground surface across the site during advancement of soil bores. Monitoring wells screened the full length of the bedrock and were installed with flush mounted gatic covers. Groundwater levels were observed to be between 1.914 m (MW03) and 5.195m (MW02) depth below casing during sampling. The top of the casing (TOC) was not surveyed due to the preliminary nature of the groundwater investigation.

The groundwater quality parameters recorded prior to groundwater sampling are shown in Table 8.2.

Table 8.2: Groundwater quality parameters

Sample location	pH	Cond. (µS/cm)	Temp (°C)	DO (mg/L)	Redox as Eh (mV)	Comments
Groundwater quality parameters						
MW01	11.04	1,806	22.3	3.77	118.7	Turbid, purged dry after ~3 L, no odour/sheen.
MW02	5.81	656	22.0	3.01	160	Clear initially, then slightly turbid, no odour/sheen.
MW03	7.47	559	20.1	1.02	186.6	Very turbid, no odour/sheen. Purged dry after ~ 47 L.

Notes:
DO = dissolved oxygen.
H_2S = Hydrogen sulphide (reducing odour).
Cond. = conductivity.
Redox value has been corrected for standard hydrogen electrode by adding 199.
Redox range, <0 mV reducing, 0 – 400 mV moderately reducing, >400 mV well oxygenated.

Monitoring well MW01 produced only a small volume of water and was highly alkaline.

Based on the remaining groundwater quality parameter measurements, the groundwater underlying the site can be described as relatively neutral to acidic pH, poorly oxygenated, moderately reducing.

9.0 Analytical results

The analytical results are presented in the following sections, separated into soil and groundwater results.

9.1 Soil

The results are summarised below by contaminant. The laboratory analytical reports are included in Appendix G. The analytical results have been compared to the screening criteria for residential land use which includes ecological and health screening levels to ascertain the magnitude of impacts, if any. The laboratory limits of reporting were below the applicable criteria for the investigation. The analytical results are summarised in the attached tables (Tables 1 - 6).

Table 9.1: Soil analytical summary

Analyte	Health criteria	Ecological criteria	Site data			
	HIL / HSL (mg/kg)	EIL/ESL (mg/kg)	No. samples analysed	Number of detects	Max' (mg/kg)	Meets screening criteria?
Metals						
Arsenic	100	100	12	3	8	Yes
Cadmium	20	-		-	-	Yes
Chromium	100	410		12	16	Yes
Copper	6,000	230		11	55	Yes
Lead	300	1,100		12	173	Yes
Nickel	400	270		10	122	Yes
Zinc	7,400	770		12	89	Yes
Mercury	40	-		-	-	Yes
BTEXN and TRH						
Benzene	0.5	50	12	-	-	Yes
Toluene	160	85		-	-	Yes
Ethylbenzene	55	70		-	-	Yes
Xylenes	40	105		-	-	Yes
Naphthalene	3	170		-	-	Yes
F1 TRHs C_6-C_{10}	45	180		-	-	Yes
F2 TRHs >C_{10}-C_{16}	**110**	**120**		1	**410**	**No**
F3 TRHs >C_{16} – C_{34}	-	**1,300**		5	**3,810**	**No**
F4 TRHs >C_{34} – C_{40}	-	5,600		3	560	Yes
PAHs						
BaP TEQ	**3**	-	12	8	**78.9**	**No**
BaP	-	**0.7**		8	**54.6**	**No**
Total (PAHs)	**300**	-		8	**1,150**	**No**
VOCs						
Total VOCs	-	-	1	-	-	Yes
Asbestos						

Analyte	Health criteria	Ecological criteria	Site data			
	HIL / HSL (mg/kg)	EIL/ESL (mg/kg)	No. samples analysed	Number of detects	Max' (mg/kg)	Meets screening criteria?
Asbestos	Detect	-	5	-	-	Yes

Table notes:
1 - Health screening levels for residential landuse, 0m to <1m depth, TRH and BTEXN.
2 – Health investigation levels for residential landuse (HILs A) not including TRH, BTEXN.
3 – Environmental screening/investigation levels for urban residential and public open space, assuming coarse soil type due to disturbed nature of soils. EILs calculated using generic values and using the EIL calculator spreadsheet.
- = not detected above the LOR.

Site criteria was exceeded in samples collected from the fill material in locations BH02, BH03 and TP02. BH02 was located on the Junior School, TP02 was located on the Senior School and BH03 was located on the Main Campus.

HILs were exceeded in the following samples for the analytes listed below:
- BH03_0.25 for TRH F2, Total PAHs and benzo(a)pyrene TEQ; and
- BH02_0.4, BH02_0.55, BH02_1.5 for benzo(a)pyrene TEQ.

EILs were exceeded in the following samples for the analytes listed below:
- BH03_0.25 for TRH F2, TRH F3 and benzo(a)pyrene; and
- BH02_0.2, BH02_0.4, BH02_0.55, BH02_1.0, BH02_1.5, and TP02_0.3 for benzo(a)pyrene.

9.2 Groundwater

The groundwater results are summarised below. The laboratory analytical reports are included in Appendix M. The analytical results are summarised in the attached tables (Tables 7 - 10) and summarised in Table 9.2 below.

Table 9.2: Summary of groundwater analytical results (ug/L)

Analyte	Marine Waters[1]	Drinking Water	Health Screening Levels[2]	Recreational[3]	Site maximum concentration	Sample location
Metals						
Arsenic	-	**10**	-	100	**35**	**MW02**
Cadmium	0.7	2	-	20	-	-
Chromium	**4.4**	**50**	-	**500**	**564**	**MW01**
Copper	**1.3**	2,000	-	20,000	**26**	**MW01**
Lead	4.4	10	-	100	-	-
Nickel	**7**	**20**	-	200	**20**	**MW03**
Zinc	**15**	-	-	-	**36**	**MW03**
Mercury	0.1	1	-	10	-	-
Volatile hydrocarbons						
Benzene	500	1	800	10	nd	-
Toluene	-	800	NL	8,000	7	-

Analyte	Marine Waters[1]	Drinking Water	Health Screening Levels[2]	Recreational[3]	Site maximum concentration	Sample location
Ethyl-benzene	-	300	NL	3,000	8	-
Xylenes	-	600	NL	6,000	102	-
Naphthalene	50	-	NL	-	5	-
F1 TRHs C6 – C10	-	-	1,000	-	820	-
Semi-volatile hydrocarbons						
F2 TRHs >C10 – C16	-	-	NL	-	710	-
F3 TRHs >C16 - C34	-	-	NL	-	2,010	-
F4 TRHs >C34 – C40	-	-	NL	-	250	-
Benzo(a)pyrene	-	**0.01**	-	**0.1**	**1.0**	**MW03**

Table notes:
1. Criteria from NEPM, 2013.
2. HSLs for commercial purposes used.
3. NHMRC Guidelines for Managing Risks in Recreational Water (2008).

Bold – exceeds highlighted criterion.
NL – no limit.

As shown above, exceedances of marine water and drinking water criteria were present on-site, associated with metals consisting of arsenic, chromium, copper, nickel, zinc as well as PAH compound benzo(a)pyrene.

10.0 Discussion and Conceptual Site Model

10.1 Fill material

Fill material exceeding site criteria was identified on all three properties in the samples analysed. These exceedances were with respect to:

- TRH F2 (>C_{10}-C_{16});
- TRH F3 (>C_{16}-C_{34});
- benzo(a)pyrene TEQ;
- benzo(a)pyrene; and/or
- total PAHs.

An online PAH Source Analyst (pahsourceanalyst.com) was developed by Environmental Earth Sciences International, Artarmon NSW. The analyst attempts to match one or more PAH suite test results against a database of known PAH sources such as coal tars, ash and roadseal.

The inputs and results are provided in Appendix M. The analysis suggested a clear match for samples BH02_1.5 and TP02_0.3 collected from the Junior School and Senior School with ash from black coal which is consistent with gasworks waste. The sample reviewed from the Main Campus however was most closely matched to roadseal.

Gasworks waste fill is likely a widespread issue on the three properties and also likely across the wider Northern Sydney area. Based on the preliminary nature of the assessment conducted, this requires further investigation.

While this fill material is capped by concrete or artificial turf, the exposure is limited and it is unlikely to pose an unacceptable risk. Disturbance of this material during the proposed works will require management.

Consideration will also need to be given to this material if it is proposed to be disposed of off-site. Classification will be required in accordance with NSW EPA, *Waste Classification Guidelines, 2014*.

10.2 Underground fuel storage

A UST was identified within the small workshop area of the Main Campus. Monitoring well MW03 installed on the Main Campus had detectable concentrations of BTEXN and TRH compounds as well as benzo(a)pyrene in excess of site criteria. There is a potential that this is associated with leaks from this UST, but it should be noted that this is a preliminary investigation, and uncertainties remain.

In accordance with NSW EPA (2009) *Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008*, where two years have elapsed since fuel was put in or taken from a tank, it must be abandoned (after removing the fuel) in accordance with the Occupational Health and Safety (Dangerous Goods) Regulation 2001.

10.3 Groundwater

Groundwater exceedances consisted of metals across all three monitoring wells, and benzo(a)pyrene in MW03. At this stage, it is uncertain if this is related to poor filling practice processes on-site and leaching of associated contaminants, fuel storage, contamination from the dry cleaners or a broader regional contamination issue in Kirribilli. Further investigation is required. Based on the findings, a duty to report to NSW EPA may exist.

10.4 Asbestos

Potential asbestos containing material fragments were not observed on surface soils or within the soil profile, however based on the limited scale of the investigation, the potential of unexpected asbestos finds remains. This is particularly relevant for the southern portion of the Junior School and the northern portion of the Main Campus, where the former buildings were demolished. Due to the age of the buildings, there is a likelihood that the old buildings contained asbestos, such as friable lagging.

10.5 Conceptual Site Model

The conceptual site model (CSM) is a representation of site-related information regarding contamination sources, receptors and exposure pathways between those sources and receptors. The CSM for the site, following the soil investigation works is detailed in Table 11.1 and Figure 5 as a flow chart, attached.

It should be noted that the investigation locations were based on the proposed areas of disturbance rather than targeting sources or to characterise the site systematically and therefore uncertainties remain.

Table 10.1: CSM discussion

Element	Site specific information
The physical and built environment, including former, existing and proposed structures.	The site consists of a college consisting of a Junior School, Senior School and Main Campus.
Known and potential sources of contamination and contaminants of concern, including chemical storage, use and disposal.	Potential sources of contamination are related to impacted fill material, underground fuel storage and poor demolition practices. In addition, there is the potential of broader regional groundwater contamination.
Potentially affected media, such as soil, groundwater, surface water and air, including extent and magnitude, and potential variations, e.g. preferential pathways etc.	Media consists of soil and groundwater. Impacted fill was identified on all three properties, with exceedances of site criteria for TRH and PAHs. Groundwater impact exceeding criteria for metals was present in all three groundwater monitoring wells and MW03, assumed to be downgradient exceeded criteria for benzo(a)pyrene). In addition, TRH and BTEXN compounds were detected.
Human and ecological receptors.	The following potential human and ecological receptors exist on and off-site: *Fill material* – future construction/demolition workers. *Groundwater impact* – surface water.
Potential and complete exposure pathway to human and/or environmental receptors.	Complete pathways are largely limited to construction workers during the proposed development application site. The groundwater impact requires further investigation.
Data gaps	No comparison of groundwater to local regional groundwater is present to determine if elevated metals and TRH/PAHs are site-specific or regional.

11.0 Conclusions

These investigation conclusions are based on the information described in this report and appendices, and the conclusions should be read in conjunction with the complete report, including Section 1.4, General limitations to environmental information.

This PSI has been undertaken on this site prior to works associated with a development application (DA). The issues identified should be addressed during future redevelopment works in accordance with the contaminated land assessment process outline in NEPM, amended 2013 which is endorsed by NSW EPA.

Four primary issues have been identified, being:

- Impacted fill material present on all three sites.
- The presence of a former underground storage tank on-site, which requires decommissioning.
- Metals and benzo(a)pyrene concentrations in groundwater above investigation levels, and TRH and BTEXN detections.
- Potential of asbestos finds.

Table 10.1 highlights the issues from the investigation which should be managed, and Table 10.2 summarises the decision-making process for NSW EPA (DECC 2006).

Table 10.1: Primary issues from the investigation

Issue	PSI outcome	Recommendation
Fill material on-site	Fill material was identified on all three sites which exceeded site criteria. It is understood that as part of the proposed development, excavation of fill is likely to occur. These works will disturb this material and it's understood that it will be surplus to requirements and require off-site disposal.	Based on the preliminary nature of the investigation, this should be investigated further. This material will require management during the proposed development works to prevent exposure to construction workers, depending on the extent of disturbance.
UST	A UST was identified on the Main Campus site.	Decommission USTs in accordance with NSW EPA UPSS Regulation.
Groundwater – metals and benzo(a)pyrene	Elevated metals concentrations and benzo(a)pyrene were identified in site monitoring wells.	Further assessment of groundwater is required to determine if this is a site specific issue associated with fill/fuel storage or a broader regional issue. Based on the exceedances of drinking water, consideration should be given to the duty to notify the NSW EPA.
Asbestos – poor demolition practices	Asbestos was identified, but the potential for unexpected finds remains.	Take this into consideration during the proposed excavation works.

Table 10.2: Evaluation of decision making process, EPA, 2017

EPA, 2017	Evaluation
All site assessment, remediation and validation reports follow applicable guidelines	This report has been prepared based on the relevant guidelines. It has also taken into account the relevant updates in the amended NEPM (2013).
Any aesthetic issues have been adequately addressed.	Aesthetic issues still remain on the site, due to the impacted fill present on all three properties.
Soils have been assessed against relevant health-based investigation levels and the potential for migration of contamination from soils to groundwater has been considered.	Yes.
Groundwater (where relevant) has been assessed against relevant health-based investigation levels and, if required, any potential impacts to buildings and structures from the presence of contaminants considered.	Yes.
Hazardous ground gases (where relevant) have been assessed against relevant health-based investigation levels and screening values.	N/A
Any issues relating to local area background soil concentrations that exceed relevant investigation levels have been adequately addressed in the site assessment report(s)	No issues have arisen for soil.
The impact of chemical mixtures have been assessed.	No issues have arisen.
Any potential ecological risks have been assessed.	Soils have been assessed in accordance with EILs and ESLs.
Any evidence of, or potential for, migration of contaminants from the site have been appropriately addressed, including potential risks to off-site receptors, and reported to the site owner or occupier.	Further investigation is required regarding groundwater. Exceedances of criteria are present but it is uncertain if this is related to the site, or a broader regional issue.
The site management strategy (where relevant) is appropriate including post-remediation environmental plans.	Site management will depend on the extent of disturbance of impacted fill proposed during the DA works.

12.0 Glossary and references

12.1 Glossary

AST	Aboveground storage tank
BTEXN	Benzene, toluene, ethyl benzene, xylenes and naphthalene
CSM	Conceptual site model
EIL	Environmental Investigation Level
ESL	Environmental Screening Level
EMP	Environmental Management Plan
ESA	Environmental site assessment
GME	Groundwater monitoring event
HHRA	Human health risk assessment
HIL	Health Investigation Level
HSL	Health Screening Level
LOR	Limit of reporting
Metals	Arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), and zinc (Zn)
NATA	National Association of Testing Authorities
NEPM/C	National Environmental Protection Measure/Council
OCPs	Organochlorine pesticides
OH&S	Occupational health and safety
OPPs	Organophosphorus pesticides
PAHs	Polycyclic aromatic hydrocarbons, including the USEPA 16 priority pollutants: naphthalene; acenaphthylene; acenaphthene; fluorine; phenanthrene; anthracene; fluoranthene; pyrene; benzo(a) anthracene; chrysene; benzo(b)fluoranthene; benzo(k) fluoranthene; benzo(a)pyrene; indeno(1.2.3.cd)pyrene; dibenz (a.h)anthracene; and benzo(g.h.i)perylene
PCBs	Polychlorinated biphenyls
PID	Photo-ionisation detector
PSH	Phase separated hydrocarbons
QA/QC	Quality assurance/quality control
RAP	Remediation action plan

RPD	Relative Percentage Difference
SWL	Standing water level
TRHs	Total recoverable hydrocarbons, including volatile C6 – C10 fraction and semi- and non-volatile >C10 – C36 fractions
UCL	Upper confidence limit
UST	Underground storage tank
VRP	Voluntary remediation proposal
VOCs	Volatile organic compounds

12.2 References

References

Troedson A.L. 2015. *Sydney Area 1:100 000 and 1:25 000, Coastal Quaternary Geology Map Series*. Geological Survey of New South Wales, Maitland.

NSW Department of Primary Industries – Water Division (2018) http://allwaterdata.water.nsw.gov.au/water.stm (accessed January 2018).

Guidelines made by EPA

DEC (2007) *Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination*. NSW EPA, Sydney.

Department of Environment, Climate Change and Water (DECCW) (2009) *Guidelines for Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008*. NSW DECCW, Sydney.

EPA (2017) *Contaminated Land Management: Guidelines for the NSW Site Auditor Scheme (3rd edition)*. EPA, Sydney.

EPA (1995a) *Contaminated Sites: Guidelines for the Vertical Mixing of Soil on Former Broad-acre Agricultural Land*. NSW EPA, Sydney.

EPA (1995b) *Contaminated Sites: Sampling Design Guidelines*. NSW EPA, Sydney.

EPA (1997) *Contaminated Sites: Guidelines for Assessing Banana Plantation Sites*. NSW EPA, Sydney.

EPA (2005) *Contaminated Sites: Guidelines for Assessing Former Orchards and Market Gardens*. NSW EPA, Sydney.

EPA (1999) *Contaminated Sites: Guidelines on Significant Risk of Harm from Contaminated Land and the Duty to Report*. NSW EPA, Sydney.

EPA (2000) *Environmental Guidelines: Use and Disposal of biosolids products*. NSW EPA, Sydney.

EPA (2012) *Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases*. NSW EPA, Sydney.

EPA (2015) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*. NSW DECC, Sydney.

EPA (November 2014) *Waste Classification Guidelines – Part 1: Classifying Waste*. NSW EPA, Sydney, NSW.

Office of Environment & Heritage (2011) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites*. NSW OE&H, Sydney.

Guidelines approved by the EPA

ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Paper No 4, Canberra.

ANZECC/NHMRC (1992) *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*. Australian and New Zealand Environment and Conservation Council and the National Health and Medical Research Council, Canberra.

Australian Government Department of Health (2017) *Health Based Guidance Values for PFAS for use in site investigations in Australia*.

Department of Health and Ageing and EnHealth Council (2002) *Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards*. Commonwealth of Australia, Canberra.
Lock, W. H., (1996) "Composite Sampling", *National Environmental Health Forum Monographs, Soil Series No. 3*. SA Health Commission, Adelaide.

NEPC (1999) *National Environment Protection (Assessment of Site Contamination) Measure, Schedule A and Schedules B(1)-B(10), amended April 2013*. National Environment Protection Council, Adelaide.

NHMRC/ NRMMC (2011) *Australian Drinking Water Guidelines*. National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, and Natural Resource Management Ministerial Council (NRMMC), Australian Government, Canberra.

NSW Agricultural/CMPS&F (1996) *Guidelines for the Assessment and Clean Up of Cattle Tick Dip Sites for Residential Purposes*. NSW Agricultural and CMPS&F Environmental, Canberra.

Figures

Figure 1. Site Locality Plan

Preliminary Site Investigation
St Aloysius College,
Kirribilli NSW
Reference: 17066

Client: W&G
Drawn: GC 06/12/17
Source: NSW Gov SIX

CAVVANBA consulting

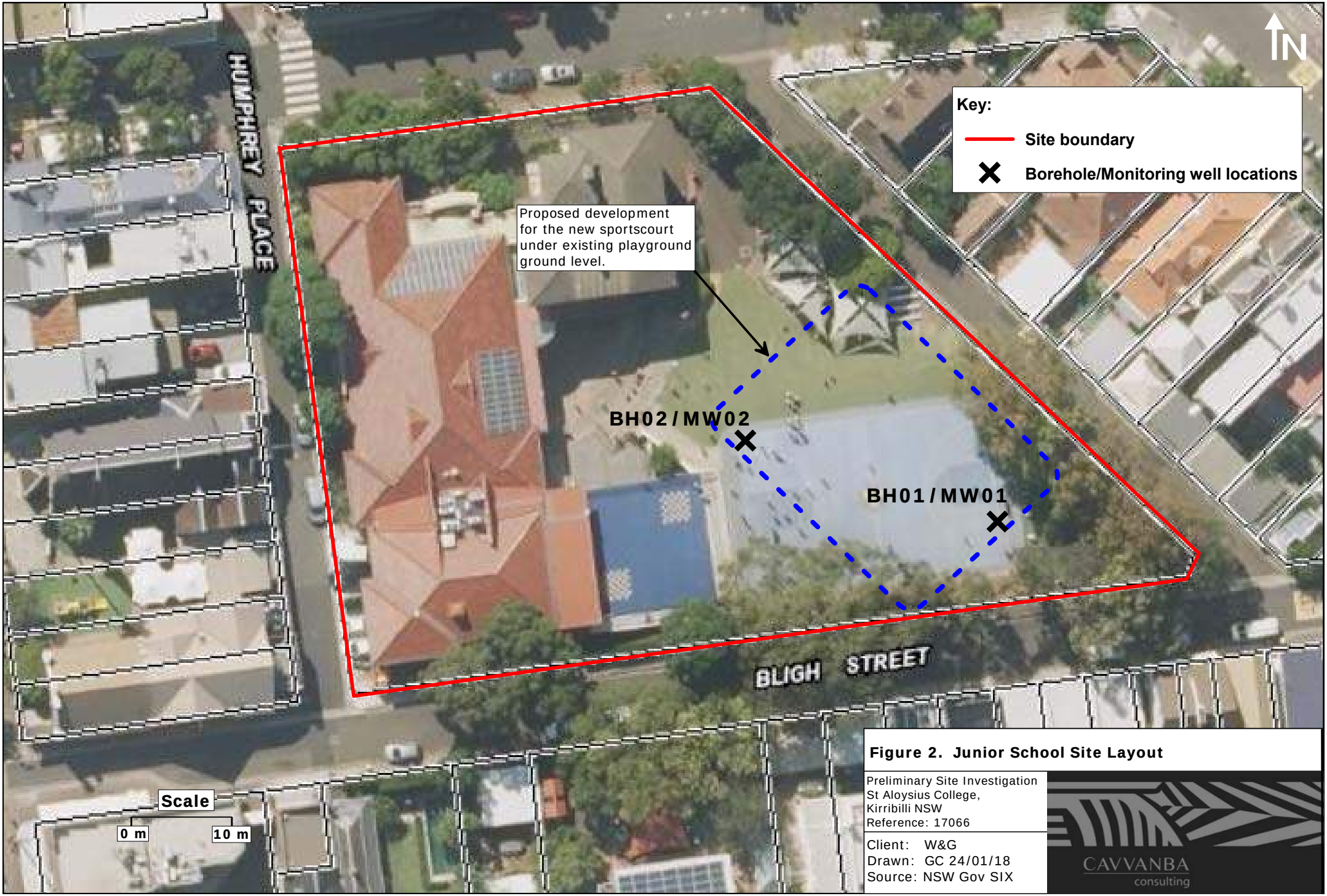


Figure 2. Junior School Site Layout

Preliminary Site Investigation
St Aloysius College,
Kirribilli NSW
Reference: 17066

Client: W&G
Drawn: GC 24/01/18
Source: NSW Gov SIX

CAVVANBA consulting

Figure 3. Senior School Site Layout

Preliminary Site Investigation
St Aloysius College,
Kirribilli NSW
Reference: 17066

Client: W&G
Drawn: GC 24/01/18
Source: NSW Gov SIX

CAVVANBA consulting

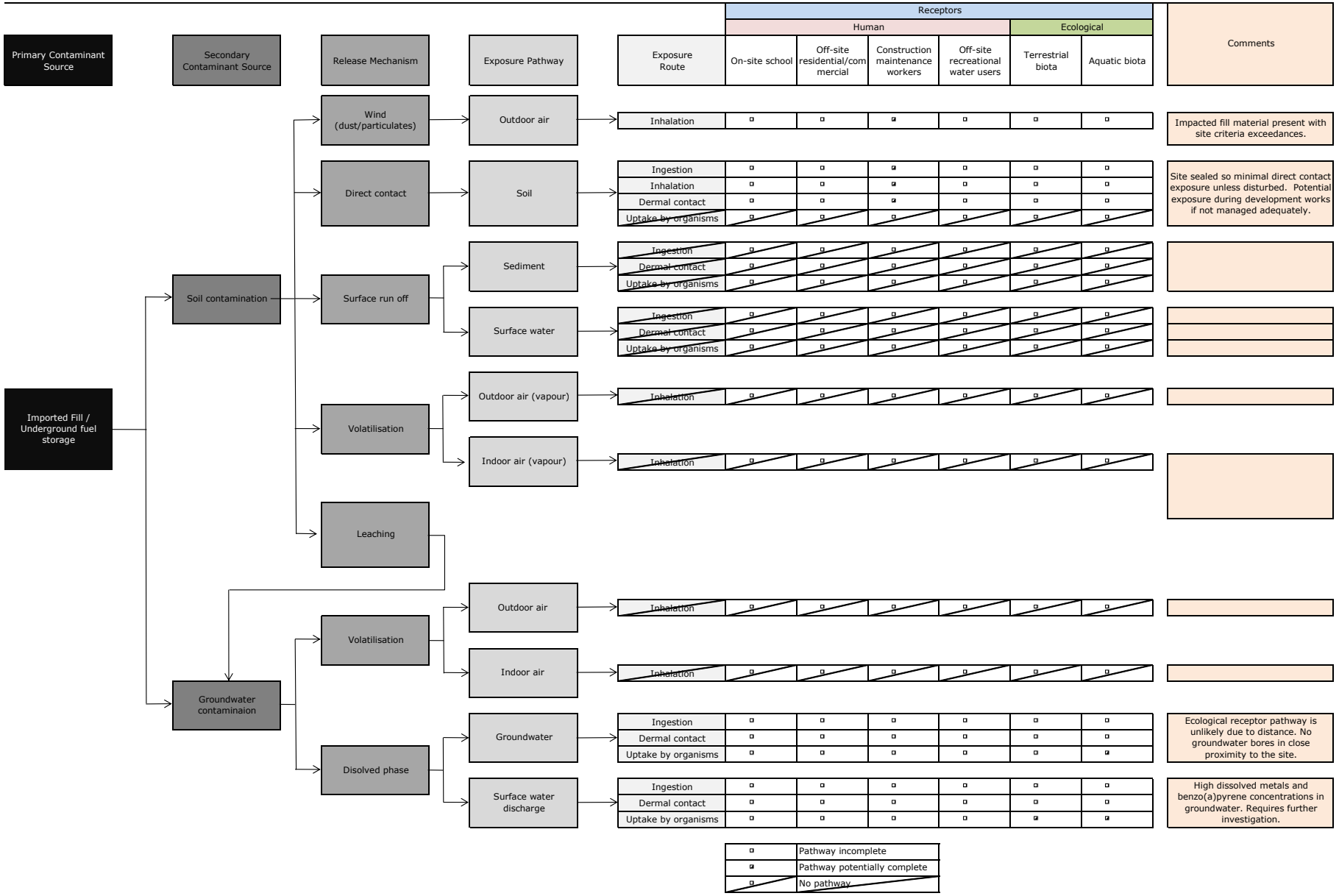
Figure 4. Main Campus Site Layout

Preliminary Site Investigation
St Aloysius College,
Kirribilli NSW
Reference: 17066

Client: W&G
Drawn: GC 24/01/18
Source: NSW Gov SIX

CAVVANBA consulting

Figure 5: Conceptual Site Model Flow Chart



Tables

Table 1: Sample Description and Analytical Summary

Sample	Depth (m)	PID (ppm)	Date sampled	Description	Analysis				
					TRHs	BTEXN	PAHs	8 metals	VOCs
Analytical									
BH01	0.50	2.9	07/12/17	FILL: Gravelly sand: Fine to course grained sand, orange brown, fine to medium, sub-angular gravel, trace low plasticity clay.	•	•	•	•	
BH02	0.20	5.8	08/12/17	FILL: Sandy gravel: Fine to course gravel, sub angular, brown and grey, fine to course sand.	•	•	•	•	
BH02	0.40	7.1	08/12/17	FILL: Sandy gravel: Fine to course gravel, sub angular, brown and grey, fine to course sand.	•	•	•	•	
BH02	0.55	1.7	08/12/17	FILL: Sandy gravel: Fine to course gravel, sub angular, brown and grey, fine to course sand.	•	•	•	•	
BH02	1.00	5.8	08/12/17	FILL: Sandy gravel: Fine to course gravel, sub angular, brown and grey, fine to course sand.	•	•	•	•	
BH02	1.50	11.5	08/12/17	FILL: Gravelly clay: low plasticity, red and brown, fine to medium, sub angular gravel.	•	•	•	•	•
BH02	1.90	-	08/12/17	FILL: Gravelly clay: low plasticity, red and brown, fine to medium, sub angular gravel.	•	•	•	•	
BH03	0.25	-	09/01/18	FILL: Clayey sand: Fine to course grained sand, grey brown and orange, low plasticity clay (slight hydrocarbon odour)	•	•	•	•	
TP01	0.10	46.7	07/12/17	FILL: Sand: Fine to course grained sand, dark grey with low plasticity clay, trace roots <2mm	•	•	•	•	
TP01	0.50	1.7	07/12/17	FILL: Gravelly clayey sand: Fine to course sand, plae brown and pale grey brown, low plasticity clay, fine to course, sub-angular gravel, with cobbles, trace sub-angular boulders	•	•	•	•	
TP02	0.15	8.5	07/12/17	FILL: Gravelly sand: Fine to course grained sand, dark grey, fine to course, sub-rounded gravel with low plasticity clay.	•	•	•	•	
TP02	0.30	11.9	07/12/17	FILL: Clayey sand: Fine to course grained sand, brown and grey, brown mottled pale grey, low plasticity clay with fine to course sub-angular gravel with angular cobbles. Trace clay pockets <50mm, gravel 0.25-0.40mm: 3 nos of sub-angular boulders. Locally gravels tredning to sand gravel.	•	•	•	•	

Table 2: Soil Analytical Summary, Metals

Sample	Depth (m)	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
LORs		*5*	*1*	*2*	*5*	*5*	*2*	*5*	*0.1*
Analytical									
BH01	0.50	nd	nd	14	36	9	25	24	nd
BH02	0.20	nd	nd	11	36	27	25	82	nd
BH02	0.40	nd	nd	9	35	21	21	39	nd
BH02	0.55	nd	nd	12	9	36	3	39	nd
BH02	1.00	8	nd	13	7	50	nd	42	nd
BH02	1.50	5	nd	12	16	116	3	89	nd
BH02	1.90	6	nd	16	9	20	5	43	nd
BH03	0.25	nd	nd	6	nd	91	nd	49	nd
TP01	0.10	nd	nd	9	55	48	122	41	nd
TP01	0.50	nd	nd	11	5	58	7	37	nd
TP02	0.15	nd	nd	9	48	34	120	51	nd
TP02	0.30	nd	nd	11	7	173	4	57	nd
Criteria									
HILs - Residential A		100	20	100	6,000	300	400	7,400	40
EILs - Urban residential and public open space (aged)		100	-	410	230	1,100	270	770	-

See table notes at end of section

Table 3: Soil Analytical Summary, BTEXN and TRHs (mg/kg)

Sample	Depth (m)	Benzene	Toluene	Ethyl benzene	meta- & para-Xylenes	ortho-Xylene	Naphthalene	F1 TRHs C6 - C10	F2 TRHs >C10 - C16	F3 TRHs >C16 - C34	F4 TRHs >C34 - C40
LORs		*0.2*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*10*	*50*	*100*	*100*
Analytical											
BH01	0.50	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH02	0.20	nd	nd	nd	nd	nd	nd	nd	nd	140	nd
BH02	0.40	nd	nd	nd	nd	nd	nd	nd	nd	190	nd
BH02	0.55	nd	nd	nd	nd	nd	nd	nd	nd	820	180
BH02	1.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH02	1.50	nd	nd	nd	nd	nd	nd	nd	nd	460	140
BH02	1.90	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BH03	0.25	nd	nd	nd	nd	nd	nd	nd	**410**	**3,810**	560
TP01	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TP01	0.50	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TP02	0.15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
TP02	0.30	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Statistics											
Samples analysed		12	12	12	12	12	12	12	12	12	12
Detects		0	0	0	0	0	0	0	1	5	3
% detect		0%	0%	0%	0%	0%	0%	0%	8%	42%	25%
Maximum		-	-	-	-	-	-	-	**410**	**3,810**	560
Mean		-	-	-	-	-	-	-	410	1,084	293
Median		-	-	-	-	-	-	-	410	460	180
Minimum		-	-	-	-	-	-	-	nd	nd	nd
Criteria Low - high density residential (HSLs), urban residential and public open space (ESLs)											
Health screening levels 0m to <1m		0.5	160	55	40		3	45	**110**	no limit	no limit
Health screening levels 1m to <2m		0.5	220	no limit	60		no limit	70	240	no limit	no limit
Health screening levels 2m to <4m		0.5	310	no limit	95		no limit	110	440	no limit	no limit
Health screening levels 4m+		0.5	540	no limit	170		no limit	200	no limit	no limit	no limit
Health investigation levels		-	-	-	-	-	-	-	-	-	-
Ecological screening levels (fine texture)		10	65	40	1.6		-	180	**120**	**1,300**	5,600
Ecological investigation levels		-	-	-	-	-	170	-	-	-	-

See table notes at end of section

Table 4: Soil Analytical Summary, PAHs and VOCs (mg/kg)

Sample	Depth (m)	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Total PAHs	B(a)P TEQ	Total VOCs
LORs		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	-	-	-
Analytical																			
BH01	0.50	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH02	0.20	nd	nd	nd	1.6	0.6	4.3	4.2	1.8	1.6	1.8	0.8	**1.8**	0.6	nd	0.7	19.8	2.3	-
BH02	0.40	nd	nd	nd	3.2	1.2	8	7.8	3.1	3.1	3.7	1.2	**3.3**	1.6	nd	1.9	38.1	**4.3**	-
BH02	0.55	3.3	0.7	1.6	30.8	7.7	35	30.8	14.7	12.4	15.3	5.6	**12.1**	4.8	1.6	5.3	183	**17.9**	-
BH02	1.00	nd	nd	nd	1.7	0.6	3.1	2.9	1.4	1.3	1.8	0.6	**1.5**	0.7	nd	0.8	16.4	2	-
BH02	1.50	2.2	0.9	2.8	19.6	5.2	25.8	23.1	10.3	9.1	11.1	4	**9.6**	4.1	1.3	4.5	134	**14**	nd
BH02	1.90	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
BH03	0.25	33.6	4.8	36.3	294	54.5	204	194	66.4	59.3	58.8	19.8	**54.6**	21.9	6.8	25.8	**1,150**	**78.9**	-
TP01	0.10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
TP01	0.50	nd	nd	nd	0.6	nd	1.2	1.2	0.6	0.5	0.5	nd	0.5	nd	nd	nd	5.1	0.6	-
TP02	0.15	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	-
TP02	0.30	nd	nd	nd	0.9	nd	2	2	1	0.9	0.9	nd	**0.8**	nd	nd	nd	8.5	1	-

Table 4: Soil Analytical Summary, PAHs and VOCs (mg/kg)

Sample	Depth (m)	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Total PAHs	B(a)P TEQ	Total VOCs
LORs		*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	-	-	-
Analytical																			
Statistics																			
Samples analysed		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	1
Detects		3	3	3	8	6	8	8	8	8	8	6	8	6	3	6	8	8	0
% detect		25%	25%	25%	67%	50%	67%	67%	67%	67%	67%	50%	67%	50%	25%	50%	67%	67%	0%
Maximum		33.6	4.8	36.3	294.0	54.5	204	194.0	66.4	59.3	58.8	19.8	**54.6**	21.9	6.8	25.8	**1,150**	**78.9**	-
Mean		13.0	2.1	13.6	44.1	11.6	35.4	33.3	12.4	11.0	12	5.3	**10.5**	5.6	3.2	6.5	194.4	15	-
Median		3.3	0.9	2.8	2.5	3.2	6.2	6.0	2.5	2.4	2.8	2.6	2.6	2.9	1.6	3.2	29.0	3.3	-
Minimum		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Criteria																			
HILs - Residential A		NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	**300**	**3**	-
ESLs - Urban residential and public open space		NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	**0.7**	NL	NL	NL	NL	NL	-

See table notes at end of section

Table 5: Soil Analytical Summary, Asbestos

Sample	Depth (m)	Date	Asbestos
LORs			-
Analytical			
Soil			
BH02	0.40	08/12/17	No
BH02	0.55	08/12/17	No
BH02	1.00	08/12/17	No
BH02	1.50	08/12/17	No
BH02	1.90	08/12/17	No
Criteria - Contamination threshold values			
General Soild Waste - Asbestos Present			No

See table notes at end of section

Table 6: Soil Analytical Summary, Quality Control (mg/kg)

Analyte	LOR mg/kg	TP01	QS01	**RPD**	BH02	QS02	**RPD**	Trip Blank	Trip Spike	TSC	**Trip Spike**
Type	-	*Primary*	*Duplicate*	*%*	*Primary*	*Duplicate*	*%*	-	-	-	*Recovery*
Date	-	07/12/17	07/12/17	-	08/12/17	08/12/17	-	5/12/17	30/11/17	30/11/17	-
Media	*Soil*	*Soil*	*Soil*	-	*Soil*	*Soil*	-	-	-	-	-
Heavy metals											
Arsenic	*5*	nd	5	-	5	nd	-	-	-	-	-
Cadmium	*1*	nd	nd	-	nd	nd	-	-	-	-	-
Chromium	*2*	11	11	0	12	12	0	-	-	-	-
Copper	*5*	5	7	33	16	19	17	-	-	-	-
Lead	*5*	58	92		116	72	47	-	-	-	-
Nickel	*2*	7	7		3	3	0	-	-	-	-
Zinc	*5*	37	82	**76**	89	71	23	-	-	-	-
Mercury	*0.1*	nd	nd	-	nd	nd	-	-	-	-	-
Organics											
Benzene	*0.2*	nd	nd	-	nd	nd	-	nd	nd	nd	-
Toluene	*0.5*	nd	nd	-	nd	nd	-	nd	7.9	8.2	96
Ethyl benzene	*0.5*	nd	nd	-	nd	nd	-	nd	1.1	1.3	85
meta- & para-Xylene	*0.5*	nd	nd	-	nd	nd	-	nd	5.7	6.8	84
ortho-Xylene	*0.5*	nd	nd	-	nd	nd	-	nd	2.4	3.1	77
TRHs C6 – C10	*10*	nd	nd	-	nd	nd	-	nd	11	14	79
TRHs >C10 - C16	*50*	nd	nd	-	nd	nd	-	-	-	-	-
TRHs >C16 - C34	*100*	nd	nd	-	460	600	26	-	-	-	-
TRHs >C34 - C40	*100*	nd	nd	-	140	130	7	-	-	-	-
Data Quality Indicator		-	-	***<50%***	-	-	*<50%*	-	-	-	*70-130%*

See tables notes at end of section

Soil Analytical Summary Table Notes

LOR denotes limit of reporting (standard LOR unless otherwise shown)

PBILs denotes phytotoxicity based investigation levels

nd denotes not detected above the LOR

NL denotes non-limiting

- denotes not analysed/not available

Bold - Exceeds landuse criteria

^ denotes raised LOR

TRH C6-C10 F1 = TRH C6-C10 minus BTEX compounds

*analyte list shown on laboratory report

1. Methyl mercury / inorganic mercury
2. Netherlands protection of terrestrial organisms/ Netherlands human health based and human health and ecologically based protection level.
3. Criteria for phenol

Table 7: Groundwater Analytical Summary, Metals (ug/L)

Sample	Date	Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
LORs		*1*	*0.1*	*1*	*1*	*1*	*1*	*5*	*0.1*
Analytical									
MW01	15/01/18	nd	nd	**564**	**26**	nd	2	nd	nd
MW02	15/01/18	**35**	nd	3	nd	nd	**11**	**36**	nd
MW03	15/01/18	nd	nd	nd	nd	nd	**20**	**31**	nd
Criteria									
GILs - Drinking Water		**10**	2	**50***	2000	10	**20**	-	1
GILs - Marine water		-	0.7	4.4	**1.3**	4.4	**7**	**15**	0.1

* - Chromium criteria as Cr(VI)

** - Arsenic criteria as As (III) / As (V)

*** - Canadian interim value

See table notes at end of section

Table 8: Groundwater Analytical Summary, BTEXN, TRHs (ug/L)

Sample location	Date	Benzene	Toluene	Ethyl benzene	Xylenes	Naphthalene	C6 - C10 TRHs	F1 C6 - C10 TRHs	F2 >C10 - C16 TRHs	F3 >C16 - C34 TRHs	F4 >C34 - C40 TRHs	>C10 - C40 TRHs
LORs		*1*	*2*	*2*	*2*	*5*	*20*	*20*	*100*	*100*	*100*	*100*
Analytical												
MW01	15/01/18	nd	nd	nd	13	nd	40	30	270	nd	nd	270
MW02	15/01/18	nd	nd	nd	nd	nd	nd	nd	710	450	nd	1,160
MW03	15/01/18	nd	7	8	102	5	940	820	260	2,010	250	2,530
Criteria - Residential												
Health levels 2 m - < 4 m		800	NL	NL	NL	NL	-	1,000	NL	NL	NL	NL
Marine water [1]		500	-	-	-	50	-	-	-	-	-	-
Drinking water[2]		1	800 (25)	300 (3)	600 (20)	-	-	-	-	-	-	-
Recreational Criteria		10	8,000	3,000	6,000	-	-	-	-	-	-	-

See tables notes at end of section

Table 9: Groundwater Analytical Summary, PAHs (ug/L)

Sample	Date	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benz(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1.2.3.cd)pyrene	Dibenz(a.h)anthracene	Benzo(g.h.i)perylene	Total PAHs	B(a)P TEQ
LORs		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*0.5*	*1*	*1*	*1*	*0.5*	*0.5*
Analytical																			
MW01	15/01/18	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MW02	15/01/18	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MW03	15/01/18	2.4	nd	nd	nd	4.8	1.2	6.5	7	3.3	2	2	1.1	**1**	nd	nd	nd	31.3	1.7
Statistics																			
Samples analysed		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Detects		1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	1	1
% detect		33%	0%	0%	0%	33%	33%	33%	33%	33%	33%	33%	33%	33%	0%	0%	0%	33%	33%
Maximum		2.4	0.0	0.0	0.0	4.8	1.2	6.5	7.0	3.3	2.0	2.0	1.1	**1.0**	0.0	0.0	0.0	31.3	1.7
Mean		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Median		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Minimum		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Criteria																			
Marine water GILs		50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drinking Water		-	-	-	-	-	-	-	-	-	-	-	-	**0.01**	-	-	-	-	-

See table notes at end of section

Table 10: Groundwater Analytical Summary, Phenols, OCs, OPs, PCBs ug/L

Sample	Date	Total Phenolic Compounds	Total PCBs	Total OCPs	Total OPPs
LORs		-	-	-	-
Analytical					
MW01	15/01/18	nd	nd	nd	nd
MW02	15/01/18	nd	nd	nd	nd
MW03	15/01/18	nd	nd	nd	nd
Criteria					
GILs - Drinking Water		-	-	-	-
GILs - Marine water		-	-	-	-

See table notes at end of section

Table 11: Groundwater Analytical Summary, Quality Control (ug/L)

Analyte	LOR mg/L	MW02	QS01	**RPD**	Trip Blank	Trip Spike	Trip Spike	Trip Spike
Type	-	*Primary*	*Duplicate*	*%*	*Lab prep*	*Field*	*Lab*	*Recovery*
Date	-	*15/01/18*	*15/01/18*	-	*12/01/18*	*12/01/18*	*12/01/18*	-
Metals								
Arsenic	*0.001*	0.035	0.034	3	-	-	-	-
Cadmium	*0.0001*	nd	nd	-	-	-	-	-
Chromium	*0.001*	0.003	nd	-	-	-	-	-
Copper	*0.001*	nd	nd	-	-	-	-	-
Nickel	*0.001*	nd	nd	-	-	-	-	-
Lead	*0.001*	0.011	0.012	9	-	-	-	-
Zinc	*0.005*	0.036	0.037	3	-	-	-	-
Mercury	*0.0001*	nd	nd	-	-	-	-	-
BTEXN								
Benzene	*1*	nd	nd	-	nd	16	*20*	80
Toluene	*2*	nd	nd	-	nd	16	*20*	80
Ethylbenzene	*2*	nd	nd	-	nd	15	*20*	75
meta- & para-Xylene	*2*	nd	nd	-	nd	15	*20*	75
ortho-xylene	*2*	nd	nd	-	nd	15	*20*	75
Naphthalene	*5*	nd	nd	-	nd	16	*20*	80

Table 11: Groundwater Analytical Summary, Quality Control (ug/L)

Analyte	LOR mg/L	MW02	QS01	**RPD**	Trip Blank	Trip Spike	Trip Spike	Trip Spike
Type	-	*Primary*	*Duplicate*	*%*	*Lab prep*	*Field*	*Lab*	*Recovery*
Date	-	*15/01/18*	*15/01/18*	-	*12/01/18*	*12/01/18*	*12/01/18*	-
TRHs and PAHs								
C6 - C10 Fraction minus BTEX (F1)	*20*	nd	nd	-	nd	-	-	-
> C10 - C16 Fraction (F2)	*50*	710	400	**56**	-	-	-	-
> C16 - C34 Fraction	*100*	450	280	47	-	-	-	-
< C34 - C40 Fraction	*50*	nd	nd	-	-	-	-	-
> C10 - C40 Fraction (sum)	*50*	1,160	680	**52**	-	-	-	-
Sum of PAHs	*2*	nd	nd	-	-	-	-	-
Data Quality Indicator	-	-	-	***<50%***	*nd*	-	-	*70-130%*

See tables notes at end of section

* Date Trip Spike/Blank used in the field

Groundwater Analytical Summary Table Notes

LOR denotes limit of reporting (standard LOR unless otherwise shown)

nd denotes not detected above the LOR

Bold - Exceeds criteria

^ denotes LOR raised

- denotes not analysed/not available

* TPHs in waters used as screening analysis. If > LOR, check specific toxicants e.g. BTEX, PAHs, etc. For recreational waters/aesthetics, oil/petrol not to be noticeable as a visible film on the water or detectable by odour.

1. Aquatic ecosystem criteria from Australian New Zealand Environment and Conservation Council (ANZECC) / Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* , including Table 3.4.1 and Section 8.3.7.

DECCW/DERM specify that the 95% species protection levels are to be applied for slightly to moderately-disturbed ecosystems (most urban catchments) and the 99% species protection levels for pristine or vulnerable ecosystems or where the contaminants are intractable (e.g. bioaccumulative).

2. Drinking water criteria from National Health and Medical Research Council (NHMRC) & Natural Resource Management Ministerial Council (NRMMC) (2011) *Australian Drinking Water Guidelines* .

The guideline values are health related and are described as the concentration that does not result in any significant risk to the health of the consumer over a lifetime of consumption. Numbers in brackets are aesthetic values, e.g. appearance, taste and/or odour. The guideline values relate to the quality of water at the point of use, e.g. kitchen or bathroom tap.

While exposure is predominately through ingestion, skin adsorption and/or inhalation are considered in calculating the guideline value (Page 6-7, NHMRC/NRMMC 2004). However, this only addresses consumption/use of drinking water, it does not address inhalation from subsurface, and drinking water criteria should not be used as risk assessment screening values for onsite contaminant concentrations.

Appendix A

Groundwater Bore Search Results

NSW Office of Water
Work Summary

GW114492

Licence: 10BL604468 **Licence Status:** ACTIVE

Authorised Purpose(s): MONITORING BORE
Intended Purpose(s): MONITORING BORE

Work Type: Bore
Work Status: Equipped
Construct.Method: Auger - Solid Flight
Owner Type: Private

Commenced Date:
Completion Date: 04/05/2011
Final Depth: 10.00 m
Drilled Depth: 10.00 m

Contractor Name: Terratest
Driller: Paul James Barker
Assistant Driller:

Property: ROYAL SYDNEY YACHT SQUADRON 33 PEEL STREET KIRRIBILLI 2061 NSW
Standing Water Level: 1.200
GWMA:
GW Zone:
Salinity:
Yield:

Site Details

Site Chosen By:

	County	Parish	Cadastre
Form A:	CUMBE	CUMBE.57	1//89565
Licensed:			

Region: 10 - Sydney South Coast
CMA Map:
River Basin: - Unknown
Area/District:
Grid Zone:
Scale:

Elevation: 0.00 m (A.H.D.)
Elevation Source: Unknown
Northing: 6253249.0
Easting: 335259.0
Latitude: 33°50'53.5"S
Longitude: 151°13'09.7"E

GS Map: -
MGA Zone: 0
Coordinate Source: Unknown

Construction

Negative depths indicate Above Ground Level; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

Hole	Pipe	Component	Type	From (m)	To (m)	Outside Diameter (mm)	Inside Diameter (mm)	Interval	Details
1		Hole	Hole	0.00	2.20	125			Auger - Solid Flight
1		Hole	Hole	2.20	10.00	100			Rotary - Water
1	1	Casing	Pvc Class 18	0.00	2.00	60	59		Seated on Bottom, Screwed
1	1	Opening	Slots - Horizontal	2.00	10.00	60		1	Casing - Machine Slotted, PVC Class 9, Screwed, SL: 45.0mm

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
1.00	10.00	9.00	Unknown	1.20					

Geologists Log
Drillers Log

From (m)	To (m)	Thickness (m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	FILLING DARK BROWN,SILTY SANDY CLAY	Fill	

0.30	1.30	1.00	FILLING DARK BROWN,SILY SANDY CLAY,SANDSTONE	Fill	
1.30	1.70	0.40	SANDSTONE,LOW STRENGTH,YELLOW BROWN	Sandstone	
1.70	10.00	8.30	SANDSTONE,MD.STRENGTH GREY	Sandstone	

Remarks

13/08/2014: Nat Carling, Added status, drill method, depth & rock types, updated work type.

***** End of GW114492 *****