



Douglas Partners

Geotechnics | Environment | Groundwater

Report on
Geotechnical Investigation

PNRL Centre of Excellence and Community Facility
corner Kennedy Avenue and Stone Mason Drive,
Kellyville

Prepared for
Paramatta National Rugby League Club Pty Ltd

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Integrated Practical Solutions





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Report on Geotechnical Investigation

PNRL Centre of Excellence and Community Facility

corner Kennedy Avenue and Stone Mason Drive, Kellyville

1. Introduction

This report presents the results of a geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for the proposed PNRL Centre of Excellence and Community Facility at corner Kennedy Avenue and Stone Mason Drive, Kellyville. The investigation was commissioned in an email dated 18 August 2021 by Mr Kael Williams of Mostyn Copper on behalf of Paramatta National Rugby League Club Pty Ltd and was undertaken in accordance with DPs' proposal 207155.00 dated 20 July 2021.

It is understood that the proposed development includes the construction of two buildings (the Parramatta Eels Centre of Excellence and the Sports Hub), a grandstand and a new carpark. The Centre of Excellence includes a one level basement while the Sports Hub involves cut and fill to form the building platform. Geotechnical investigation was carried out to provide information on subsurface conditions for planning, costing and design purposes. This report will also be used to support a development application for the proposed development as a State Significant Development (Application Number-24452975).

At the time of investigation, the northern portion of the Parramatta Eels Centre of Excellence and new carpark were occupied by a contractor compound. Additional investigation at a later stage is required at a later stage.

This investigation included the drilling of boreholes, the installation of groundwater monitoring wells and dynamic cone penetrometer (DCP) tests followed by laboratory testing of selected samples. The details of the field work and laboratory testing are presented in this report, together with comments and recommendations on design and construction.

DP carried out a preliminary site (contamination) investigation (PSI) in conjunction with this geotechnical investigation, the results of which are presented in a separate report (DP Report Reference 207155.00.R.002.Rev0).

2. Previous Investigations

DP has previously undertaken geotechnical investigations on the site of Kellyville Park incorporating the subject site and the reports reviewed. These investigations included the excavation of two test pits (Pit 5 and Pit 10) for the sports field, carpark and access road to the south and east of the site (DP Report Reference 73017.00 July 2010) and three augered bores (Bore 101, Bore 102 and Bore 104) for the carpark to the east of the site (DP Report Reference 94527.00 December 2018). The information from these test pits and boreholes has been used in the preparation of this current report.

A summary of the conditions encountered in the relevant tests is included in the development of the geotechnical model in Section 9.1. The relevant test pit and borehole logs are included in Appendix F.

3. Site Description

The proposed development is located within Kellyville Park at the corner of Kennedy Avenue and Stone Mason Drive, Kellyville (within Lot 60 DP 10702 and Lot 1 DP167535). The Stage One investigation area (“the site”) comprises an irregular shaped area of approximately 0.7 hectares, with maximum north-south and east-west dimensions of approximately 190 m and 80 m, respectively.

At the time of the field work, the southern portion of the site predominantly comprised a grassed area with a batter slope estimated to be 3 m to 4 m high with a fall of about 2H:1V (Horizontal:Vertical) towards the west.

The northern portion of the site comprised grassed and asphalt paved areas with some portable site sheds at the western end and parking and storage areas at the eastern end. This area includes a compound occupied by Daracon for the Memorial Drive roadworks which is covered by a pavement hardstand and site sheds. It is understood that at the completion of site works, estimated to be at the end of 2023, Daracon will remove the site compound including all demountables and the roadbase placed across the footprint of the site.

Medium to large sized trees were scattered over the site, predominantly over the northern half.

The site is bounded by the following:

- North – site compound for the Memorial Avenue road works comprising portable site sheds and an asphalt parking area;
- East – Stone Mason Drive and an existing asphalt carpark;
- South – Kennedy Avenue; and
- West – grassed sports fields and a cleared area for proposed sports fields.

The site and surrounding area slopes gently to the south-west towards a tributary of Strangers Creek located about 250 m to the west of the site.

Table 1 presents site identification details and a location plan showing the approximate site area is presented in Figure 1.

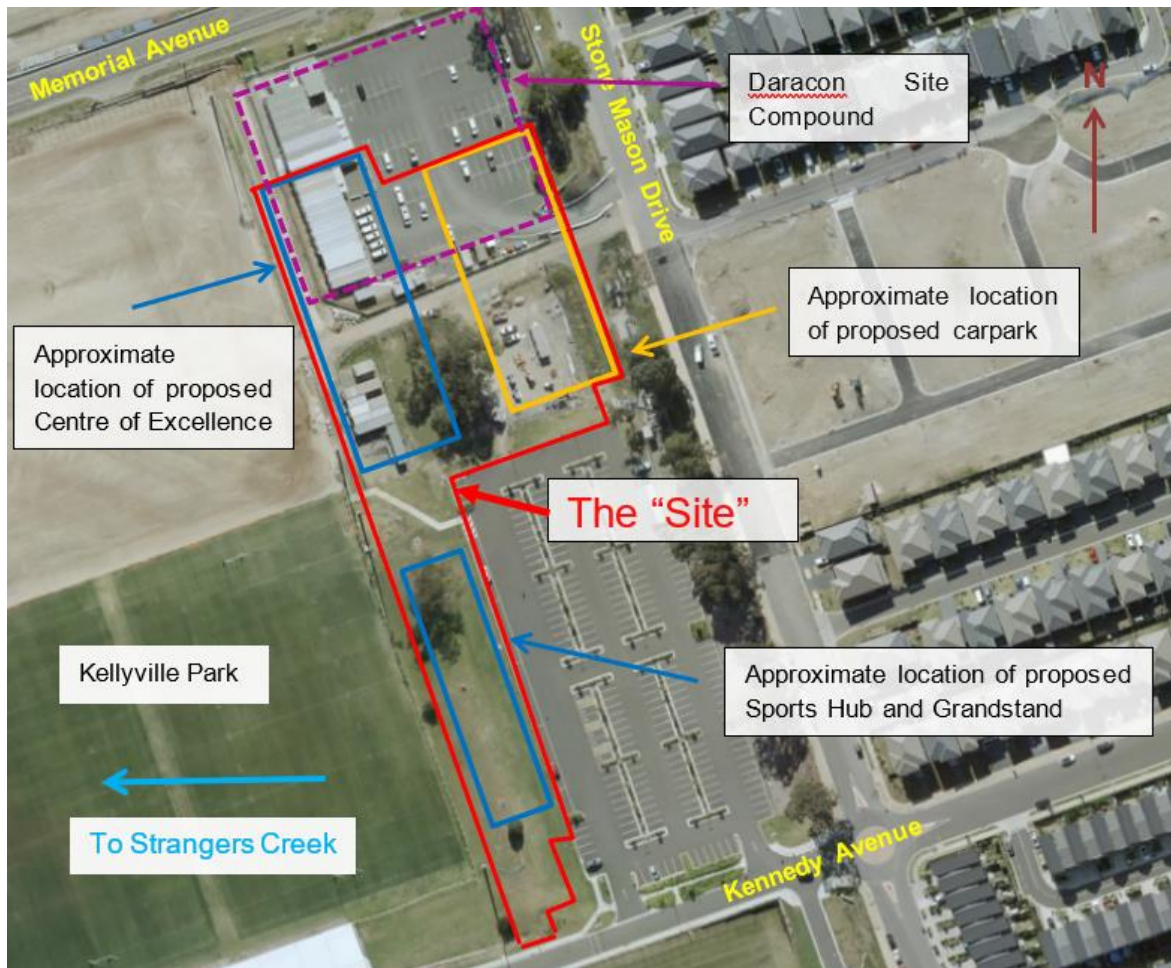


Figure 1: Site Location Plan (Source: Metro Map)

4. Published Data

4.1 Geology

Reference to the Penrith 1:100 000 scale Geological Series Sheet indicates that the site is predominantly underlain by Ashfield Shale of the Wianamatta Group of Triassic age. Ashfield Shale typically comprises dark grey to black shale, siltstone and laminate which weathers to a residual clay profile of medium to high plasticity.

Field investigation confirmed the presence of Ashfield Shale on-site.

4.2 Hydrogeology

The closest surface water receptor to the site is Strangers Creek located about 250 m west of the site. It is understood that this includes a minor dam known as Sydney Water's Basin 35.

Based on the local topography, groundwater is anticipated to flow to the west towards Strangers Creek.

A search of the NSW Department of Primary Industries Water (DPI Water) online map of registered groundwater works was undertaken as part of the investigation. The search carried out on 1 September 2021 identified no registered groundwater boreholes within 500 m of the site that contained groundwater information.

4.3 Soil Landscape

Reference to the Penrith 1: 100 000 scale Soil Landscape Series Sheet indicates that the site is located close to the boundary between the Blacktown and Luddenham soil landscape groups. The Blacktown Group is characterised by moderately reactive, highly plastic subsoil with poor drainage, whereas the Luddenham Group is characterised by moderately reactive, highly plastic subsoil with high soil erosion susceptibility.

4.4 Acid Sulfate Soils

Review of published mapping indicates that the site is in an area of 'no known occurrence of acid sulfate soils.' The NSW Acid Sulfate Soils Manual 1998 published by the Acid Sulfate Soils Management Advisory Committee (ASSMAC) indicates that ASS (and Potential Acid Sulfate Soils – PASS) normally occur in alluvial or estuarine soils below RL 5 m AHD although occasionally are encountered up to RL 12 m AHD. Considering the ASS mapping and given that the site soils are at site elevations above RL 60 m AHD, it is considered unlikely that ASS is present on-site.

4.5 Salinity

The Department of Infrastructure, Planning and Natural Resources (DIPNR) "Map of Salinity Potential in Western Sydney 2002" suggests that the site is in an area of "moderate salinity potential" with a higher potential in the lower elevation areas south-west of the site in close proximity to the Strangers Creek system.

4.6 Historical Aerial Photographs

Review of historical aerial photographs from 1943 (refer Drawings 2 to 5 in Appendix B) indicates that the site was used for mainly agricultural purposes until progressive development as a sports field was carried out between 2000 and 2001. A creek-line, now backfilled, along an approximate east-west alignment bisects the site.

5. Field Work

5.1 Methods

The field work included the following:

- Drilling of three boreholes (Bores 201, 203 and 205) using hand tools to practical refusal at depths of 0.2 m to 0.9 m.
- Drilling of eight boreholes (Bores 202, 204 and 206 to 211) using a track mounted drilling rig with 110 mm diameter spiral flight augers. The boreholes were drilled to depths of between 0.7 m and 5.8 m. Standard penetration tests (SPTs) were completed at regular depths within the overburden.
- Extension of four boreholes (Bores 202, 204, 206 and 209) into the underlying bedrock using NMLC coring techniques to obtain continuous 52 mm diameter core samples of the rock for identification and strength testing purposes. The boreholes were terminated at depths of between 5.8 m and 10.0 m.
- Five DCP tests carried out to 1.2 m depth or prior refusal in accordance with AS1289.6.3.2, to estimate the strength/relative density of the near-surface soils.

Undisturbed and disturbed samples were collected from the boreholes to assist with logging and for laboratory testing.

Two boreholes, Bores 202 and 209, were converted to groundwater wells at the completion of drilling. The wells involved inserting a Class 18 uPVC screen and casing to the required depth, backfilling the screened length with clean gravel, sealing the top of the gravel with bentonite pellets and backfilling the casing with drilling spoil. Approximately 1 m of casing was left extending above the ground surface and a PVC cap was placed on the end to enable groundwater monitoring of the well. Following installation, the wells were purged of groundwater and measurement of the groundwater levels was carried out on two subsequent occasions.

The ground surface levels (measured in 'metres above Australian Height Datum AHD') together with the Eastings and Northings (measured to GDA2020) at the borehole locations were determined by using a high precision Differential GPS which is accurate to approximately 0.1 m. The locations of the boreholes are shown on Drawing 1 in Appendix B.

5.2 Results

The detailed borehole logs are provided in Appendix C. Notes defining classification methods and terms used to describe the soils and rocks are included in Appendix A. The subsurface conditions encountered underlying the site can be summarised as follows:

- Topsoil: Clayey silt, gravelly and silty clay to depths ranging between 0.1 m and 0.3 m in all boreholes except Boreholes 206, 210 and 211;
- Fill: Pavement materials (asphaltic concrete and roadbase in Bore 206) to depths of 50 mm to 150 mm to

- Gravelly clay and sandy gravel with sand, concrete fragments, plastic and ripped shale to depths of 0.5 m to 1.1 m in Bores 205, 207, 210 and 211;
- Natural Soil:
 - Typically stiff to hard silty clay to depths of 3.2 m and 0.9 m in all boreholes except Bores 201, 203 and 211 and where natural clay was not encountered. Bore 204 included firm to stiff clay to 2.0 m depth;
- Weathered Rock:
 - Very low strength, pale grey and red-brown siltstone was encountered below depths of 0.15 m to greater than 2.3 m. Some extremely low strength seams and medium and high strength ironstone bands were encountered within these layers;
- Very Low, Low and Medium Strength Siltstone
 - Alternating bands of very low, low and medium strength with clay seams, highly to slightly weathered, highly fractured to fractured, grey siltstone at depths of 1.9 m to 6.3 m. Numerous bedding planes and some joints and crushed zones were observed in this layer
- Medium and High Strength Siltstone
 - High strength, fresh stained to fresh, slightly fractured, dark grey, siltstone at depths of 3.6 m to 8.0 m in Bores 204 and 209.

A summary of the subsurface layers is provided in Table 1 below.

Table 1: Summary of Subsurface Layers

Bore	RL (m AHD)	Top of Natural Clay		Top of Weathered Siltstone		Top of Low and Medium Strength Siltstone		Top of Medium and High Strength Siltstone	
		Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)
201	63.1	-	-	0.15	63.0	-	-	-	-
202	67.6	0.2	67.4	2	65.6	5.4	62.2	-	-
203	62.6	-	-	0.3	62.3	-	-	-	-
204	66.9	0.2	66.7	5.8	61.1	6.3	60.6	8	58.9
205	62.0	0.6	61.4	0.8	61.2	-	-	-	-
206	63.4	0.2	63.2	0.8	62.6	2.2	61.2	-	-
207	65.9	1.1	64.8	>2.3	<63.6	-	-	-	-
208	64.1	0.3	63.8	0.7	63.4	-	-	-	-
209	65.5	0.7	64.8	1.7	63.8	1.9	63.6	3.6	61.9
210	66.6	0.7	65.9	1	65.6	-	-	-	-
211	66.6	-	-	0.5	66.1	-	-	-	-

Free groundwater was not observed during auger drilling of the boreholes. The use of water as a drilling fluid prevented groundwater observations during rotary drilling and coring of the boreholes.

Groundwater levels were measured by experienced geotechnical engineer in the monitoring wells on four subsequent occasions. A summary of the groundwater levels measured to date are provided in Table 2.

Table 2: Results of Groundwater Measurements

Bore No.	Surface RL (m AHD)	Standpipe Measurements – Water Level							
		16 September 2021		7 October 2021		9 November 2021		10 November 2021	
		Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)	Depth (m)	RL (m AHD)
202	67.6	3.9	63.7	4.5	63.1	3.2	64.4	3.4	64.2
209	65.5	3.5	62.0	3.6	61.9	4.4	61.1	4.4	61.1

6. Laboratory Testing

6.1 Mechanical Testing

Selected samples from the boreholes were tested in the laboratory for measurement of moisture content, compaction properties and CBR. The detailed results are given in Appendix D and summarised in Table 3.

Table 3: Results of Laboratory Testing - Geotechnical

Sample Location	Material	Depth (m)	FMC (%)	OMC (%)	MDD (t/m ³)	CBR (%)	ECN
210	Silty Clay	0.7 – 1.0	13.6	18.1	1.77	5	2
211	Fill (Gravelly Clay)	0.1 – 0.5	8.3	12.8	1.88	40	-

Notes: FMC = Field Moisture Content OMC = Standard Optimum Moisture Content
 MDD = Maximum Dry Density CBR = California bearing ratio
 ECN = Emerson Crumb number

The results of the laboratory testing indicate the following:

- The CBR values were 5 % and 40 % for the natural silty clay and clay fill samples tested.
- The field moisture contents ranged from 8.3 % to 13.6 % for the silty clay samples tested. The field moisture contents of the samples were both 4.5 % dry of the optimum moisture content.
- The Emerson Crumb Number was 2 indicating the clay sample was highly dispersive.

6.2 Chemical Testing

Selected samples collected from the boreholes were also tested in the laboratory for determination of aggressivity to concrete and steel, textural classification and salinity.

A result summary table (Appendix D) presents the results of laboratory tests, assessments of aggressivity to concrete and steel, textural classification, calculated salinity electrical conductivity (ECe) and salinity class inferred from ECe values using the method of Richards (1954). The detailed laboratory test reports and chain of custody information are also provided in Appendix D.

The total test sample numbers and the range of test results obtained are summarised in Table 4.

Table 4: Results of Laboratory Testing - Chemical

Parameter		Units	Number of Tests	Range of Results
pH		pH units	11	5.1 – 5.8
Chlorides		(mg/kg)	2	<10 – 10
Sulphates		(mg/kg)	2	35 – 50
Aggressivity [AS 2159]	to Concrete	-	-	non-aggressive to mildly aggressive
	to Steel	-	-	non-aggressive
EC1:5 [Lab.]		(μ S/cm)	11	33 - 250
ECe [M x EC1:5] ¹		(dS/m)	11	<2 – 2.3
Salinity Class [after Richards]		-	11	Non-Saline to Slightly Saline

Notes: 1 M is soil textural factor

6.2.1 Aggressivity

Test results showing the aggressivity assessed by pH, sulphate concentrations and chloride concentration criteria (of AS 2159) at the borehole locations, together with the aggressivity class ranges indicated in Australian Standard AS 2159 are given in Appendix D. The inferred very low permeability of the sampled clay-rich soils indicates that soils at all boreholes are in Condition “B” as defined by AS 2159.

The results show that the samples tested indicate the ground conditions are non-aggressive to mildly aggressive to concrete and non-aggressive to steel with reference to AS2159. The pH profiles with depth are shown in Figure 2 (following page).

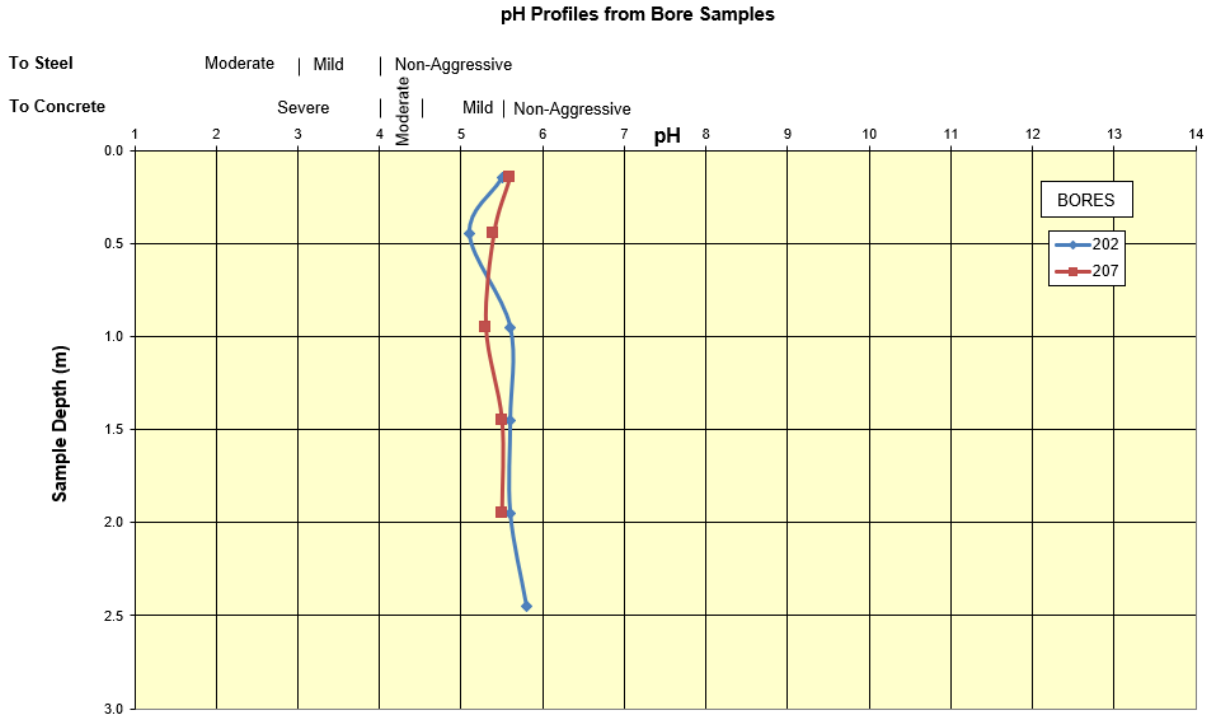


Figure 2: Vertical pH Profiles

6.2.2 Salinity

Figure 3 (following page) shows the salinity classifications based on the electrical conductivity (ECe) at borehole locations, together with the salinity classifications of Richards (1954). Test results are provided in Appendix D.

The results indicate that the samples tested were varied ranging from non-saline to slightly saline.

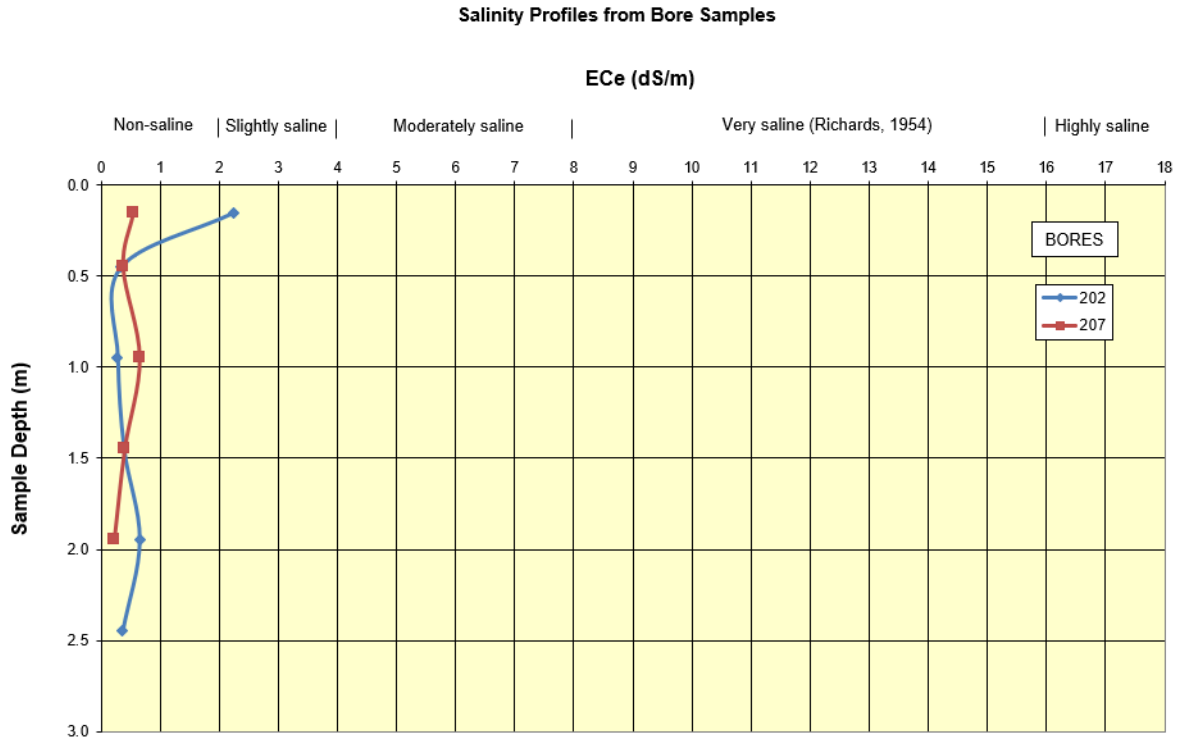


Figure 3: Vertical Salinity Profiles and Salinity Classes

6.2.3 Point Load Testing

Point Load Strength Index (Is_{50}) testing was carried out on selected rock core specimens. The results of the tests are shown on the borehole logs at the appropriate depths. Figure 4 (following page) shows the range of Is_{50} results at the various depths (shown as Reduced Levels relative to AHD).

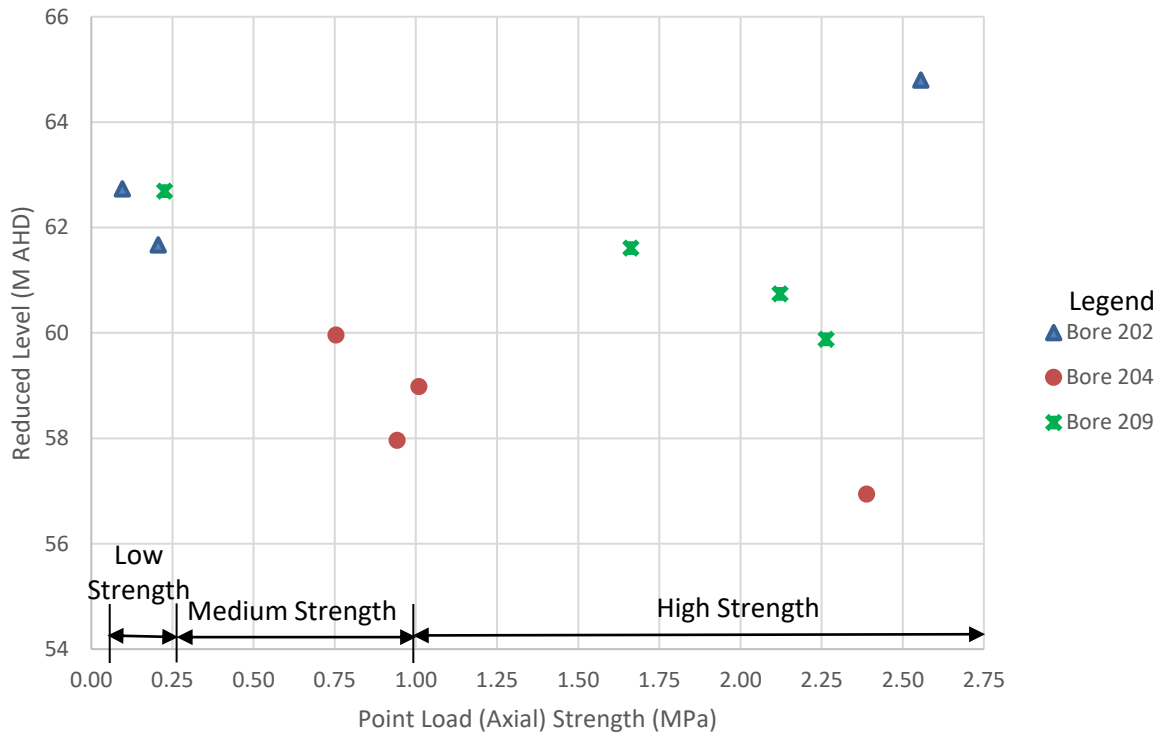


Figure 4: Results of Axial Point Load Tests

7. Proposed Development

It is understood that the proposed development will include the construction of two buildings as described below:

- Building A – Grandstand and Sports Hub. The Sports Hub is to finished floor slab level at RL 63.95 and will include an excavation understood to be up to 5 m deep. Access through the Grandstand will be via three access tunnels with a Finished Floor Slab level ranging from 63.2 m AHD.
- Building B – Centre of Excellence – a two storey building. The ground floor finished floor level to be at RL 63.6 m AHD. The construction of this building will require up to 3 m of cut on its eastern side and up to 0.5 m of fill on its western side to form the building platform level.

It understood that typical working column loads are expected to be of the order of 1000 kN to 1500 kN and potential column uplift loads of about 300 kN.

8. Geotechnical Model

The site is expected to be underlain by the following geological sequence:

- Unit 1 - Fill to depths of 0.2 m to 1.1 m. The fill includes a surficial topsoils layer.
- Unit 2 - Natural clays, where present, typically to depths of 0.2 m to 2.3 m. It is suspected that where the depth of clay is significantly deeper, to 5.8 m in Bore 204, that this is the location of an old creek that bisected the site (refer Section 4.6). The clays on site are typically highly reactive and of high plasticity.
- Unit 3 - Weathered Siltstone in the area from depths of 0.2 m to 5.8 m. The thickness of the weathered siltstone was typically in the range of 0.2 m to 3.4 m. The siltstone is expected to be in the very low and low strength range with some clay seams and higher strength layers.
- Unit 4 - Siltstone of alternating bands of very low, low and medium strength. The higher strength layers are typically ironstained. The high degree of variation, fracturing, extremely weathered/clay seams suggest that there may be potential faulting of this layer.
- Unit 5 - Siltstone of medium and high strength, fresh, slightly fractured with some laminations.

It is suspected that previous earthworks on-site to form current site levels, may have excavated and removed natural soils, particularly along the batter slope.

Groundwater was encountered during this investigation at depths of 3.5 m to 4.5 m and is expected to flow downgradient to the west. At these recorded levels the groundwater is expected to be seepage within the Unit 4 siltstone with the aquifer for the area a significant depth below the bulk excavation levels. Notwithstanding these recorded levels, water seepage could occur at a higher level along the soil/rock interface and through bedding planes, faults and joints within the rock. Groundwater levels, including those influenced by seepage, are expected to fluctuate with variations in climatic conditions.

It would be prudent to confirm the geotechnical model to optimise design over the northern part of the site, where the Daracon Compound is located, for the development overlying this part of the site.

9. Comments

9.1 General

This geotechnical investigation indicated that the site is underlain by a typical Western Sydney geological profile. The proposed development can be constructed on the site provided normal engineering controls and standard industry practices are carried out. The subsequent sections of this report provide comments on the geotechnical aspects of design and construction for the proposed development.

It is understood that specific comment is required about the impact of the proposed development on the dam know as Basin 35. Basin 35 is at least 250 m to the west of the proposed works. Given the distance and the geological profile between the proposed works and the Basin 35 dam the proposed works are not expected to adversely affect the structural integrity of the Basin 35 dam.

9.2 Preliminary Site Classification

The results of field work indicate that the site is underlain by topsoil or fill (up to about 1.1 m depth) overlying residual clay soils of variable strength then weathered rock. Furthermore, the development areas across the site are located in close proximity to trees. Where mature trees are located near the proposed building footprint, a “P” classification would be assigned to the site in accordance with the abnormal moisture provisions and uncontrolled fill greater than 0.4 m thick of AS2870 – 2011 “Residential Slabs and Footings”. Class P sites require design from engineering principles.

Previous laboratory testing indicates that the clays at the site are of high plasticity and therefore likely to be susceptible to shrink-swell movements in response to seasonal variations in soil moisture content. Based on the soil depth, and the results of laboratory testing, it is considered that the natural soil profile would be expected to be consistent with a Class “H1” site as per AS 2870. AS2870 indicates that characteristic surface movements (y_s) of up to 60 mm are expected for a Class “H1” site.

Where present, the effect of adjacent trees needs to be considered in the design. Using the methods of AS2870, an additional 10 mm to 15 mm of ground movement should be allowed for within the design where trees up to 15 m in height are within 5 m of the proposed structure.

9.3 Site Preparation and Earthworks

9.3.1 Excavation Conditions

Excavation to depths of up to 3.0 m is generally expected to encounter topsoil, fill and natural soils. Excavation within the soils and any very low strength rock should be achievable using conventional earthmoving equipment such as hydraulic excavators.

Excavation within any low strength or stronger siltstone (Units 2 and 5) if encountered, will likely require hydraulic rock breakers in conjunction with heavy ripping for effective removal of this material. Low productivity can be expected during the excavation of these stronger materials.

Material won from excavations on-site is generally considered suitable for re-use as structural fill on-site provided it free of deleterious materials (e.g. any localised areas of building materials, vegetation affected soil etc). Some moisture conditioning of excessively wet or dry material may be required. Material won from rock excavations would need to be broken down to a suitable size. Additional comments on suitable fill material are provided in Section 9.2.3.

Vibration generated during earthworks operations would generally be at a level that would not adversely affect the neighbouring structures.

It is anticipated that there may be some seepage of groundwater into the excavation. Further comments on groundwater are included in Section 9.4.

The proposed excavations on site are expected to be shallow in which case the guidelines as given in SafeWork would be appropriate. If batters are required for shallow excavations, a batter of 1H:1V could be adopted for natural clay or clay filling.

9.3.2 Disposal of Excavated Material

All surplus excavated materials will need to be disposed of in accordance with the Protection of the Environment Operations Act 1997 (POEO Act). All materials removed from the site are defined as waste under the POEO Act and must be disposed of in accordance with one of the following:

- Virgin excavated natural materials (VENM) as defined under the POEO Act, permitting beneficial reuse; or
- A waste category meeting the criteria set out in the NSW EPA Waste Classification Guidelines 2014, with the materials disposed to a landfill licenced to receive the waste under the assigned classification or taken to a recycling facility licenced to receive the waste; or
- Material complying with a Resource Recovery Order (RRO) as defined under the Protection of the Environment Operations (Waste) Regulation 2014, with complying materials able to be reused under certain conditions.

Accordingly, environmental testing will need to be carried out to determine the most appropriate off-site destination(s) for the surplus excavated material.

9.3.3 Site Preparation

For planning purposes, the following site preparation measures are recommended for subgrade preparation and any site platform filling placement for the development:

- remove any deleterious, soft, wet or highly compressible material or material rich in organics or root matter (such as topsoils). Based on DP's investigation this will typically range from 0.1 m to 0.2 m depth but locally deeper at some locations. Topsoil materials should be separately stockpiled for use in landscaping or removed off site. Fill materials could potentially be reused on-site subject to geotechnical inspection and approval;
- roll the exposed surface with at least six passes of a minimum 12 tonne deadweight smooth drum roller, with a final test roll pass accompanied by careful visual inspection to ensure that any deleterious materials such as soft, wet or highly compressible soil and any organics are identified and removed;
- place approved filling, where required, in layers not exceeding 250 mm loose thickness, with each layer compacted to a minimum dry density ratio of 98% Standard within 2% of optimum moisture content (OMC). New fill to form pavement subgrades will be required to be compacted to a minimum dry density ratio of 100% relative to Standard compaction. New filling should be free of oversize particles (>75mm) and deleterious material;
- moisture conditioning of clay soils may be required if soils are saturated or dry. The soils on-site were observed to be 2% wet of optimum moisture content and would generally require drying.

Moisture conditioning of saturated soils would involve drying in 'sunny and windy' weather, blending with other drier materials or lime stabilisation. Where the soil is dry, it is expected that this will involve either tyning or excavation with the addition of water to increase the moisture content;

- promptly cover any exposed clay at subgrade level with a minimum 150 mm of select granular fill (minimum CBR 15%) to reduce potential wetting and drying and trafficability problems. Alternatively, lime stabilisation of the subgrade could be considered to limit the potential for moisture susceptibility; and
- new filling required to achieve design levels for support of any on-ground slabs and/or structural loads will need to be carried out under Level 1 testing conditions as defined in AS 3798–2007 "Guidelines on Earthworks for Commercial and Residential Developments". Level 2 testing is recommended for filling materials beneath pavements, recreational and landscaping areas.

The above procedures will require geotechnical inspection and testing services during construction.

9.4 Excavation Support

9.4.1 General

Vertical excavations in Units 1 to 5 will not be stable for any extended period of time due to either the low shear strength of the soils/weathered rock (Units 1 to 3) or the high degree of fracturing of the siltstone and laminite (Units 4 and 5).

The sidewalls of the basement excavation will therefore require temporary shoring support during excavation and permanent retaining wall support as part of the final construction. The following methods of support are recommended:

- **Temporary Batters (for excavations up to 4 m)** - Temporary batter could be used to support the sides of the excavation to a depth of up to 4 m, but will only where space permits. The temporary batters will allow block retaining walls, or similar, to be constructed in front of the batter. Further details regarding batter slopes are provided in Section 9.3.2.
- **Soldier pile/infill panel wall system** - where batters cannot be provided, it is suggested that the excavation be supported by temporary shoring and permanent retaining walls such as a soldier pile/infill panel wall system. The soldier piles would generally be spaced at about 2 m to 3 m centres and should be founded at least two pile diameters below the lowest excavation level (both bulk and detailed) adjacent to the pile location. Soldier piles typically involve either bored piles or continuous flight auger (CFA) piles.

At the completion of each excavation lift, reinforced shotcrete infill panels should be constructed. At no stage should progressive vertical excavation proceed beyond 2 m without infill panel support being constructed. It is possible that adverse jointing may give rise to unstable wedges and thus cause localised or even major instability in the exposed material. Regular inspections by a geotechnical professional following each progressive lift of excavation would be prudent to determine if any further stabilisation measures are required.

Strip drains should be installed behind the shotcrete of the soldier pile/infill panel wall system to facilitate drainage and prevent build-up of water pressures behind the shoring.

- **Continuous pile wall** – for retaining walls requiring greater stiffness then consideration could be given to installing a continuous pile wall. A continuous pile wall involves the installation of either bored or CFA piles immediately adjacent to each other to provide a continuous pile wall.

The presence of high and very high strength rock layers will require a drilling rig with sufficient torque capacity to drill through these layers. The drilling contractor should confirm that the proposed drill rig is of sufficient size and capacity to be able to confidently drill through these high and very high strength layers.

9.4.2 Batter Slopes

The maximum unsupported batter slopes up to 4 m in height are provided in Table 5.

Table 5: Temporary Batter Slopes

Material Description	Temporary Batter Slope (H:V)	Permanent Batter Slope (H:V)
Fill and Natural Soils (Units 1 and 2)	1.5:1	2:1
Very Low, Low and Medium Strength Siltstone (Units 3 and 4)	1:1 ¹	1:1 ¹
Medium and High Strength Siltstone (Unit 5)	0.5:1 ¹	0.75:1 ¹

- Note: 1. Subject to geotechnical inspection every 2 m drop of excavation to determine if flatter batters or stabilisation measures are required.
2. Flatter slopes may be required for maintenance purposes (e.g. mowing purposes)

Temporary batters in filling and soil in excess of 4 m in height may have to be cut at a flatter angle, incorporate benches or shotcrete, a soldier pile retaining wall (or similar) and include a rockbolt/anchor support (to be assessed by geotechnical engineer).

9.4.3 Retaining Wall Design

The design of retaining walls should take due account of both lateral earth pressures and surcharges acting on the walls. This includes the neighbouring buildings loads, any traffic loads, construction surcharge loads, etc.

It is suggested that the design of cantilevered shoring systems (or shoring systems with one row of anchors) be based on a triangular earth pressure distribution using the earth pressure coefficients provided in Table 6. 'Active' earth pressure coefficient (K_a) values may be used where some wall movement is acceptable. 'At Rest' earth pressure coefficient (K_0) values should be used where the wall movement needs to be limited.

Table 6: Recommended Design Parameters for Shoring Systems

Material	Unit Weight (kN/m ³)	Earth Pressure Coefficient	
		Active (K _a)	At Rest (K _o)
Fill and Natural Clays (Units 1 and 2) See Notes 1 and 4	20	0.35	0.5
Very Low and Low Strength Siltstone (Units 3 and 4) See Notes 1 and 3	22	0.2	0.3
Medium and High Strength Siltstone (Unit 5) See Notes 1 to 3	24	0	0

- Notes:
1. The values above assume a level surface behind the wall.
 2. It is assumed that the rock mass is free of adverse dipping joints and seams. Geotechnical inspection during construction to confirm
 3. It should also be noted that K_o designs will not prevent stress relief movement from occurring.

For braced walls or where two or more rows of anchors are used, the shoring can be designed using a rectangular or trapezoidal earth pressure distribution.

An alternative approach, where the support pressure is related to the height of soil/weathered rock retained, could also be used. Where there are no movement-sensitive structures, an earth pressure distribution equal to 4H kPa can be used (where H, in metres, equals the depth to the top of self-supporting medium strength or stronger rock). Where the wall movement is to be minimised (i.e., close to adjacent buildings or services) the lateral earth pressure can be calculated using 6H kPa. For movement-sensitive structures, where it is critical that deformation is controlled, it may be necessary to calculate the pressure using 8H kPa. These pressures can be applied as either rectangular or trapezoidal earth pressure distributions. Note these earth pressure distributions are “pressure envelopes”, selected to ensure that no row of anchors is overloaded during the temporary support phase. The actual magnitude and distribution of lateral earth pressures is likely to differ from the uniform distributions given above.

The design of temporary and permanent support will need to consider the possibility that a 45° joint in the bedrock will daylight near the base of the shoring, leading to a large wedge of rock requiring support by the temporary and permanent retaining structures. Sufficient anchoring of the shoring wall should be undertaken to prevent movements along such joints, even though there is a low probability that such a joint would run the full length and height of the supported face. It is suggested that design be carried out such that the temporary support system has a factor of safety of 1.2 against the ultimate sliding force along the most unfavourable joint plane, with provision for installation of additional anchor support in the unlikely event that such a joint or fault is present. Note this approach will require very careful geotechnical inspection during construction.

The support system would typically comprise anchors spaced evenly over the face. These anchors should have their bond lengths behind the projected joint and should provide sufficient force to resist the movement of the resulting wedge. The frictional resistance of the wedge along the joint may be calculated assuming an internal angle of friction of 25°. Additional anchors may be required to increase the factor of safety if a large wedges is identified during excavation.

Wall design using the parameters given in Table 6 assume the following:

- A level surface behind the crest of the excavation is assumed;
- Retaining walls will need to allow for hydrostatic pressures unless designed as fully drained walls;
- All construction and other surcharge loading (e.g., stacked materials) are accounted for;
- Passive resistance for piles founded below the base of the bulk excavation may be based on a working passive bearing pressure of at least 1000 kPa, provided that the rock comprises medium strength or stronger rock (e.g. Unit 5). The first 0.5 m of rock socket below the bulk excavation level should not be taken into account for the purpose of passive restraint. The minimum socket depth should be equal to the greater of one pile diameter or 1.0 m below the lowest level of any nearby excavation (including any detailed excavations), but subject to analysis. This is also relevant where toe anchors are installed, just prior to fully exposing the toe of the pile. Higher passive design parameters may be assigned with investigation involving cored boreholes.

The final or detailed design of retaining walls is normally undertaken using interactive computer programs such as WALLAP, PLAXIS or FLAC, which can take due regard of soil-structure interaction during the progressive stages of wall construction, anchoring and bulk excavation.

9.4.4 Anchor Design

Temporary ground anchors will be required for the lateral restraint of most boundary shoring walls until such time that the walls are permanently strutted by the building floor slabs. The anchors should preferably have their bond length within weathered (or stronger) rock.

Suggested allowable bond stresses for the design of temporary ground anchors are given in Table 7.

Table 7: Bond Stresses for Anchor Design

Material Description	Ultimate Bond Stress (kPa)
Fill and Natural clays (Units 1 and 2)	100
Very Low, Low and Medium Strength Siltstone (Units 3 and 4)	300
Medium Strength and Higher Strength Siltstone (Unit 5) <small>See Note 1</small>	1000

Notes: 1. Higher bond stresses could potentially be assigned with additional investigation.

Ground anchors should be designed to have a free length that extends beyond an imaginary line drawn upwards at an angle of 45° from the toe of the wall. The minimum free length should be 3 m. After installation, each anchor should be proof loaded to 125% of the design working load and locked-off at between 80% to 100% of the working load, depending on the amount of stress relief expected. Periodic checks should be carried out during the construction phase to ensure that the lock-off load is maintained and not lost due to creep effects or other causes. The above parameters are based on the assumption that the anchor holes are clean and thoroughly flushed and that the grouting and other installation procedures are carried out in accordance with good anchoring practice. The anchoring contractor should demonstrate that design bond values are achievable with the proposed anchor construction methods.

All permanent ground anchors will require appropriate corrosion protection (fully grouted and sheathed with trumpets on the bearing plates) to maintain the integrity of the anchor for its design life.

Approval should be sought from the adjacent property owners where anchors extend below neighbouring properties, roads or public access areas. Due consideration should also be given to adjacent below-ground excavations, services, etc.

9.5 Groundwater

Given the elevated topographical location of the site it is expected that the regional groundwater table will be below the proposed bulk excavation levels. Seepage should, however, be expected along the top of the rock and possibly through joints and bedding planes in the rock, particularly after periods of prolonged rainfall.

It is not possible to provide an accurate estimate of the seepage based on the available data. This would require further details of the basement and shoring design, together with packer/permeability testing of the rock. A common approach for excavation in low permeability clay and rock is to monitor the seepage rates during the excavation to confirm and/or re-assess the proposed sump and pump system capacity.

During construction and in the long term, it is anticipated that seepage into the excavation could be controlled by perimeter and subfloor drainage connected to a “sump-and-pump” system. On this basis, a drained basement should be suitable for this site, however, this will also be subject to review and approval by the relevant government authority. Generally, water collected from dewatering operations should be suitable for disposal by pumping to stormwater drains subject to confirmation testing and approval from the authorities.

It is possible that seepage into the basement may give rise to precipitation of red brown iron oxide residue from the groundwater and therefore perimeter and subfloor drains should be designed for easy access to allow for inspection, maintenance and periodic cleaning.

9.6 Foundations

Based on available information, it is anticipated that at least Weathered Siltstone (Unit 3) will be exposed at the lowest bulk excavation levels over at least some of the building footprints. It is recommended that all footing loads be transferred to a consistent stratum to achieve uniform founding conditions so as to avoid potential differential settlement across the building.

For structures required to support significant loads a combination of piles and possibly shallow foundations (where the rock depth is relatively shallow) are therefore recommended over the site to uniformly found on the same rock layer. Bored piles, potentially with temporary or permanent liners (i.e., casing) to manage issues associated with possible water seepage are considered appropriate for the site. Alternatively, piles may be constructed using continuous flight auger (CFA) piles.

If bored piles are used, then allowance should also be made for seepage inflows and removal of water during construction and/or the use of cleaning buckets and tremie pour methods. Consideration should

also be given to the potential presence of high strength ironstone bands within the weaker rock profile and the equipment that is required to drill through these higher strength bands.

Lightly loaded structures (e.g. carpark light towers) could be founded on natural clay soils or controlled fill. Due consideration of the soil reactivity should be made with footings founded on natural clay or controlled fill (refer Section 9.1).

The design of shallow or piled footings, for axial compression loading, may be based on the maximum Limit State Design or Working Stress parameters given in Table 8.

Table 8: Maximum Foundation Design Parameters

Unit	Working Stress Design Values		Limit State Design Values		Elastic Modulus (MPa)
	Allowable End Bearing Pressure (kPa)	Shaft Adhesion (kPa)	Ultimate End Bearing Pressure (kPa)	Shaft Adhesion (kPa)	
Stiff (or stronger) Natural Clays or Controlled Fill	150	-	400	-	20
Very Low to Low Strength Shale (Unit 3)	700	50	1500	150	75
Alternating bands of Very Low, Low and Medium Strength Siltstone (Unit 4)	1000	100	3,000	150	200
Medium and High Strength Siltstone (Unit 5)	3500	350	20,000	800	1000

Note:

1. Shaft adhesion applicable to the design of bored piles, uncased over the rock socket length, where adequate sidewall cleanliness and roughness are achieved.
2. Controlled fill is fill placed under Level 1 (full-time) testing conditions in accordance with AS3798.

Foundations proportioned on the basis of the allowable bearing pressures provided in Table 8 would be expected to experience total settlements of less than 1% of the pile diameter or footing width under the applied working load, with differential settlements between adjacent columns expected to be less than half of this value.

For design using the ultimate values provided in Table 8, a geotechnical strength reduction factor (ϕ_g) should be determined by the designer. The serviceability assessment should be based on using geotechnical parameters that are appropriately selected and to which no reduction factor is applied.

The design of footings is usually governed by settlement criteria and performance rather than the ultimate bearing capacity or Ultimate Limit State condition. The Serviceability limit could be assessed,

for normal 'static' load cases, using the elastic modulus value given in Table 8. This modulus value is appropriate for the anticipated working stress values or strain expected under serviceability loading.

For uplift or tension loading, 60% of the above shaft adhesion parameters may be adopted for design purposes. In addition to traditional 'piston pull-out' or sidewall slip failure mechanisms, the uplift capacity should be checked for 'cone pull-out' failure modes. This should be based on AS4678-2002 "Earth-retaining Structures". Uplift capacity for groups of piles will need to consider interaction between piles, which will generally lead to a lesser capacity than the sum of the capacity of individual piles in the group.

Where shallow footings are located close to subvertical excavations in rock it may be necessary to downgrade the applied bearing pressure. Unless laterally supported, the entire base should be below an imaginary 'influence line', projected upwards at 45° from the base of the subject excavation. Such situations should be reviewed by the designer on a case-by-case basis.

All footings should be inspected by an experienced geotechnical professional to check the adequacy of the foundation material.

9.7 Earthquake Design

A Hazard Factor (Z) of 0.08 would be appropriate for preliminary design in accordance with Australian Standard AS 1170.4 – 2007 *Structural design actions – Part 4: Earthquake actions in Australia*. The site sub-soil class is considered to be Class C_e dependant on the depth to competent rock on the site.

9.8 Floor Slabs

Where buildings are to be designed with a suspended floor slab, site preparation measures will be minimal. If slabs are to be cast on ground (but designed as suspended slabs), then checks should be made to ensure that concrete is not poured onto softened or wet ground that could lead to deformation of the slab. Furthermore, in areas where clay is present, to reduce the potential for swelling of soils beneath the slab, the top 100 mm of the ground surface should be scarified and loosed prior to forming up for the slab. Alternatively, void formers could be used if a lower risk approach is required.

Where site preparation is undertaken in accordance with Section 9.2.3, on-grade slabs could be constructed in place of suspended slabs. Based on the results of the subsurface investigations, subgrade conditions are expected to be formed over natural clay and/or clay filling.

Floor slabs should be cast independently of pads or pile and beam footings and incorporate control joints to allow for differential movements. Edge protection, such as deepened stiffening edge beams in conjunction with surface paving should also be included to minimise the effects of reactivity movements due to the moderate reactivity of the site clays.

9.9 Pavements

Based on the highly reactive clays on-site, concrete pavements and ground slabs should be articulated to allow for differential movement together with a drainage system to limit the potential for shrink-swell movements that could potentially damage pavements.

The CBR values obtained in previous investigations is in the range of 5 % to 40 %. Based on experience in the area and allowing for variability of results, it is suggested that the design of pavements be based on a design CBR value of 3 %. If imported material is used to level the site and form subgrade levels, the design CBR value will depend on the type and depth of imported material. Pavements should be placed on a subgrade prepared in accordance with the recommendations provided in Section 9.2.3.

The design CBR value given above depends on the provision of adequate surface and subsoil drainage to maintain the subgrade as close to OMC as possible. Subsoil drainage should be installed to not less than 500 mm depth below subgrade level adjacent to the pavement. Preparation of subgrade surfaces should be such that adequate cross-falls for the surface drainage purposes are achievable across the final pavement.

9.10 Site Maintenance and Drainage

Surface and subsurface drainage for the building should be incorporated into the design.

Care should be taken to avoid external influences on the soil moisture-regime to prevent erosion and softening of the exposed soils. Detailing of surface and subsurface drainage should be aimed at avoiding substantial wetting of the soils beneath building and pavement areas. Surface water should be directed away from building or hardstand areas and the upper section of services trenches should be backfilled with compacted clay soil to avoid the trench acting as an inlet drain.

Site trafficability during dry weather should pose no problems, however inclement weather may cause clayey soils to soften and become unsuitable for construction traffic until the site conditions dry. In areas where high levels of construction traffic are expected, a temporary hardstand comprising crushed rock could be constructed to aid in trafficability during wet weather.

A copy of the CSIRO Building Technology File BTF 18 entitled, 'Foundation Maintenance and Footing Performance, A Homeowners Guide', which further describes appropriate site maintenance requirements set out within Appendix B of AS2870 is included in Appendix E.

10. Limitations

Douglas Partners (DP) has prepared this report for this project at Memorial Avenue, Kellyville in accordance with DP's proposal dated 20 July 2021 and acceptance received from Mr Kael Williams of Mostyn Copper dated 18 August 2021. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Paramatta National Rugby League Club Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this

report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of atypical safety hazards arising from this advice is restricted to the (geotechnical / environmental / groundwater) components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

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

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

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

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

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

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

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

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

DATA FOR DESCRIPTION AND CLASSIFICATION OF SOILS – Page 1

Major Divisions				Description		Field Identification				
				Group Symbol*	Typical Name	Grading		Nature of Fines	Dry Strength	
COARSE-GRAINED SOILS	More than 65% by dry mass, (excluding that larger than 63 mm) is greater than 0.075 mm	GRAVEL	More than 50% of coarse grains are greater than 2.36 mm	GW	Well graded gravels and gravel-sand mixtures, little or no fines.	Good	Wide range in grain size	'Clean' materials (not enough fines to bind grains)	None	
				GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.	Poor	Predominantly one size or gap graded			
		GRAVELLY SOILS	More than 50% of coarse grains are less than 2.36 mm	GM	Silty gravels, gravel-sand-silt mixtures.	Good to Fair	'Dirty' materials with excess of fines	Fines are non-plastic	None to medium	
				GC	Clay gravels, gravel-sand-clay mixtures.			Fines are plastic	Medium to high	
	SAND	More than 50% of coarse grains are less than 2.36 mm	SANDY SOILS	SW	Well graded sands and gravelly sands, little or no fines.	Good	Wide range in grain size	'Clean' materials (not enough fines to bind grains)	None	
				SP	Poorly graded sands and gravelly sands, little or no fines.	Poor	Predominantly one size or gap graded			
				SM	Silty sand, sand-silt mixtures.	Good to Fair	'Dirty' materials with excess of fines	Fines are non-plastic	None to medium	
				SC	Clayey sands, sand-clay mixtures.			Fines are plastic	Medium to high	
	* For coarse grained soils where the fines content is between 5% and 12%, the soil shall be given a dual classification eg GP-GM.							Dry Strength	Dilatancy	Toughness
	FINE-GRAINED SOILS	More than 35% by dry mass, (excluding that larger than 63 mm) is less than 0.075 mm	Liquid Limit less than 35%	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.	None to low		Slow to rapid	Low	
CL				Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high		None to slow	Medium		
OL				Organic silts and organic silty clays of low plasticity	Low to medium		Slow	Low		
35% <LL< 50%		CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high		None to slow	Medium			
		Liquid Limit greater than 50%	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.	Low to medium		None to slow	Low to medium		
CH			Inorganic clays of high plasticity, fat clays.	High to very high		None	High			
OH			Organic clays of medium to high plasticity.	Medium to high		None to very slow	Low to medium			
			Pt	Peat muck and other highly organic soils.	Readily identified by colour, odour, spongy feel and generally fibrous texture					

ORDER OF DESCRIPTION

In the soil description the terms should be given in the following order:

SOIL NAME & UNIFIED CLASSIFICATION SYMBOL.

Plasticity, behavioural or particle characteristics of the primary soil component
Colour

Secondary soil components' name(s), estimated proportion(s), plasticity, behavioural or particle characteristics, colour and where practical, its plasticity

Moisture Condition (disturbed or undisturbed state)

Consistency of fine-grained soils (undisturbed state only)

Relative density of coarse-grained soils (determined by in situ tests)

Structure of soil (in undisturbed state)

Zoning

Defects

Cementing

Origin of soil

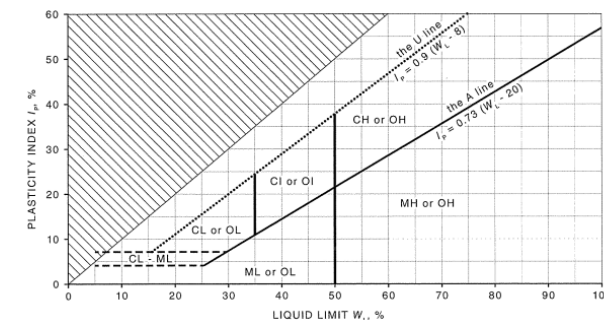
Additional observations

EXAMPLES:

Silty SAND SM: fine to coarse grained, light brown, 15% non-plastic fines, with gravel, 20% angular particles, moist, apparently dense in place, alluvial.

SILT ML: low plasticity, brown, trace fine sand, w > PL, firm, estuarine.

PLASTICITY CHART (after AS 1726:2017)



PARTICLE SIZES

Boulders	> 200 mm
Cobbles	63 mm to 200 mm
Gravel	2.36 mm to 63 mm
Sand	0.075 mm to 2.36 mm
Silt and Clay	< 0.075 mm

SAND

COARSE	MEDIUM	FINE	SILT
2.36-0.6 mm	0.6-0.2 mm	0.2-0.075 mm	0.075-0.002 mm

SILT

The classification system excludes the boulder and cobble fractions of the soil and classifies only the materials less than 63 mm in size.

DATA FOR DESCRIPTION AND CLASSIFICATION OF SOILS – Page 2

GRAVEL

Density	Field Test
LOOSE	By inspection of voids and particle packing.
DENSE	

SAND

Density	Field Test	DPT Blows per 300 mm ⁽¹⁾		SPT N Blows	CPT q _c MPa	Relative Density %	Estimated Friction Angle
		Dry ⁽²⁾	Wet ⁽³⁾				
VERY LOOSE	Easily penetrated with 13 mm reinforcing rod pushed by hand.	< 1	0	0 – 4	0 – 2	0 – 15	25 - 30
LOOSE	Easily penetrated with 13 mm reinforcing rod pushed by hand. Can be excavated with a spade; 50 mm wooden peg can be easily driven.	1 - 3	< 1	4 – 10	2 – 5	15 – 35	27 - 32
MEDIUM DENSE	Penetrated 300 mm with 13 mm reinforcing rod driven by 2 kg hammer – hard shovelling.	3 - 8	1 - 6	10 – 30	5 – 15	35 – 65	30 - 35
DENSE	Penetrated 300 mm with 13 mm reinforcing rod driven with 2 kg hammer, requires pick for excavation; 50 mm wooden peg hard to drive	8 – 15	6 - 10	30 – 50	15 – 25	65 – 85	35 - 40
VERY DENSE	Penetrated only 25 – 50 mm with 13 mm reinforcing rod driven by 2 kg hammer.	> 15	> 10	> 50	> 25	85 – 100	38 - 43

⁽¹⁾Valid for depths up to approx 1m bgl; ⁽²⁾At a mc of approx. 3%-5%; ⁽³⁾At a mc of approx. 15%.

SILT & CLAY

Consistency	Field Test	DCP Blows per 150 mm	SPT N Blows	Undrained Shear Strength C _u	Unconfined Compressive Strength q _u	CPT q _c kPa
				Shear Vane (kPa)	PP* (kPa)	
VERY SOFT	Easily penetrated > 40 mm by thumb. Exudes between thumb and fingers when squeezed in hand	< 1	< 2	< 12	< 25	0 - 180
SOFT	Easily penetrated 10 mm by thumb. Moulded by light finger pressure.					
FIRM	Impression by thumb with moderate effort. Moulded by strong finger pressure	1.5 – 3	4 – 8	25 – 50	50 – 100	375 - 750
STIFF	Slight impression by thumb cannot be moulded with finger	3 – 6	8 – 16	50 – 100	100 – 200	750 - 1500
VERY STIFF	Very tough. Readily indented by thumbnail.	6 – 12	16 – 32	100 – 200	200 – 400	1500 - 3000
HARD	Brittle. Indented with difficulty by thumbnail.	> 12	> 32	> 200	> 400	> 3000
FRIABLE	Easily crumbled or broken into small pieces by hand.					

* Pocket Penetrometer (PP) may overestimate q_u by a factor of 1.5 to 2.0.

Note: Visual-tactile assessment is indicative only. Use in-situ testing for logging

MOISTURE OF FINE GRAINED SOILS

Moist, dry of plastic limit	w < PL	Wet, near liquid limit	w ≈ LL
Moist, near plastic limit	w ≈ PL	Wet, wet of liquid limit	w > LL
Moist, wet of plastic limit	w > PL		

DEGREE OF SATURATION OF SANDS

Condition of Sand	Criteria	Degree of Saturation (%)
Dry	Non-cohesive and free-running	0 – 25%
Moist	Feels cool, darker colour, grains tend to adhere to one another	25 – 75%
Wet	Feels cold, makes hands wet, should be close to water table	75 – 99%

FIELD IDENTIFICATION PROCEDURE FOR FINE GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus 0.4 mm sieve size particles. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):

After removing particles larger than 0.4 mm sieve size, prepare a pat of moist soil with a volume of about 8000 mm³. Add enough water if necessary to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil. Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):

After removing particles larger than 0.4 mm sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same dry strength but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):

After removing particles larger than the 0.4 mm sieve size, a specimen of soil about 12 mm cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about 3 mm in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced, and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached. After the thread crumbles, the pieces should be lumped together, and a slight kneading action continued until the lump crumbles.

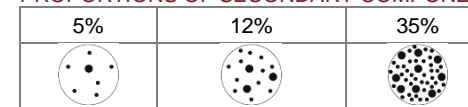
The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay or low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

PROPORTION OF MINOR AND SECONDARY COMPONENTS

Term	Meaning	Approximate Proportion	
		Coarse Soils	Fine Soils
Trace	Just detectable by feel or eye. Soil properties of main component virtually unaffected.	< 5% fines < 15% coarse fraction	< 15% sand / gravel
With	Easily detectable by feel or eye. Soil properties only slightly affected by minor components.	5% – 12% fines 15% – 30% coarse fraction	15% – 30% sand / gravel
Prefix	Easily detected by feel or eye. Soil properties significantly affected by secondary components.	> 12% fines > 30% coarse fraction	> 30% sand / gravel

PROPORTIONS OF SECONDARY COMPONENTS



DATA FOR DESCRIPTION AND CLASSIFICATION OF ROCK

SEDIMENTARY ROCK TYPE DEFINITIONS

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

Rocks possessing characteristics of two groups are described by their predominant particle size with reference also to the minor constituents, e.g. Clayey SANDSTONE, Sandy SHALE.

DEGREE OF WEATHERING

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

*If highly and moderately weathered rock cannot be differentiated use the term, 'Distinctly Weathered (DW)'.

ORDER OF DESCRIPTION

In the rock description the terms should be given in the following order:
ROCK NAME
Grain size and type
Colour
Fabric and texture
Inclusions and minor components
Moisture content
Durability
Strength
Weathering and/or alteration
Defects – type, orientation, spacing, roughness
Stratigraphic unit
Geological structure

STRATIFICATION

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

DEGREE OF FRACTURING

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

Term	Description
Fragmented	The core is comprised primarily of fragments of length less than 20 mm, and mostly of width less than the core diameter
Highly Fractured	Core lengths are generally less than 20 mm to 40 mm with occasional fragments
Fractured	Core lengths are mainly 30 mm to 100 mm with occasional shorter and longer sections
Slightly Fractured	Core lengths are generally 300 mm or longer with occasional sections of 100 mm to 300 mm
Unbroken	The core contains very few fractures

ROCK STRENGTH

Rock strength is classified using the unconfined compressive strength (UCS). Where adequate UCS data are not available then the classification may be based on the Point Load Strength ($I_{s(50)}$) and refers to the strength of the rock substance in the direction normal to the bedding.

Strength Term	UCS MPa	Field Guide	Approx $I_{s(50)}$ MPa
Material less than very low strength is to be described using soil properties			
Very Low	2	Material crumbles under firm blows with sharp end of pick; can be peeled with knife. Pieces up to 30 mm thick can be broken by finger pressure.	0.1
Low		Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.	
Medium	6	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.	0.3
High	20	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.	1.0
Very High	60	Hand specimen breaks with pick after more than one blow; rock rings under hammer.	3.0
Extremely High	200	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.	10.0

The approximate point load strength ($I_{s(50)}$) is based on an assumed ratio to UCS of 1:20. This ratio may vary widely and should be determined for each site and rock type.

DISCONTINUITIES / DEFECTS

<p>The actual defect is described not the process which formed or may have formed it, e.g. 'sheared zone', not 'zone of shearing'; the latter suggests a currently active process.</p> <p>Spacing*: A measure of the spacing of discontinuities. Measure mean and range of spacings for each set where possible (do not use descriptive terms).</p> <p>Thickness, openness: Measured in millimetres normal to plane of the discontinuity.</p> <p>Persistence*: The areal extent of a discontinuity. Give trace lengths in metres.</p> <p>Roughness and Shape*: A measure of the inherent surface unevenness and waviness of the defect relative to its mean plane.</p>	<p>Coating or Infilling: Clean: no visible coating or infilling. Stained: no visible coating or infilling but surfaces are discoloured by mineral staining. Veneer: a visible coating or infilling of soil or mineral substance but usually unable to be measured (less than 1 mm). Patchy Veneer: if discontinuous over the plane.</p>	<p>Roughness: Very Rough Rough Smooth Polished Stickensided</p> <p>Shape*: Planar Curved Undulating Stepped Irregular</p>
* Usually determined in field exposures		

Discontinuity Spacing in Three Dimensions:

The spacing of discontinuities in exposures may be described with reference to the size and shape of rock bounded by the discontinuities.

Equidimensional	Same size in all directions
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section
Polyhedral	Irregular defects without obvious pattern

Field Procedure Logging	Figure 5.1
Ed 9 / Rev 1	May 2019



Sampling

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

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low

reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:
4,6,7
N=13
- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:
15, 30/40 mm

Sampling Methods

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Symbols & Abbreviations

Douglas Partners



Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core Drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U ₅₀	Undisturbed tube sample (50mm)
W	Water sample
pp	pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough


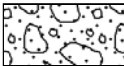
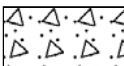

Other

fg	fragmented
bnd	band
qtz	quartz


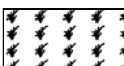
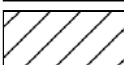
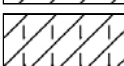
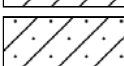
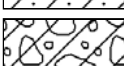
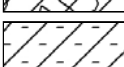

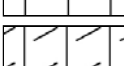
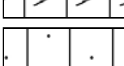

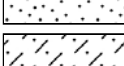
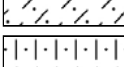
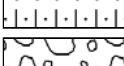
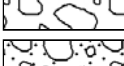
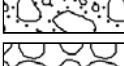

Symbols & Abbreviations

Graphic Symbols for Soil and Rock




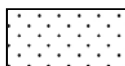
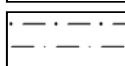
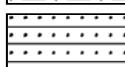
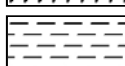
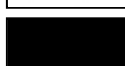
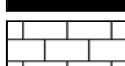
General

	Asphalt
	Road base
	Concrete
	Filling

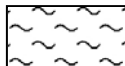
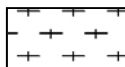

Soils

	Topsoil
	Peat
	Clay
	Silty clay
	Sandy clay
	Gravelly clay
	Shaly clay
	Silt
	Clayey silt
	Sandy silt
	Sand
	Clayey sand
	Silty sand
	Gravel
	Sandy gravel
	Cobbles, boulders
	Talus

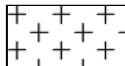
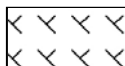
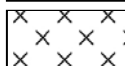
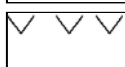

Sedimentary Rocks

	Boulder conglomerate
	Conglomerate
	Conglomeratic sandstone
	Sandstone
	Siltstone
	Laminite
	Mudstone, claystone, shale
	Coal
	Limestone

Metamorphic Rocks

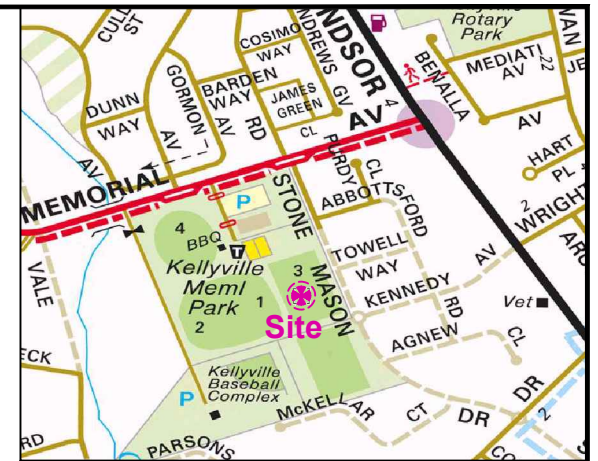
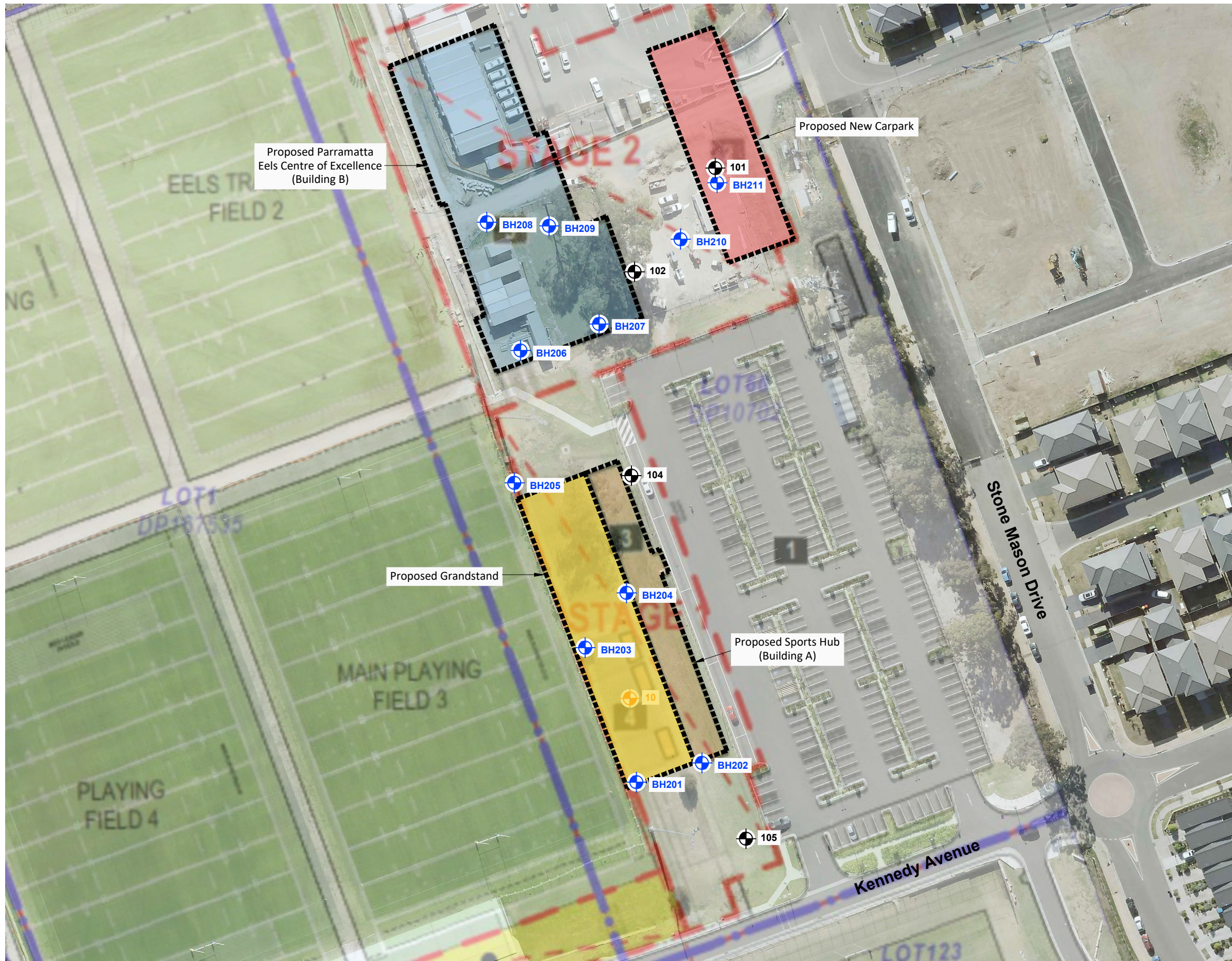
	Slate, phyllite, schist
	Gneiss
	Quartzite

Igneous Rocks

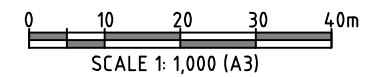
	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry

Appendix B

Drawings



Location Plan




LEGEND:-

- Borehole Location and Number
- Previous Bore Locations (2019)
- Previous Bore Location (2012)

NOTE:-

1. Test locations are approximate only and are shown with reference to existing site features.
2. Image obtained from Metromap. Date of imagery 16-08-2021.

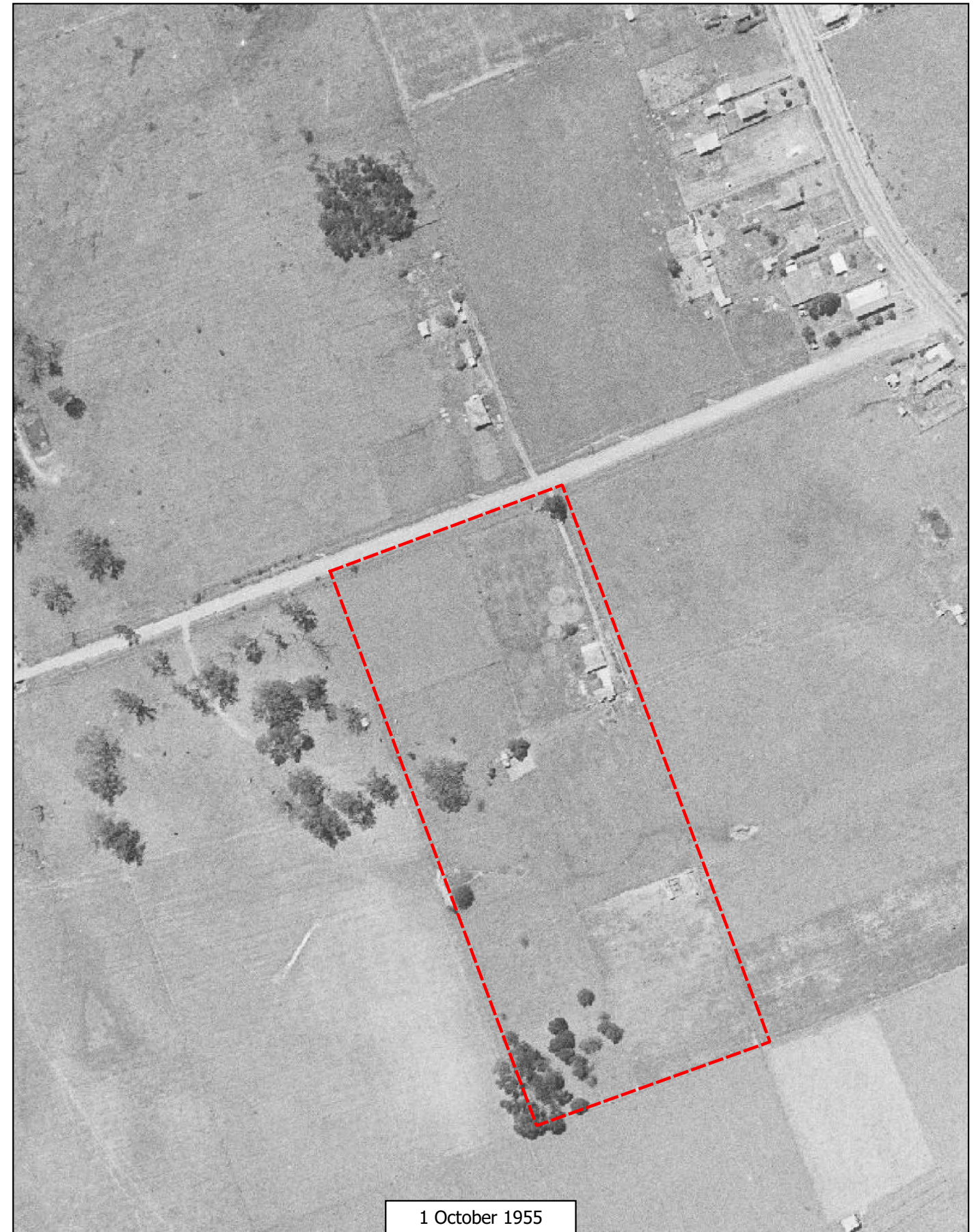
Legend

 Approximate Site Boundary



1 January 1943


70 0 70 140 210 280 m



1 October 1955



Legend

 Approximate Site Boundary



1 January 1970


70 0 70 140 210 280 m



18 August 1991



Legend

 Approximate Site Boundary




1 January 2000

40 0 40 80 120 160 m



31 January 2011



Legend
 Approximate Site Boundary



7 December 2020

40 0 40 80 120 160 m



16 August 2021

Appendix C

Results of Field Work

BORE: BH202

PROJECT: 207155.00

August 2021



Project No: 207155.00
BH ID: 202
Depth: 2.7-6m
Core Box No.: 1/1



2.7 m - 6.0m

BOREHOLE LOG

CLIENT: Paramatta National Rugby League Club Pty Ltd
PROJECT: PNRL Centre of Excellence and Community Facility
LOCATION: cnr Kennedy Avenue and Stone Mason Drive, Kellyville

SURFACE LEVEL: 62.6
COORDINATE E:310824.5 N: 6267157.1
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 203
PROJECT No: 207155.00
DATE: 22/07/21
SHEET: 1 of 1

GROUNDWATER		CONDITIONS ENCOUNTERED					SAMPLE			TESTING AND REMARKS				
		RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY (°)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE
	0.0		FILL/ (CL) Gravelly CLAY; brown; with vegetation throughout (Topsoil)	[Cross-hatch pattern]	FILL	NA		<PL						
	0.35		SILTSTONE; very low strength, Ashfield Shale	[Horizontal lines]	XWM	XWR		NA						
	62		Borehole discontinued at 0.35m depth Limit of investigation											
	61													
	60													
	59													
	58													

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NOTES: (°)Soil origin is "probable" unless otherwise stated. (°)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hand Tools
METHOD: Hand Auger to 0.45 m
REMARKS:

OPERATOR:
CASING:
LOGGED: Boyd

BORE: BH204

PROJECT: 207155.00

August 2021



Project No: 207155.00
BH ID: 204
Depth: 5.8-10m
Core Box No.: 1/1



5.8m – 10.0m

BOREHOLE LOG

CLIENT: Paramatta National Rugby League Club Pty Ltd
PROJECT: PNRL Centre of Excellence and Community Facility
LOCATION: cnr Kennedy Avenue and Stone Mason Drive, Kellyville

SURFACE LEVEL: 62
COORDINATE E:310806.3 N: 6267199.3
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 205
PROJECT No: 207155.00
DATE: 22/07/21
SHEET: 1 of 1

GROUNDWATER		CONDITIONS ENCOUNTERED					SAMPLE			TESTING AND REMARKS				
		RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY (°)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE
	0.0		FILL/ Clayey SILT; brown; with vegetation throughout (Topsoil)		FILL	NA	<PL							
	0.2		FILL/ (CL) Gravelly CLAY; brown grey		FILL	PC	<PL							
	0.6		(CH) Silty CLAY; orange brown mottled grey; hard		RES	H	<PL							
	0.85		SILTSTONE; very low strength, Ashfield Shale		XWM	XWR	NA							
	0.85	61	Borehole discontinued at 0.85m depth Limit of investigation									1		
		60										2		
		59										3		
		58										4		

NOTES: (°)Soil origin is "probable" unless otherwise stated. (°)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Hand Tools **OPERATOR:** **LOGGED:** Boyd
METHOD: Hand Auger to 0.45 m **CASING:**
REMARKS:

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BOREHOLE LOG

CLIENT: Paramatta National Rugby League Club Pty Ltd
PROJECT: PNRL Centre of Excellence and Community Facility
LOCATION: cnr Kennedy Avenue and Stone Mason Drive, Kellyville

SURFACE LEVEL: 66
COORDINATE E:310828.1 N: 6267240.1
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 207
PROJECT No: 207155.00
DATE: 25/08/21
SHEET: 1 of 1

GROUNDWATER		CONDITIONS ENCOUNTERED					SAMPLE				TESTING AND REMARKS			
		RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY. (°)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE
25/08/21, No free groundwater observed	65	0.0	FILL/ (CI) Silty CLAY; brown; medium plasticity; with rootlets throughout		FILL	NA	<PL			A	0.0 - 0.1			
		0.5	FILL/ (CI) Silty; brown mottled orange; with rootlets throughout		FILL	ST TO VST	<PL			A	0.4 - 0.5			
		1.1	(CI-CH) Silty CLAY; orange; medium to high plasticity		RES	ST	<PL	4,8,12		A	0.9 - 1.0			
		1.7	(CI-CH) Silty CLAY; pale grey; medium to high plasticity		RES	ST TO H				A	1.4 - 1.5			
	64	2.0								A	1.9 - 2.0			
		2.3	Borehole discontinued at 2.30m depth Limit of investigation											
	63	3.0												
	62	4.0												

NOTES: (°)Soil origin is "probable" unless otherwise stated. (°)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Multi Drill **OPERATOR:** Traccess **LOGGED:** KA
METHOD: Solid Flight Auger to 2.3m **CASING:** Not used
REMARKS:

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BOREHOLE LOG

CLIENT: Paramatta National Rugby League Club Pty Ltd
PROJECT: PNRL Centre of Excellence and Community Facility
LOCATION: cnr Kennedy Avenue and Stone Mason Drive, Kellyville

SURFACE LEVEL: 65.5
COORDINATE E:310815.3 N: 6267265.3
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 209
PROJECT No: 207155.00
DATE: 25/08/21
SHEET: 1 of 2

GROUNDWATER		CONDITIONS ENCOUNTERED										SAMPLE			TESTING			
		DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	SOIL	WEATH.	DEPTH (m)	STRENGTH	RECOVERY (%)	RQD	FRACTURE SPACING (m)	DEFECTS & REMARKS	SAMPLE REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE	RESULTS AND REMARKS
25/08/21, No free groundwater observed	0.0	FILL/ Clayey SILT; brown; with vegetation throughout (Topsoil)	[Cross-hatch]	FILL	NA	NA								A	0.0-0.1			
	0.1			FILL/ (Cl) Silty CLAY; brown; medium plasticity	FILL	VC	<PL									A	0.1-0.4	
	0.7	(Cl-CH) Silty CLAY; pale grey; medium to high plasticity	[Diagonal lines]	RES	VST	<PL								A	0.4-0.9			
	1.0	(Cl-CH) Silty CLAY; pale grey yellow; medium to high plasticity	[Diagonal lines]	RES	VST	<PL								A	0.9-1.0			
	1.3			RES	VST TO H	<PL								A	1.0-1.4	SPT	4,10,16 N=26	
	1.7	SILTSTONE; grey; very low strength with clay seams, Ashfield Shale	[Dotted]	XWM	XWR	NA												
	1.9	SILTSTONE; grey mottled orange; low strength, with clay seams, Ashfield Shale	[Dotted]															
	2.0																	
	2.5	SILTSTONE; high strength, Ashfield Shale	[Dotted]															
	3.0																	
3.6																		
4.0																		
4.7	SILTSTONE; grey; high strength, Ashfield Shale	[Dotted]																

NOTES: ^(#)Soil origin is "probable" unless otherwise stated. ^(*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Multi Drill **OPERATOR:** Tracess **LOGGED:** KA
METHOD: Solid Flight Auger to 1.7m, Rotary to 1.9m then NMLC coring to 5.82m **CASING:** NW
REMARKS: Well construction details: 3.0m slotted, 3.0m blank, 0.5m bentonite, 0.9m stick up

BORE: BH209

PROJECT: 207155.00

August 2021



Project No: 207155.00
BH ID: 209
Depth: 1.9-5.82m
Core Box No.: 1/1



1.9m - 5.82m

BOREHOLE LOG

CLIENT: Paramatta National Rugby League Club Pty Ltd
PROJECT: PNRL Centre of Excellence and Community Facility
LOCATION: cnr Kennedy Avenue and Stone Mason Drive, Kellyville

SURFACE LEVEL: 66.6
COORDINATE E:310849 N: 6267261.9
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 210
PROJECT No: 207155.00
DATE: 16/09/21
SHEET: 1 of 1

GROUNDWATER		CONDITIONS ENCOUNTERED					SAMPLE			TESTING AND REMARKS				
		RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY (°)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)	TEST TYPE
	0.06		ASPHALTIC CONCRETE; FILL/ (CL) Gravelly CLAY; brown; with sand and ripped shale gravel		FILL	WC	<PL			A	0.2 - 0.3			
	0.7		(CH) Silty CLAY; brown grey; (possibly extremely weathered siltstone)		RES	H	<PL			B	0.5 - 0.7			
	1.0		SILTSTONE; grey; very low strength, Ashfield-Shale		XWM	NA	NA				1.0			
	1.1	Borehole discontinued at 1.10m depth Limit of investigation												
	65													
	2													
	64													
	3													
	63													
	4													
	62													

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NOTES: (°)Soil origin is "probable" unless otherwise stated. (°)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Multi Drill
METHOD: Solid Flight Auger to 1.1m
REMARKS:

OPERATOR: Traccess
CASING:



LOGGED: Boyd

BOREHOLE LOG

CLIENT: Paramatta National Rugby League Club Pty Ltd
PROJECT: PNRL Centre of Excellence and Community Facility
LOCATION: cnr Kennedy Avenue and Stone Mason Drive, Kellyville

SURFACE LEVEL: 66.6
COORDINATE E:310858.4 N: 6267276.4
DATUM/GRID: GDA2020 Zone 56
DIP/AZIMUTH: 90°/---

LOCATION ID: 211
PROJECT No: 207155.00
DATE: 16/09/21
SHEET: 1 of 1

GROUNDWATER		CONDITIONS ENCOUNTERED					SAMPLE			TESTING AND REMARKS			
		RL (m)	DEPTH (m)	DESCRIPTION OF STRATA	GRAPHIC	ORIGIN (#)	CONSIS. (°)	DENSITY (°)	MOISTURE	REMARKS	TYPE	INTERVAL	DEPTH (m)
	66	0.06	ASPHALTIC CONCRETE; FILL/ (GP) Sandy GRAVEL; brown and grey; fraction with concrete fragments, plastic and ripped shale gravel and cobbles		FILL	VC	<PL	NA		A B	0.1 0.2 0.3		
	66	0.5	SILTSTONE; grey; low strength, Ashfield Shale (possibly medium strength)		XWM	XWR	NA			A	0.5 0.6		
	66	0.7	Borehole discontinued at 0.70m depth Limit of investigation										
	65	1											
	65	2											
	64	3											
	63	4											
	62												

NOTES: (°)Soil origin is "probable" unless otherwise stated. (°)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

PLANT: Multi Drill

OPERATOR: Traccess

LOGGED: Boyd

METHOD: Solid Flight Auger to 0.7m

CASING:

REMARKS:

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Appendix D

Laboratory Test Results

Material Test Report

Report Number: 207155.00-1
Issue Number: 1
Date Issued: 14/10/2021
Client: Paramatta National Rugby League Club Pty Ltd
 c/-Mostyn Copper, Sydney NSW 2000
Contact: Kael Williams
Project Number: 207155.00
Project Name: PNRL Centre of Excellence and Community Facility
Project Location: cnr Kennedy Avenue and Stone Mason Drive, Kellyville NSW
Work Request: 8302
Sample Number: SY-8302A
Date Sampled: 24/09/2021
Dates Tested: 24/09/2021 - 12/10/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: 211 (0.1-0.5m)
Material: Gravelly CLAY

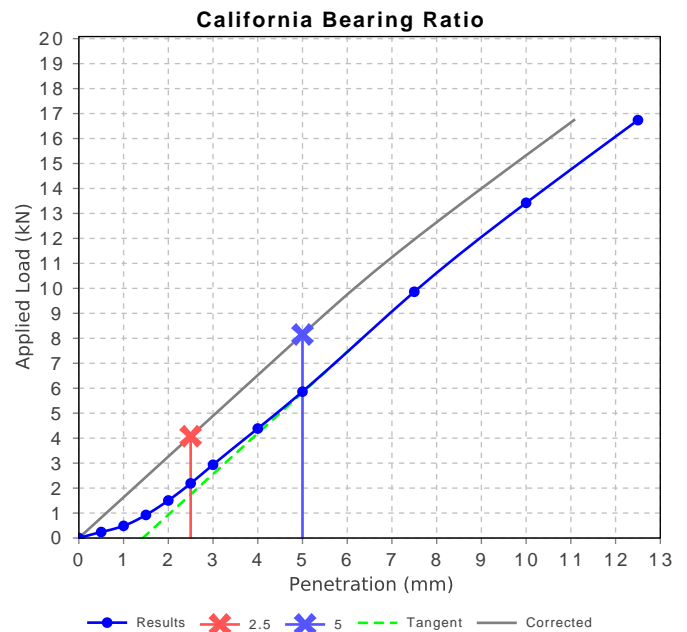


Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Andrew Hutchings
 Laboratory Manager

Laboratory Accreditation Number: 828

California Bearing Ratio (RMS T117 & T120)		Min	Max
CBR taken at	5 mm		
CBR %	40		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m ³)	1.884		
Optimum Moisture Content (%)	12.8		
Target Laboratory Density Ratio (%)	100		
Laboratory Density Ratio (%)	100		
Target Laboratory Moisture Ratio (%)	100		
Laboratory Moisture Ratio (%)	96		
Dry Density after Soaking (t/m ³)	1.875		
Field Moisture Content (%)	8.3		
Moisture Content Top 30mm (%)	13.3		
Moisture Content Full Depth (%)	13.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	0.9		
Material Retained on 19mm (%)	22		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	21.5		



Material Test Report

Report Number: 207155.00-1
Issue Number: 1
Date Issued: 14/10/2021
Client: Paramatta National Rugby League Club Pty Ltd
 c/-Mostyn Copper, Sydney NSW 2000
Contact: Kael Williams
Project Number: 207155.00
Project Name: PNRL Centre of Excellence and Community Facility
Project Location: cnr Kennedy Avenue and Stone Mason Drive, Kellyville NSW
Work Request: 8302
Sample Number: SY-8302B
Date Sampled: 24/09/2021
Dates Tested: 24/09/2021 - 12/10/2021
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Sample Location: 210 (0.7-1.0m)
Material: Silty CLAY



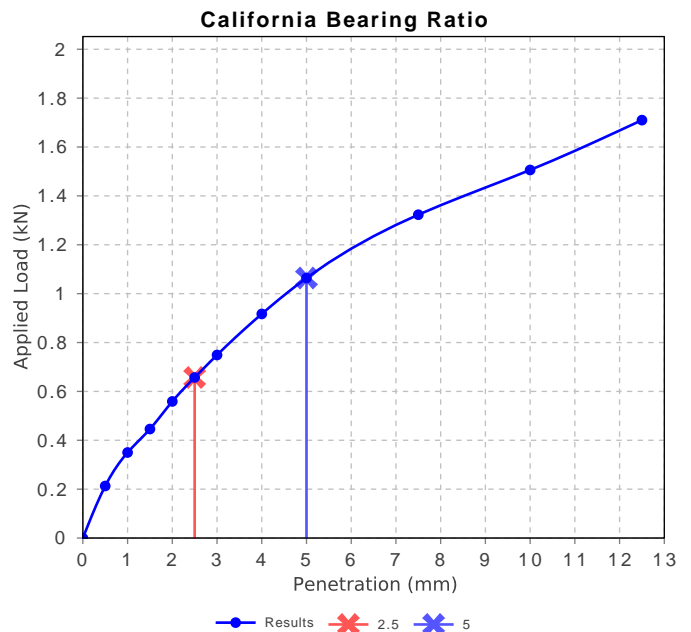
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Andrew Hutchings
 Laboratory Manager

Laboratory Accreditation Number: 828

California Bearing Ratio (RMS T117 & T120)		Min	Max
CBR taken at	5 mm		
CBR %	5		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Maximum Dry Density (t/m ³)	1.767		
Optimum Moisture Content (%)	18.1		
Target Laboratory Density Ratio (%)	100		
Laboratory Density Ratio (%)	100		
Target Laboratory Moisture Ratio (%)	100		
Laboratory Moisture Ratio (%)	99		
Dry Density after Soaking (t/m ³)	1.751		
Field Moisture Content (%)	13.6		
Moisture Content Top 30mm (%)	21.4		
Moisture Content Full Depth (%)	19.2		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Swell (%)	1.2		
Material Retained on 19mm (%)	2		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	2.1		

Emerson Class Number of a Soil (AS 1289 3.8.1)		Min	Max
Emerson Class	2		
Soil Description	Silty CLAY		
Nature of Water	Distilled		
Temperature of Water (°C)	22		





CERTIFICATE OF ANALYSIS 278877

Client Details

Client	Douglas Partners Pty Ltd
Attention	Gavin Boyd
Address	96 Hermitage Rd, West Ryde, NSW, 2114

Sample Details

Your Reference	207155.00, Kellyville
Number of Samples	15 Soil
Date samples received	23/09/2021
Date completed instructions received	24/09/2021

Analysis Details

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

Report Details

Date results requested by	01/10/2021
Date of Issue	01/10/2021

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Asbestos Approved By

Analysed by Asbestos Approved Analyst: Lucy Zhu
Authorised by Asbestos Approved Signatory: Lucy Zhu

Results Approved By

Diego Bigolin, Inorganics Supervisor
Dragana Tomas, Senior Chemist
Giovanni Agosti, Group Technical Manager
Josh Williams, LC Supervisor
Lucy Zhu, Asbestos Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

vTRH(C6-C10)/BTEXN in Soil						
Our Reference		278877-1	278877-2	278877-3	278877-4	278877-5
Your Reference	UNITS	BD1-160921	BD1-220921	201	205	203
Depth		-	-	0-0.1	0-0.1	0-0.1
Date Sampled		16/09/21	22/09/21	22/09/21	22/09/21	22/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021	29/09/2021	29/09/2021
TRH C ₆ - C ₉	mg/kg	<25	<25	<25	<25	<25
TRH C ₆ - C ₁₀	mg/kg	<25	<25	<25	<25	<25
vTPH C ₆ - C ₁₀ less BTEX (F1)	mg/kg	<25	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Total +ve Xylenes	mg/kg	<3	<3	<3	<3	<3
Surrogate aaa-Trifluorotoluene	%	78	84	75	87	82

vTRH(C6-C10)/BTEXN in Soil						
Our Reference		278877-6	278877-7	278877-8	278877-9	278877-10
Your Reference	UNITS	208	208	210	210	206
Depth		0-0.1	0.3-0.4	0.2-0.3	0.4-0.6	0.05-0.15
Date Sampled		16/09/21	16/09/21	16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021	29/09/2021	29/09/2021
TRH C ₆ - C ₉	mg/kg	<25	<25	<25	<25	<25
TRH C ₆ - C ₁₀	mg/kg	<25	<25	<25	<25	<25
vTPH C ₆ - C ₁₀ less BTEX (F1)	mg/kg	<25	<25	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1	<1	<1
Total +ve Xylenes	mg/kg	<3	<3	<3	<3	<3
Surrogate aaa-Trifluorotoluene	%	80	85	84	86	92

vTRH(C6-C10)/BTEXN in Soil				
Our Reference		278877-11	278877-12	278877-13
Your Reference	UNITS	206	211	211
Depth		0.2-0.5	0.2-0.3	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021
TRH C ₆ - C ₉	mg/kg	<25	<25	<25
TRH C ₆ - C ₁₀	mg/kg	<25	<25	<25
vTPH C ₆ - C ₁₀ less BTEX (F1)	mg/kg	<25	<25	<25
Benzene	mg/kg	<0.2	<0.2	<0.2
Toluene	mg/kg	<0.5	<0.5	<0.5
Ethylbenzene	mg/kg	<1	<1	<1
m+p-xylene	mg/kg	<2	<2	<2
o-Xylene	mg/kg	<1	<1	<1
naphthalene	mg/kg	<1	<1	<1
Total +ve Xylenes	mg/kg	<3	<3	<3
Surrogate aaa-Trifluorotoluene	%	84	83	91

svTRH (C10-C40) in Soil						
Our Reference		278877-1	278877-2	278877-3	278877-4	278877-5
Your Reference	UNITS	BD1-160921	BD1-220921	201	205	203
Depth		-	-	0-0.1	0-0.1	0-0.1
Date Sampled		16/09/21	22/09/21	22/09/21	22/09/21	22/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021	29/09/2021	29/09/2021
TRH C ₁₀ - C ₁₄	mg/kg	<50	<50	<50	<50	<50
TRH C ₁₅ - C ₂₈	mg/kg	<100	<100	<100	<100	400
TRH C ₂₉ - C ₃₆	mg/kg	<100	<100	<100	<100	540
Total +ve TRH (C10-C36)	mg/kg	<50	<50	<50	<50	950
TRH >C ₁₀ -C ₁₆	mg/kg	<50	<50	<50	<50	140
TRH >C ₁₀ - C ₁₆ less Naphthalene (F2)	mg/kg	<50	<50	<50	<50	140
TRH >C ₁₆ -C ₃₄	mg/kg	<100	<100	<100	<100	770
TRH >C ₃₄ -C ₄₀	mg/kg	<100	<100	<100	<100	180
Total +ve TRH (>C10-C40)	mg/kg	<50	<50	<50	<50	1,100
Surrogate o-Terphenyl	%	100	101	104	96	83

svTRH (C10-C40) in Soil						
Our Reference		278877-6	278877-7	278877-8	278877-9	278877-10
Your Reference	UNITS	208	208	210	210	206
Depth		0-0.1	0.3-0.4	0.2-0.3	0.4-0.6	0.05-0.15
Date Sampled		16/09/21	16/09/21	16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021	29/09/2021	29/09/2021
TRH C ₁₀ - C ₁₄	mg/kg	<50	<50	<50	<50	<50
TRH C ₁₅ - C ₂₈	mg/kg	<100	<100	<100	<100	<100
TRH C ₂₉ - C ₃₆	mg/kg	<100	<100	<100	<100	<100
Total +ve TRH (C10-C36)	mg/kg	<50	<50	<50	<50	<50
TRH >C ₁₀ -C ₁₆	mg/kg	<50	<50	<50	<50	<50
TRH >C ₁₀ - C ₁₆ less Naphthalene (F2)	mg/kg	<50	<50	<50	<50	<50
TRH >C ₁₆ -C ₃₄	mg/kg	150	<100	<100	<100	<100
TRH >C ₃₄ -C ₄₀	mg/kg	<100	<100	110	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	150	<50	110	<50	<50
Surrogate o-Terphenyl	%	75	106	115	103	100

svTRH (C10-C40) in Soil				
Our Reference		278877-11	278877-12	278877-13
Your Reference	UNITS	206	211	211
Depth		0.2-0.5	0.2-0.3	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021
TRH C ₁₀ - C ₁₄	mg/kg	<50	<50	<50
TRH C ₁₅ - C ₂₈	mg/kg	<100	<100	<100
TRH C ₂₉ - C ₃₆	mg/kg	<100	<100	<100
Total +ve TRH (C10-C36)	mg/kg	<50	<50	<50
TRH >C ₁₀ -C ₁₆	mg/kg	<50	<50	<50
TRH >C ₁₀ - C ₁₆ less Naphthalene (F2)	mg/kg	<50	<50	<50
TRH >C ₁₆ -C ₃₄	mg/kg	<100	120	<100
TRH >C ₃₄ -C ₄₀	mg/kg	<100	<100	<100
Total +ve TRH (>C10-C40)	mg/kg	<50	120	<50
Surrogate o-Terphenyl	%	79	101	96

PAHs in Soil						
Our Reference		278877-1	278877-2	278877-3	278877-4	278877-5
Your Reference	UNITS	BD1-160921	BD1-220921	201	205	203
Depth		-	-	0-0.1	0-0.1	0-0.1
Date Sampled		16/09/21	22/09/21	22/09/21	22/09/21	22/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	30/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	<0.1	0.2	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	0.2	0.3	<0.1	<0.1
Pyrene	mg/kg	<0.1	0.2	0.3	<0.1	<0.1
Benzo(a)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	0.09	0.1	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve PAH's	mg/kg	<0.05	0.4	0.78	<0.05	<0.05
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Surrogate <i>p</i> -Terphenyl-d14	%	97	86	90	80	88

PAHs in Soil						
Our Reference		278877-6	278877-7	278877-8	278877-9	278877-10
Your Reference	UNITS	208	208	210	210	206
Depth		0-0.1	0.3-0.4	0.2-0.3	0.4-0.6	0.05-0.15
Date Sampled		16/09/21	16/09/21	16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	28/09/2021	29/09/2021	29/09/2021	30/09/2021	30/09/2021
Naphthalene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	<0.1	0.2	<0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	<0.1	0.2	<0.1	<0.1
Pyrene	mg/kg	<0.1	<0.1	0.2	<0.1	<0.1
Benzo(a)anthracene	mg/kg	<0.1	<0.1	0.2	<0.1	<0.1
Chrysene	mg/kg	<0.1	<0.1	0.1	<0.1	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	<0.05	0.08	<0.05	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve PAH's	mg/kg	<0.05	<0.05	0.97	<0.05	<0.05
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5
Surrogate <i>p</i> -Terphenyl-d14	%	100	88	93	88	91

PAHs in Soil				
Our Reference		278877-11	278877-12	278877-13
Your Reference	UNITS	206	211	211
Depth		0.2-0.5	0.2-0.3	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	30/09/2021	30/09/2021	30/09/2021
Naphthalene	mg/kg	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	<0.1	<0.1	<0.1
Fluorene	mg/kg	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	<0.1	0.1	<0.1
Anthracene	mg/kg	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	<0.1	0.3	<0.1
Pyrene	mg/kg	<0.1	0.3	<0.1
Benzo(a)anthracene	mg/kg	<0.1	0.2	<0.1
Chrysene	mg/kg	<0.1	0.2	<0.1
Benzo(b,j+k)fluoranthene	mg/kg	<0.2	0.2	<0.2
Benzo(a)pyrene	mg/kg	<0.05	0.1	<0.05
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.1	<0.1	<0.1
Dibenzo(a,h)anthracene	mg/kg	<0.1	<0.1	<0.1
Benzo(g,h,i)perylene	mg/kg	<0.1	<0.1	<0.1
Total +ve PAH's	mg/kg	<0.05	1.3	<0.05
Benzo(a)pyrene TEQ calc (zero)	mg/kg	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(half)	mg/kg	<0.5	<0.5	<0.5
Benzo(a)pyrene TEQ calc(PQL)	mg/kg	<0.5	<0.5	<0.5
Surrogate <i>p</i> -Terphenyl-d14	%	82	82	85

Organochlorine Pesticides in soil						
Our Reference		278877-3	278877-4	278877-5	278877-6	278877-8
Your Reference	UNITS	201	205	203	208	210
Depth		0-0.1	0-0.1	0-0.1	0-0.1	0.2-0.3
Date Sampled		22/09/21	22/09/21	22/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	29/09/2021
alpha-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
HCB	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	91	88	88	90	89

Organochlorine Pesticides in soil				
Our Reference		278877-10	278877-12	278877-13
Your Reference	UNITS	206	211	211
Depth		0.05-0.15	0.2-0.3	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	30/09/2021	30/09/2021	30/09/2021
alpha-BHC	mg/kg	<0.1	<0.1	<0.1
HCB	mg/kg	<0.1	<0.1	<0.1
beta-BHC	mg/kg	<0.1	<0.1	<0.1
gamma-BHC	mg/kg	<0.1	<0.1	<0.1
Heptachlor	mg/kg	<0.1	<0.1	<0.1
delta-BHC	mg/kg	<0.1	<0.1	<0.1
Aldrin	mg/kg	<0.1	<0.1	<0.1
Heptachlor Epoxide	mg/kg	<0.1	<0.1	<0.1
gamma-Chlordane	mg/kg	<0.1	<0.1	<0.1
alpha-chlordane	mg/kg	<0.1	<0.1	<0.1
Endosulfan I	mg/kg	<0.1	<0.1	<0.1
pp-DDE	mg/kg	<0.1	<0.1	<0.1
Dieldrin	mg/kg	<0.1	<0.1	<0.1
Endrin	mg/kg	<0.1	<0.1	<0.1
Endosulfan II	mg/kg	<0.1	<0.1	<0.1
pp-DDD	mg/kg	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	<0.1	<0.1	<0.1
pp-DDT	mg/kg	<0.1	<0.1	<0.1
Endosulfan Sulphate	mg/kg	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	<0.1	<0.1	<0.1
Total +ve DDT+DDD+DDE	mg/kg	<0.1	<0.1	<0.1
Surrogate TCMX	%	81	78	77

Organophosphorus Pesticides in Soil						
Our Reference		278877-3	278877-4	278877-5	278877-6	278877-8
Your Reference	UNITS	201	205	203	208	210
Depth		0-0.1	0-0.1	0-0.1	0-0.1	0.2-0.3
Date Sampled		22/09/21	22/09/21	22/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	29/09/2021
Dichlorvos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Dimethoate	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Diazinon	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos-methyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ronnel	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Fenitrothion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Malathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorpyriphos	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Parathion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Bromophos-ethyl	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Ethion	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Azinphos-methyl (Guthion)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	91	88	88	90	89

Organophosphorus Pesticides in Soil				
Our Reference		278877-10	278877-12	278877-13
Your Reference	UNITS	206	211	211
Depth		0.05-0.15	0.2-0.3	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	30/09/2021	30/09/2021	30/09/2021
Dichlorvos	mg/kg	<0.1	<0.1	<0.1
Dimethoate	mg/kg	<0.1	<0.1	<0.1
Diazinon	mg/kg	<0.1	<0.1	<0.1
Chlorpyrifos-methyl	mg/kg	<0.1	<0.1	<0.1
Ronnel	mg/kg	<0.1	<0.1	<0.1
Fenitrothion	mg/kg	<0.1	<0.1	<0.1
Malathion	mg/kg	<0.1	<0.1	<0.1
Chlorpyrifos	mg/kg	<0.1	<0.1	<0.1
Parathion	mg/kg	<0.1	<0.1	<0.1
Bromophos-ethyl	mg/kg	<0.1	<0.1	<0.1
Ethion	mg/kg	<0.1	<0.1	<0.1
Azinphos-methyl (Guthion)	mg/kg	<0.1	<0.1	<0.1
Surrogate TCMX	%	81	78	77

PCBs in Soil						
Our Reference		278877-3	278877-4	278877-5	278877-6	278877-8
Your Reference	UNITS	201	205	203	208	210
Depth		0-0.1	0-0.1	0-0.1	0-0.1	0.2-0.3
Date Sampled		22/09/21	22/09/21	22/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	29/09/2021
Aroclor 1016	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Surrogate TCMX	%	91	88	88	90	89

PCBs in Soil				
Our Reference		278877-10	278877-12	278877-13
Your Reference	UNITS	206	211	211
Depth		0.05-0.15	0.2-0.3	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil
Date extracted	-	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	30/09/2021	30/09/2021	30/09/2021
Aroclor 1016	mg/kg	<0.1	<0.1	<0.1
Aroclor 1221	mg/kg	<0.1	<0.1	<0.1
Aroclor 1232	mg/kg	<0.1	<0.1	<0.1
Aroclor 1242	mg/kg	<0.1	<0.1	<0.1
Aroclor 1248	mg/kg	<0.1	<0.1	<0.1
Aroclor 1254	mg/kg	<0.1	<0.1	<0.1
Aroclor 1260	mg/kg	<0.1	<0.1	<0.1
Total +ve PCBs (1016-1260)	mg/kg	<0.1	<0.1	<0.1
Surrogate TCMX	%	81	78	77

Acid Extractable metals in soil						
Our Reference		278877-1	278877-2	278877-3	278877-4	278877-5
Your Reference	UNITS	BD1-160921	BD1-220921	201	205	203
Depth		-	-	0-0.1	0-0.1	0-0.1
Date Sampled		16/09/21	22/09/21	22/09/21	22/09/21	22/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	30/09/2021	30/09/2021	30/09/2021	30/09/2021	30/09/2021
Arsenic	mg/kg	<4	8	7	<4	7
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	3	12	12	2	14
Copper	mg/kg	1	25	21	<1	19
Lead	mg/kg	2	70	55	1	53
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	<1	7	6	<1	7
Zinc	mg/kg	5	79	69	4	94

Acid Extractable metals in soil						
Our Reference		278877-6	278877-7	278877-8	278877-9	278877-10
Your Reference	UNITS	208	208	210	210	206
Depth		0-0.1	0.3-0.4	0.2-0.3	0.4-0.6	0.05-0.15
Date Sampled		16/09/21	16/09/21	16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	30/09/2021	30/09/2021	30/09/2021	30/09/2021	30/09/2021
Arsenic	mg/kg	7	8	<4	8	<4
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	14	14	28	29	13
Copper	mg/kg	16	20	20	22	28
Lead	mg/kg	23	21	12	16	4
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	7	7	16	15	49
Zinc	mg/kg	69	44	44	28	27

Acid Extractable metals in soil					
Our Reference		278877-11	278877-12	278877-13	278877-16
Your Reference	UNITS	206	211	211	211 - [TRIPLICATE]
Depth		0.2-0.5	0.2-0.3	0.5-0.6	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	30/09/2021	30/09/2021	30/09/2021	30/09/2021
Arsenic	mg/kg	6	<4	<4	5
Cadmium	mg/kg	<0.4	<0.4	<0.4	<0.4
Chromium	mg/kg	11	35	15	11
Copper	mg/kg	26	25	21	23
Lead	mg/kg	19	25	26	65
Mercury	mg/kg	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	10	19	8	7
Zinc	mg/kg	44	57	36	77

Misc Soil - Inorg						
Our Reference		278877-3	278877-4	278877-5	278877-6	278877-8
Your Reference	UNITS	201	205	203	208	210
Depth		0-0.1	0-0.1	0-0.1	0-0.1	0.2-0.3
Date Sampled		22/09/21	22/09/21	22/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	29/09/2021	29/09/2021	29/09/2021	29/09/2021	29/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021	29/09/2021	29/09/2021
Total Phenolics (as Phenol)	mg/kg	<5	<5	<5	<5	<5

Misc Soil - Inorg				
Our Reference		278877-10	278877-12	278877-13
Your Reference	UNITS	206	211	211
Depth		0.05-0.15	0.2-0.3	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil
Date prepared	-	29/09/2021	29/09/2021	29/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021
Total Phenolics (as Phenol)	mg/kg	<5	<5	<5

Moisture						
Our Reference		278877-1	278877-2	278877-3	278877-4	278877-5
Your Reference	UNITS	BD1-160921	BD1-220921	201	205	203
Depth		-	-	0-0.1	0-0.1	0-0.1
Date Sampled		16/09/21	22/09/21	22/09/21	22/09/21	22/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021	29/09/2021	29/09/2021
Moisture	%	7.9	10	9.9	6.4	13

Moisture						
Our Reference		278877-6	278877-7	278877-8	278877-9	278877-10
Your Reference	UNITS	208	208	210	210	206
Depth		0-0.1	0.3-0.4	0.2-0.3	0.4-0.6	0.05-0.15
Date Sampled		16/09/21	16/09/21	16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	28/09/2021	28/09/2021	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021	29/09/2021	29/09/2021
Moisture	%	16	13	6.7	11	6.1

Moisture				
Our Reference		278877-11	278877-12	278877-13
Your Reference	UNITS	206	211	211
Depth		0.2-0.5	0.2-0.3	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil
Date prepared	-	28/09/2021	28/09/2021	28/09/2021
Date analysed	-	29/09/2021	29/09/2021	29/09/2021
Moisture	%	11	9.1	12

Asbestos ID - soils						
Our Reference		278877-3	278877-4	278877-5	278877-6	278877-8
Your Reference	UNITS	201	205	203	208	210
Depth		0-0.1	0-0.1	0-0.1	0-0.1	0.2-0.3
Date Sampled		22/09/21	22/09/21	22/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil	Soil	Soil
Date analysed	-	30/09/2021	30/09/2021	30/09/2021	30/09/2021	30/09/2021
Sample mass tested	g	Approx. 60g	Approx. 20g	Approx. 30g	Approx. 10g	Approx. 40g
Sample Description	-	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Beige fine-grained soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected
Asbestos comments	-	NO	NO	NO	NO	NO
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected	No asbestos detected

Asbestos ID - soils				
Our Reference		278877-10	278877-12	278877-13
Your Reference	UNITS	206	211	211
Depth		0.05-0.15	0.2-0.3	0.5-0.6
Date Sampled		16/09/21	16/09/21	16/09/21
Type of sample		Soil	Soil	Soil
Date analysed	-	30/09/2021	30/09/2021	30/09/2021
Sample mass tested	g	Approx. 45g	Approx. 35g	Approx. 35g
Sample Description	-	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks	Brown coarse-grained soil & rocks
Asbestos ID in soil	-	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected	No asbestos detected at reporting limit of 0.1g/kg Organic fibres detected
Asbestos comments	-	NO	NO	NO
Trace Analysis	-	No asbestos detected	No asbestos detected	No asbestos detected

Method ID	Methodology Summary
ASB-001	Asbestos ID - Qualitative identification of asbestos in bulk samples using Polarised Light Microscopy and Dispersion Staining Techniques including Synthetic Mineral Fibre and Organic Fibre as per Australian Standard 4964-2004.
Inorg-008	Moisture content determined by heating at 105+/-5 °C for a minimum of 12 hours.
Inorg-031	Total Phenolics by segmented flow analyser (in line distillation with colourimetric finish). Solids are extracted in a caustic media prior to analysis.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Org-020	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.
Org-020	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis. Note, the Total +ve TRH PQL is reflective of the lowest individual PQL and is therefore "Total +ve TRH" is simply a sum of the positive individual TRH fractions (>C10-C40).
Org-021	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD.
Org-021	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-ECD. Note, the Total +ve PCBs PQL is reflective of the lowest individual PQL and is therefore "Total +ve PCBs" is simply a sum of the positive individual PCBs.
Org-022	Determination of VOCs sampled onto coconut shell charcoal sorbent tubes, that can be desorbed using carbon disulphide, and analysed by GC-MS.
Org-022/025	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS/GC-MSMS.
Org-022/025	Soil samples are extracted with dichloromethane/acetone and waters with dichloromethane and analysed by GC-MS/GC-MSMS. Note, the Total +ve reported DDD+DDE+DDT PQL is reflective of the lowest individual PQL and is therefore simply a sum of the positive individually report DDD+DDE+DDT.

Method ID	Methodology Summary
Org-022/025	<p>Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-MS and/or GC-MS/MS. Benzo(a)pyrene TEQ as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater - 2013.</p> <p>For soil results:-</p> <ol style="list-style-type: none"> 1. 'EQ PQL' values are assuming all contributing PAHs reported as <PQL are actually at the PQL. This is the most conservative approach and can give false positive TEQs given that PAHs that contribute to the TEQ calculation may not be present. 2. 'EQ zero' values are assuming all contributing PAHs reported as <PQL are zero. This is the least conservative approach and is more susceptible to false negative TEQs when PAHs that contribute to the TEQ calculation are present but below PQL. 3. 'EQ half PQL' values are assuming all contributing PAHs reported as <PQL are half the stipulated PQL. Hence a mid-point between the most and least conservative approaches above. <p>Note, the Total +ve PAHs PQL is reflective of the lowest individual PQL and is therefore "Total +ve PAHs" is simply a sum of the positive individual PAHs.</p>
Org-023	<p>Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS.</p>
Org-023	<p>Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.</p>
Org-023	<p>Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.</p> <p>Note, the Total +ve Xylene PQL is reflective of the lowest individual PQL and is therefore "Total +ve Xylenes" is simply a sum of the positive individual Xylenes.</p>

Client Reference: 207155.00, Kellyville

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date extracted	-			28/09/2021	3	28/09/2021	28/09/2021		28/09/2021	[NT]
Date analysed	-			29/09/2021	3	29/09/2021	29/09/2021		29/09/2021	[NT]
TRH C ₆ - C ₉	mg/kg	25	Org-023	<25	3	<25	<25	0	99	[NT]
TRH C ₆ - C ₁₀	mg/kg	25	Org-023	<25	3	<25	<25	0	99	[NT]
Benzene	mg/kg	0.2	Org-023	<0.2	3	<0.2	<0.2	0	94	[NT]
Toluene	mg/kg	0.5	Org-023	<0.5	3	<0.5	<0.5	0	75	[NT]
Ethylbenzene	mg/kg	1	Org-023	<1	3	<1	<1	0	106	[NT]
m+p-xylene	mg/kg	2	Org-023	<2	3	<2	<2	0	110	[NT]
o-Xylene	mg/kg	1	Org-023	<1	3	<1	<1	0	106	[NT]
naphthalene	mg/kg	1	Org-023	<1	3	<1	<1	0	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-023	93	3	75	82	9	88	[NT]

QUALITY CONTROL: vTRH(C6-C10)/BTEXN in Soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	13	28/09/2021	28/09/2021		[NT]	[NT]
Date analysed	-			[NT]	13	29/09/2021	29/09/2021		[NT]	[NT]
TRH C ₆ - C ₉	mg/kg	25	Org-023	[NT]	13	<25	<25	0	[NT]	[NT]
TRH C ₆ - C ₁₀	mg/kg	25	Org-023	[NT]	13	<25	<25	0	[NT]	[NT]
Benzene	mg/kg	0.2	Org-023	[NT]	13	<0.2	<0.2	0	[NT]	[NT]
Toluene	mg/kg	0.5	Org-023	[NT]	13	<0.5	<0.5	0	[NT]	[NT]
Ethylbenzene	mg/kg	1	Org-023	[NT]	13	<1	<1	0	[NT]	[NT]
m+p-xylene	mg/kg	2	Org-023	[NT]	13	<2	<2	0	[NT]	[NT]
o-Xylene	mg/kg	1	Org-023	[NT]	13	<1	<1	0	[NT]	[NT]
naphthalene	mg/kg	1	Org-023	[NT]	13	<1	<1	0	[NT]	[NT]
Surrogate aaa-Trifluorotoluene	%		Org-023	[NT]	13	91	81	12	[NT]	[NT]

Client Reference: 207155.00, Kellyville

QUALITY CONTROL: svTRH (C10-C40) in Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date extracted	-			28/09/2021	3	28/09/2021	28/09/2021		28/09/2021	[NT]
Date analysed	-			29/09/2021	3	29/09/2021	29/09/2021		29/09/2021	[NT]
TRH C ₁₀ - C ₁₄	mg/kg	50	Org-020	<50	3	<50	<50	0	97	[NT]
TRH C ₁₅ - C ₂₈	mg/kg	100	Org-020	<100	3	<100	<100	0	91	[NT]
TRH C ₂₉ - C ₃₆	mg/kg	100	Org-020	<100	3	<100	<100	0	92	[NT]
TRH >C ₁₀ -C ₁₆	mg/kg	50	Org-020	<50	3	<50	<50	0	97	[NT]
TRH >C ₁₆ -C ₃₄	mg/kg	100	Org-020	<100	3	<100	<100	0	91	[NT]
TRH >C ₃₄ -C ₄₀	mg/kg	100	Org-020	<100	3	<100	<100	0	92	[NT]
Surrogate o-Terphenyl	%		Org-020	100	3	104	103	1	110	[NT]

QUALITY CONTROL: svTRH (C10-C40) in Soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	13	28/09/2021	28/09/2021		[NT]	[NT]
Date analysed	-			[NT]	13	29/09/2021	29/09/2021		[NT]	[NT]
TRH C ₁₀ - C ₁₄	mg/kg	50	Org-020	[NT]	13	<50	<50	0	[NT]	[NT]
TRH C ₁₅ - C ₂₈	mg/kg	100	Org-020	[NT]	13	<100	<100	0	[NT]	[NT]
TRH C ₂₉ - C ₃₆	mg/kg	100	Org-020	[NT]	13	<100	<100	0	[NT]	[NT]
TRH >C ₁₀ -C ₁₆	mg/kg	50	Org-020	[NT]	13	<50	<50	0	[NT]	[NT]
TRH >C ₁₆ -C ₃₄	mg/kg	100	Org-020	[NT]	13	<100	<100	0	[NT]	[NT]
TRH >C ₃₄ -C ₄₀	mg/kg	100	Org-020	[NT]	13	<100	<100	0	[NT]	[NT]
Surrogate o-Terphenyl	%		Org-020	[NT]	13	96	95	1	[NT]	[NT]

QUALITY CONTROL: PAHs in Soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date extracted	-			28/09/2021	3	28/09/2021	28/09/2021		28/09/2021	[NT]
Date analysed	-			30/09/2021	3	28/09/2021	28/09/2021		30/09/2021	[NT]
Naphthalene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	107	[NT]
Acenaphthylene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	109	[NT]
Fluorene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	109	[NT]
Phenanthrene	mg/kg	0.1	Org-022/025	<0.1	3	0.2	0.2	0	122	[NT]
Anthracene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-022/025	<0.1	3	0.3	0.4	29	104	[NT]
Pyrene	mg/kg	0.1	Org-022/025	<0.1	3	0.3	0.3	0	105	[NT]
Benzo(a)anthracene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	0.1	0	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	0.1	0	81	[NT]
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-022/025	<0.2	3	<0.2	0.2	0	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-022/025	<0.05	3	0.1	0.2	67	120	[NT]
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	0.1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-022/025	105	3	90	81	11	108	[NT]

QUALITY CONTROL: PAHs in Soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	13	28/09/2021	28/09/2021		[NT]	[NT]
Date analysed	-			[NT]	13	30/09/2021	30/09/2021		[NT]	[NT]
Naphthalene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Acenaphthylene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Acenaphthene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Fluorene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Phenanthrene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Anthracene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Fluoranthene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Pyrene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Benzo(a)anthracene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Chrysene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Benzo(b,j+k)fluoranthene	mg/kg	0.2	Org-022/025	[NT]	13	<0.2	<0.2	0	[NT]	[NT]
Benzo(a)pyrene	mg/kg	0.05	Org-022/025	[NT]	13	<0.05	<0.05	0	[NT]	[NT]
Indeno(1,2,3-c,d)pyrene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Dibenzo(a,h)anthracene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Benzo(g,h,i)perylene	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Surrogate p-Terphenyl-d14	%		Org-022/025	[NT]	13	85	85	0	[NT]	[NT]

Client Reference: 207155.00, Kellyville

QUALITY CONTROL: Organochlorine Pesticides in soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date extracted	-			28/09/2021	3	28/09/2021	28/09/2021		28/09/2021	[NT]
Date analysed	-			30/09/2021	3	28/09/2021	28/09/2021		30/09/2021	[NT]
alpha-BHC	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	92	[NT]
HCB	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
beta-BHC	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	99	[NT]
gamma-BHC	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Heptachlor	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	65	[NT]
delta-BHC	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Aldrin	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	107	[NT]
Heptachlor Epoxide	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	98	[NT]
gamma-Chlordane	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
alpha-chlordane	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Endosulfan I	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
pp-DDE	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	101	[NT]
Dieldrin	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	102	[NT]
Endrin	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	78	[NT]
Endosulfan II	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
pp-DDD	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	74	[NT]
Endrin Aldehyde	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
pp-DDT	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Endosulfan Sulphate	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	82	[NT]
Methoxychlor	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-022/025	100	3	91	88	3	106	[NT]

QUALITY CONTROL: Organochlorine Pesticides in soil					Duplicate			Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	13	28/09/2021	28/09/2021		[NT]	[NT]
Date analysed	-			[NT]	13	30/09/2021	30/09/2021		[NT]	[NT]
alpha-BHC	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
HCB	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
beta-BHC	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
gamma-BHC	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Heptachlor	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
delta-BHC	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Aldrin	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Heptachlor Epoxide	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
gamma-Chlordane	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
alpha-chlordane	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Endosulfan I	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
pp-DDE	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Dieldrin	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Endrin	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Endosulfan II	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
pp-DDD	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Endrin Aldehyde	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
pp-DDT	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Endosulfan Sulphate	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Methoxychlor	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-022/025	[NT]	13	77	77	0	[NT]	[NT]

QUALITY CONTROL: Organophosphorus Pesticides in Soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date extracted	-			28/09/2021	3	28/09/2021	28/09/2021		28/09/2021	[NT]
Date analysed	-			30/09/2021	3	28/09/2021	28/09/2021		30/09/2021	[NT]
Dichlorvos	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	70	[NT]
Dimethoate	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Diazinon	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Chlorpyriphos-methyl	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Ronnel	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	101	[NT]
Fenitrothion	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	63	[NT]
Malathion	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	103	[NT]
Chlorpyriphos	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	106	[NT]
Parathion	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	66	[NT]
Bromophos-ethyl	mg/kg	0.1	Org-022	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Ethion	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	84	[NT]
Azinphos-methyl (Guthion)	mg/kg	0.1	Org-022/025	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-022/025	100	3	91	88	3	106	[NT]

QUALITY CONTROL: Organophosphorus Pesticides in Soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	13	28/09/2021	28/09/2021		[NT]	[NT]
Date analysed	-			[NT]	13	30/09/2021	30/09/2021		[NT]	[NT]
Dichlorvos	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Dimethoate	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Diazinon	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Chlorpyriphos-methyl	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Ronnel	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Fenitrothion	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Malathion	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Chlorpyriphos	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Parathion	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Bromophos-ethyl	mg/kg	0.1	Org-022	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Ethion	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Azinphos-methyl (Guthion)	mg/kg	0.1	Org-022/025	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-022/025	[NT]	13	77	77	0	[NT]	[NT]

Client Reference: 207155.00, Kellyville

QUALITY CONTROL: PCBs in Soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date extracted	-			28/09/2021	3	28/09/2021	28/09/2021		28/09/2021	[NT]
Date analysed	-			30/09/2021	3	28/09/2021	28/09/2021		30/09/2021	[NT]
Aroclor 1016	mg/kg	0.1	Org-021	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-021	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-021	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-021	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-021	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-021	<0.1	3	<0.1	<0.1	0	100	[NT]
Aroclor 1260	mg/kg	0.1	Org-021	<0.1	3	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-021	100	3	91	88	3	106	[NT]

QUALITY CONTROL: PCBs in Soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date extracted	-			[NT]	13	28/09/2021	28/09/2021		[NT]	[NT]
Date analysed	-			[NT]	13	30/09/2021	30/09/2021		[NT]	[NT]
Aroclor 1016	mg/kg	0.1	Org-021	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1221	mg/kg	0.1	Org-021	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1232	mg/kg	0.1	Org-021	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1242	mg/kg	0.1	Org-021	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1248	mg/kg	0.1	Org-021	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1254	mg/kg	0.1	Org-021	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Aroclor 1260	mg/kg	0.1	Org-021	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Surrogate TCMX	%		Org-021	[NT]	13	77	77	0	[NT]	[NT]

Client Reference: 207155.00, Kellyville

QUALITY CONTROL: Acid Extractable metals in soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date prepared	-			28/09/2021	3	28/09/2021	28/09/2021		28/09/2021	[NT]
Date analysed	-			30/09/2021	3	30/09/2021	30/09/2021		30/09/2021	[NT]
Arsenic	mg/kg	4	Metals-020	<4	3	7	5	33	83	[NT]
Cadmium	mg/kg	0.4	Metals-020	<0.4	3	<0.4	<0.4	0	86	[NT]
Chromium	mg/kg	1	Metals-020	<1	3	12	11	9	87	[NT]
Copper	mg/kg	1	Metals-020	<1	3	21	18	15	84	[NT]
Lead	mg/kg	1	Metals-020	<1	3	55	71	25	92	[NT]
Mercury	mg/kg	0.1	Metals-021	<0.1	3	<0.1	<0.1	0	86	[NT]
Nickel	mg/kg	1	Metals-020	<1	3	6	6	0	89	[NT]
Zinc	mg/kg	1	Metals-020	<1	3	69	69	0	93	[NT]

QUALITY CONTROL: Acid Extractable metals in soil				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	13	28/09/2021	28/09/2021		[NT]	[NT]
Date analysed	-			[NT]	13	30/09/2021	30/09/2021		[NT]	[NT]
Arsenic	mg/kg	4	Metals-020	[NT]	13	<4	5	22	[NT]	[NT]
Cadmium	mg/kg	0.4	Metals-020	[NT]	13	<0.4	<0.4	0	[NT]	[NT]
Chromium	mg/kg	1	Metals-020	[NT]	13	15	20	29	[NT]	[NT]
Copper	mg/kg	1	Metals-020	[NT]	13	21	22	5	[NT]	[NT]
Lead	mg/kg	1	Metals-020	[NT]	13	26	17	42	[NT]	[NT]
Mercury	mg/kg	0.1	Metals-021	[NT]	13	<0.1	<0.1	0	[NT]	[NT]
Nickel	mg/kg	1	Metals-020	[NT]	13	8	11	32	[NT]	[NT]
Zinc	mg/kg	1	Metals-020	[NT]	13	36	42	15	[NT]	[NT]

Client Reference: 207155.00, Kellyville

QUALITY CONTROL: Misc Soil - Inorg				Duplicate				Spike Recovery %		
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-5	[NT]
Date prepared	-			29/09/2021	3	29/09/2021	29/09/2021		29/09/2021	[NT]
Date analysed	-			29/09/2021	3	29/09/2021	29/09/2021		29/09/2021	[NT]
Total Phenolics (as Phenol)	mg/kg	5	Inorg-031	<5	3	<5	<5	0	102	[NT]

Result Definitions

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

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.
Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.	
The recommended maximums for analytes in urine are taken from "2018 TLVs and BEIs", as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.	
Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2	

Laboratory Acceptance Criteria

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

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

Spikes for Physical and Aggregate Tests are not applicable.

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

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

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

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

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

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

Measurement Uncertainty estimates are available for most tests upon request.

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

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

Report Comments

Asbestos: Excessive sample volumes were provided for asbestos analysis. A portion of the supplied samples were sub-sampled according to Envirolab procedures. We cannot guarantee that these sub-samples are indicative of the entire sample. Envirolab recommends supplying 40-50g (50mL) of sample in its own container as per AS4964-2004.
Note: Samples requested for asbestos testing were sub-sampled from bags provided by the client.

Acid Extractable Metals in Soil: The laboratory RPD acceptance criteria has been exceeded for 278877-13 for Pb. Therefore a triplicate result has been issued as laboratory sample number 278877-16.

Appendix E

CSIRO Notes

Foundation Maintenance and Footing Performance: A Homeowner's Guide



BTf 18
replaces
Information
Sheet 10/91

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

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

Soil Types

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

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

Causes of Movement

Settlement due to construction

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

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

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

Erosion

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

Saturation

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

Seasonal swelling and shrinkage of soil

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

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

Shear failure

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

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

GENERAL DEFINITIONS OF SITE CLASSES

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

Tree root growth

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

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

Unevenness of Movement

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

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

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

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

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

Effects of Uneven Soil Movement on Structures

Erosion and saturation

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

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

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

Seasonal swelling/shrinkage in clay

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

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

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

Trees can cause shrinkage and damage



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

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

Movement caused by tree roots

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

Complications caused by the structure itself

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

Effects on full masonry structures

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

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

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

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

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

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

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

Effects on framed structures

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

Effects on brick veneer structures

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

Water Service and Drainage

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

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.

Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.

- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

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

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

Prevention/Cure

Plumbing

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

Ground drainage

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

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

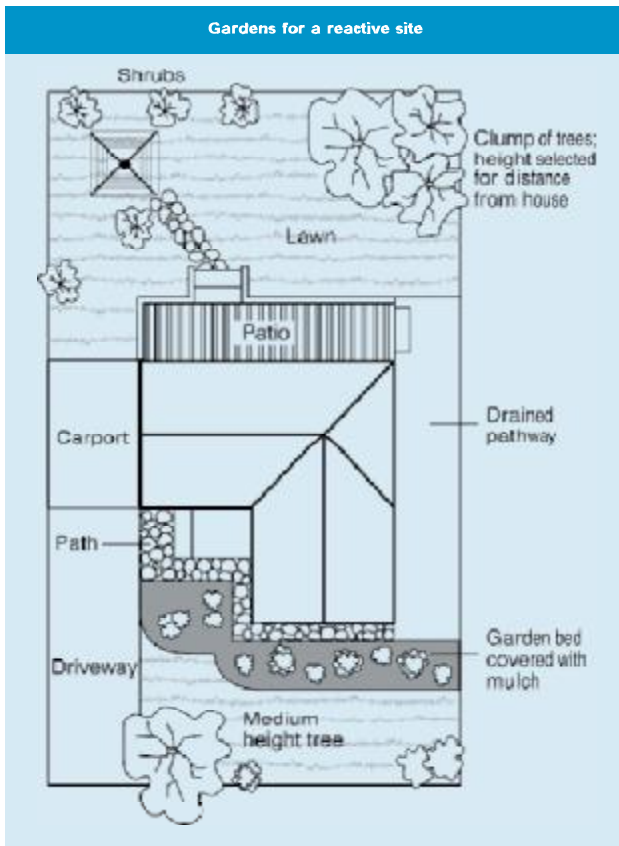
Protection of the building perimeter

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

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

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

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



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

The garden

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

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

Existing trees

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

Information on trees, plants and shrubs

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

Excavation

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

Remediation

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

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

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

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

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

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

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

Condensation

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

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

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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Appendix F

Previous Investigation Information

TEST PIT LOG

CLIENT: The Hills Shire Council
PROJECT: Proposed Sports Fields
LOCATION: Memorial Avenue, Kellyville

SURFACE LEVEL: 64.2 AHD*
EASTING: 310856
NORTHING: 6267086
DIP/AZIMUTH: 90°/--

PIT No: 5
PROJECT No: 73017
DATE: 6/6/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)				
				Type	Depth	Sample	Results & Comments		5	10	15	20	
63.8	0.2	FILLING - brown, silty clay filling with roots (topsoil)											
	0.4	FILLING - grey-orange-brown, silty clay filling, damp											
	0.5	SILTY CLAY - very stiff, orange-brown then mottled grey and orange-brown, silty clay, Mc<PL, medium to high plasticity		D	0.5								
63.3	1.1	SILTY CLAY - hard, grey silty and shaly clay, Mc<PL											
63.1	1.4	SHALE - medium strength, dark grey shale											
62.6	1.5	Pit discontinued at 1.5m - refusal on medium strength shale											
62.1	2.0												
61.6	3.0												
61.1	4.0												

RIG: 3.5t Excavator, 300mm bucket

LOGGED: A Podnar

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

Sand Penetrometer AS1289.6.3.3

REMARKS: Mc = Moisture content; PL = Plastic limit. *Level interpolated from survey plan

Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

TEST PIT LOG

CLIENT: The Hills Shire Council
PROJECT: Proposed Sports Fields
LOCATION: Memorial Avenue, Kellyville

SURFACE LEVEL: 64.2 AHD*
EASTING: 310836
NORTHING: 6267144
DIP/AZIMUTH: 90°/--

PIT No: 10
PROJECT No: 73017
DATE: 6/6/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)					
				Type	Depth	Sample	Results & Comments		5	10	15	20		
64	0.1	FILLING - grey-brown sandy silty clay filling, damp with grass cover (topsoil)												
		FILLING - orange and grey brown silty clay filling, damp. Appears moderately compacted/stiff												
	0.8	SILTY CLAY - very stiff, mottled grey and orange/red-brown, silty clay, Mc<PL, medium to high plasticity			0.8		pp = 400 (210mm recovery)							
1	1.0	SHALE - extremely low strength, grey shale				1.11								
63	1.2	Pit discontinued at 1.2m - refusal on low to medium strength shale												
62	2													
61	3													
60	4													

RIG: 3.5t Excavator, 300mm bucket

LOGGED: A Podnar

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed

Sand Penetrometer AS1289.6.3.3

REMARKS: Mc = Moisture content; PL = Plastic limit. *Level interpolated from survey plan

Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Hills Shire Council
PROJECT: Proposed On-Grade Carpark
LOCATION: Kellyville Park - Memorial Avenue, Kellyville

SURFACE LEVEL: 66.6 mAHD
EASTING: 310857.9
NORTHING: 6267280.1
DIP/AZIMUTH: 90°/--

BORE No: 101
PROJECT No: 94527.00
DATE: 17/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Well Construction Details	
				Type	Depth	Sample	Results & Comments			
66 65 64 63 62 61 60 59 58 57	0.05	ASPHALT	[Cross-hatch pattern]	A	0.1					
		FILLING - grey, sandy gravel filling, humid. Sand is fine to medium grain and gravel is fine to medium.	[Cross-hatch pattern]	A	0.2					
			[Cross-hatch pattern]	A	0.4					
			[Cross-hatch pattern]	A	0.5					
	0.7	SHALE - very low strength, grey shale with some low strength ironstone bonding.	[Horizontal lines pattern]	A	0.9					
	1		[Horizontal lines pattern]	A	1.0					
	1.2	Bore discontinued at 1.2m								
		- Practical refusal on low strength or better shale								
	2									
	3									
4										
5										
6										
7										
8										
9										

DRAFT

RIG: 3.5 Tonne Mini Excavator **DRILLER:** BM **LOGGED:** JY **CASING:** Uncased
TYPE OF BORING: 150mm diameter solid flight auger
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Edge of netball court

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Hills Shire Council
PROJECT: Proposed On-Grade Carpark
LOCATION: Kellyville Park - Memorial Avenue, Kellyville

SURFACE LEVEL: 66.5 mAHD
EASTING: 310837.2
NORTHING: 6267253.5
DIP/AZIMUTH: 90°/--

BORE No: 102
PROJECT No: 94527.00
DATE: 17/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing			Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample		
	0.06	ASPHALT	█	A	0.1			
	0.4	FILLING - grey, sandy gravel filling, humid	▨	A	0.2			
	0.4	FILLING - grey, silty clay filling, with a trace of fine gravel and sand, humid	▨	A	0.4			
	0.9	SILTY CLAY - very stiff, brown silty clay, humid		A	0.5			
	1.2	SILTY CLAY - very stiff, light grey mottled brown, with a trace of ironstone gravel		B	0.9			
	1.2			A	1.0			
	1.4			A	1.1			
	1.5			A	1.4			
	1.9			A	1.5			
	2.0			A	1.9			
	2.2			A	2.0			
	2.2	SHALE - low strength, grey shale	▬	A	2.2			
	2.3	Bore discontinued at 2.3m	▬	A	2.3			
	3							
	4							
	5							
	6							
	7							
	8							
	9							

RIG: 3.5 Tonne Mini Excavator **DRILLER:** BM **LOGGED:** JY **CASING:** Uncased
TYPE OF BORING: 300mm diameter auger to 1.1m, 150mm diameter solid flight auger to 2.3m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS: Edge of netball court

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	≻	Water seep
E	Environmental sample	≽	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)

BOREHOLE LOG

CLIENT: The Hills Shire Council
PROJECT: Proposed On-Grade Carpark
LOCATION: Kellyville Park - Memorial Avenue, Kellyville

SURFACE LEVEL: 66.8 mAHD
EASTING: 310836.4
NORTHING: 6267201.2
DIP/AZIMUTH: 90°/--

BORE No: 104
PROJECT No: 94527.00
DATE: 17/12/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing				Water	Dynamic Penetrometer Test (blows per 150mm)
				Type	Depth	Sample	Results & Comments		
DRAFT	0.1	TOPSOIL FILLING - brown silty clay filling, with some fine to medium gravel, vegetation and rootlets, damp		A	0.1				
		FILLING - brown, silty clay filling, with some fine to medium gravel, damp		A	0.2				
				A	0.4				
				A	0.5				
	0.7	FILLING - grey-brown silty clay filling, with some fine to medium gravel, damp		B	0.7				
				A	0.9				
				A	1.0				
				A	1.2				
				A	1.4				
				A	1.5				
	2	2.0m: becoming brown		A	1.9				
				A	2.0				
				A	2.4				
	2.5	SILTY CLAY - stiff, brown silty clay, with a trace of fine gravel, damp		A	2.5				
	3	Bore discontinued at 3.0m		A	2.9				
		A	3.0						

RIG: 3.5 Tonne Mini Excavator **DRILLER:** BM **LOGGED:** JY **CASING:** Uncased
TYPE OF BORING: 300mm diameter solid flight auger to 1.2m, 150mm diameter solid flight auger to 3m
WATER OBSERVATIONS: No free groundwater observed whilst augering
REMARKS:

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	G	Gas sample
B	Bulk sample	P	Piston sample
BLK	Block sample	U	Tube sample (x mm dia.)
C	Core drilling	W	Water sample
D	Disturbed sample	>	Water seep
E	Environmental sample	≡	Water level
		PLD	Photo ionisation detector (ppm)
		PL(A)	Point load axial test Is(50) (MPa)
		PL(D)	Point load diametral test Is(50) (MPa)
		pp	Pocket penetrometer (kPa)
		S	Standard penetration test
		V	Shear vane (kPa)