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Report

Phase 1 Contamination Assessment and Geotechnical Investigation Proposed Residential Apartment Building Lots 1-4 DP 581963 and Lot 11 & 13 DP 1000689 Nos 25, 25a, 27, 27a and 29 Rookwood Road Yagoona NSW 2170

Prepared for
Mr John Bouchahine
C/- Zhinar Architects
Suite 1, Level 2, No 2 Rowe Street
EASTWOOD NSW 2122

Ref: JC17306A
September 2017

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4th September 2017

Our Ref: JC17306A-r1

Mr John Bouchahine
C/- Zhinar Architects
Suite 1, Level 2, No 2 Rowe Steet
EASTWOOD NSW 2122

Attention: Mr Ramiro Lopez Pena

Dear Sir

Re Phase 1 Contamination Assessment and Geotechnical Investigation
Proposed Residential Apartment Building
Lots 1-4 DP 581963 and Lot 11 & 13 DP 1000689
Nos 25, 25a, 27, 27a and 29 Rookwood Road Yagoona NSW 2170

We are pleased to submit our Phase 1 Contamination Assessment and geotechnical investigation report for the proposed Residential Apartment building to be constructed at the above address.

This report contains information on sub-surface conditions and our comments and recommendations on geotechnical and contamination issues for the proposed development.

Should you have any queries, please contact the undersigned.

Yours faithfully
GeoEnviro Consultancy Pty Ltd

Adrian Tejada BE
Geotechnical Engineer

Solern Liew CPEng (NPER)
Director

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1. INTRODUCTION

This report presents the results of a geotechnical investigation and Phase 1 contamination investigation for the proposed residential apartment building development to be constructed at Lots 1-4 DP 581963 and Lot 11 & 13 DP 1000689, Nos 25-29 Rookwood Road Yagoona as shown on Drawing No 1. The investigation was commissioned by Mr Ramiro Lopez Pena of Zhinar Architects on behalf of Mr John Bouchahine, following our fee proposal PC17280A dated 21st June 2017.

We understand that the proposed development will include the construction of two blocks of four-storey residential apartment buildings with a single-level basement carpark. Details of building loads were not provided and we have assumed that typical loads for this type of building apply.

The purpose of the investigation was to assess the nature of the subsurface soil, rock and groundwater conditions of the site and based upon the information obtained, to present the following;

- Phase 1 assessment on site contamination that may present a risk to human health and/or the environment as a result of previous and current land use.
- Comments and recommendations on earthworks and excavation methods.
- Recommendations on suitable retaining wall/shoring system and design parameters for the basement carpark.
- Recommendations on footings for the proposed building including allowable bearing capacities and anticipated settlement.
- Basement floor slab and drainage.

2. SCOPE OF WORK

2.1 Geotechnical Investigation

The scope of work for geotechnical investigation included;

- Drilling of five boreholes (BH 1 to BH 5) at accessible locations across the site using a truck mounted B80 drill rig equipped with spiral augers, rotary augers and an NMLC diamond bit core barrel. BH 4 and 5 were cored into bedrock to depths of about 7.0m to 6.66m below existing ground surface respectively. Borehole No 1 to 3 were drilled to refusal depths of 3.7m to 4.2m below existing ground surface respectively.
- Standard Penetration testing (SPT) in the boreholes to assess the strength of the subsurface profiles. Hand penetrometer testing in the SPT split tube samples to assess the strength of the subsurface profiles.
- Visual soil classification and assessment of in-situ material and bedrock level,
- Laboratory analysis to assess bedrock properties.

2.2 Phase 1 Contamination Assessment

The contamination assessment was performed in general conformance with our understanding of the guidelines by the Australian and New Zealand Conservation Council (ANZECC) and the Department of Environment, Conservation and Climate Change (DECC). The scope of work conducted included:

- A review of historic title information obtained from the Department of Lands,
- A review of aerial survey photographs for the last 50 years,
- A review of Department of Natural Resources groundwater bore data,
- A review of published information on the subsurface conditions in the general area,
- A search on the NSW EPA's contaminated land register and licensing and Canterbury Bankstown Council's Section 149 (2) certificate,
- An inspection of the site to identify apparent or suspected areas of contamination.

3. SITE INFORMATION

3.1 Site Location

The site consists of six properties, No 25, 25a, 27, 27a and 29b Rookwood Road (ie Lots 1 to 4 in DP 581963 and Lots 11 & 13 in DP 1000689) and is situated on the eastern side of Rookwood Road in Yagoona with Stacey Street forming the rear boundary as shown on the attached Drawing No 1. The overall site is irregular in shape measuring about 35m along the Rookwood Road frontage by about 160m along the southern boundary. Refer to Drawing No 1 for Site Locality.

The site is within the jurisdiction of Canterbury Bankstown Council, Parish of Liberty Plains and County of Cumberland.

The site is situated within a residential area with the northern property consisting of a residential property and the two southern neighbouring properties consisting of a residential apartment and school.

3.2 Site Topography

The site is situated on gently undulating terrain. Natural ground surface within the site has a gentle slope dipping to the west at angles of less than 3 degrees.

Based on the survey drawings provided, ground surface within the front portion of the site is at about Reduced Level (RL) 57m Australian Height Datum (AHD) with the rear of the site at about RL 60m AHD.

3.3 Geological Setting

The 1:100,000 Soil Landscape Map of Sydney Series 9030 prepared by the Soil Conservation Services of NSW indicates the site to be underlain by residual soil belonging to the Blacktown landscape grouping. Typically, soil consists of low permeability, highly plastic and moderately reactive soil.

The 1:100,000 Geological Map of Sydney indicated the underlying bedrock consists of Bringelly Shale of the Wianamatta Group consisting of shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff.

3.4 Hydrogeology

Surface water from the site is expected to flow west into Dick River and eventually further north into the Parramatta River. Groundwater is also expected to flow in a general direction towards the west into Duck River.

Based on our local knowledge and previous investigation of the general surrounding area, we expect permanent groundwater table to be at a significant depth (i.e. in excess of 3m from ground surface). Infiltration of surface water through subsurface ground is expected to be limited due to the nature of the underlying plastic clays and shale bedrock

A study of groundwater conditions beneath the site and search of the NSW Department Infrastructure, Planning and Natural Resources groundwater database for the region was carried out. The search identified nine registered bores within 1km from the site. The following is a summary the two registered bore with relevant information;

Groundwater Number	Authorised uses	Northing	Easting	Standing Water Level (m)	Water Bearing Zones (m)	Final Depth (m)
GW109735	Monitoring Bore	6246624	318969	9.1	-	11.0
GW109734	Monitoring Bore	6246624	318933	1.8	-	4.0

Reference should be made to the Work Summary search in Appendix C for details. Based on the above information, groundwater is considered a resource in the immediate area of the site.

3.5 Site Inspection and Description

A site inspection was carried out on the 17th August 2017 by an environmental scientist from this company to observe existing site features and identify obvious or suspected areas of potential contamination.

At the time of our site investigation, property Nos 25, 25a, 27 and 27a were mainly being used for residential purposes with dwellings occupying the properties. The rear of property No 25a and 27a were being used by an appliance repairer with several white goods stored around the garages. The northern corner (ie No 29b) of the site was used as a storage area for old cars, trucks, container, caravan and scrap metal. The rear of the site (ie No 27c) was vacant with some stockpiles of bricks and tiles, a caravan and some building debris including bricks, tiles and fibro pieces sparsely scattered on the ground surface. Reference should be made to Drawing No 1 for site features and locality.

Site Feature	Description
A	Single-storey weatherboard dwelling.
B	Single-storey brick dwelling.
C	Detached weatherboard and fibro garage and shed.
D	Metal and timber carport.
E	Storage area for old cars, truck, scrap metal, corrugated metal, trailer, container, demountable office, washing machines, car part and TVs.
F	Two-storey brick dwelling.
G	Single-storey weatherboard dwelling.
H	Weatherboard garage used for storage of appliances with several white goods at the exterior along the concrete driveway.
I	Brick garage used for storage of appliances with several white goods at the exterior along the concrete driveway.
J	Old unused timber gazebo.
K	Vacant area with some stockpiles of pallets bricks and caravan at the south-western corner, bulk bag of fibro and building debris sparsely scattered on the ground surface including bricks, tiles and fibro pieces.
L	Concrete driveway.

The inspection did not reveal any obvious signs of gross ground contamination indicated by odour, discolouration of the ground or signs of vegetation distress.

4. SITE HISTORY

4.1 Historical Title Search

Historical information on the previous owners of the site was obtained from the Department of Lands. The information can often be linked to possible land uses and provides an indication of potential contamination on the site. The following is a summary of information of current and previous proprietors for the property;

As regards Lot 1 D.P. 581963

Date of Acquisition and term held	Registered Proprietor(s) & Occupations where available	Reference to Title at Acquisition and sale
15.09.1915 (1915 to 1927)	James Gilliver (Boiler Maker) Edward Victor Gilliver (Labourer) Ethel Daisy Gilliver (Spinster) Now Ethel Daisy Egert (Married Woman) (Application by Transmission not investigated)	Vol 504 Fol 110 Now Vol 3188 Fol 243
14.06.1927 (1927 to 1958)	Edward Victor Gilliver (Labourer)	Vol 3188 Fol 243
29.09.1958 (1958 to 1961)	Carlo Lo-Rizzo (Electrician) Jennifer Lo-Rizzo	Vol 3188 Fol 243
29.09.1961 (1961 to 1973)	Mecyslaw Bakunowicz (Mechanical Engineer) Marianne Bakunowicz (Married Woman)	Vol 3188 Fol 243
11.05.1973 (1973 to 1977)	Simon Raheb (Builder) Jennifer Raheb (Married Woman)	Vol 3188 Fol 243 Now Vol 13038 Fol 215
10.50.1977 (1977 to 2003)	Costi Yammine (General Hand)	Vol 13038 Fol 215 Now 1/581963
08.07.2003 (2003 to 2016)	Stephen Anthony Raheb	1/581963
11.05.2016 (2016 to Date)	# JR Bankstown Pty Limited	1/581963

As regards Lot 3 D.P. 581963

Date of Acquisition and term held	Registered Proprietor(s) & Occupations where available	Reference to Title at Acquisition and sale
15.09.1915 (1915 to 1921)	James Gilliver (Boiler Maker) Edward Victor Gilliver (Labourer) Ethel Daisy Gilliver (Spinster) Now Ethel Daisy Egert (Married Woman) (Application by Transmission not investigated)	Vol 504 Fol 110
09.04.1921 (1921 to 1927)	Richard Bacon (Grazier)	Vol 504 Fol 110 Now Vol 3188 Fol 244
10.03.1927 (1927 to 1928)	John Percival Muller (Estate Agent)	Vol 3188 Fol 244 Now Vol 4137 Fol 118
14.05.1928 (1928 to 1945)	Stephen Gilbert Friend (Clerk)	Vol 4137 Fol 118
26.07.1945 (1945 to 1973)	Earl Kitchener Stewart	Vol 4137 Fol 118 Now Vol 7441 Fol 158
11.05.1973 (1973 to 1980)	Sarkis Raheb (Builder)	Vol 7441 Fol 158 Now Vol 13038 Fol 217
15.07.1980 (1980 to 2003)	Anthony Raheb (Clerk of Petty Sessions) Christopher Raheb (Senior Sales Representative)	Vol 13038 Fol 217 Now 3/581963
18.03.2003 (2003 to 2016)	Christopher Raheb	3/581963
11.05.2016 (2016 to Date)	# JR Bankstown Pty Limited	3/581963

As regards Lot 11 D.P. 1000689

Date of Acquisition and term held	Registered Proprietor(s) & Occupations where available	Reference to Title at Acquisition and sale
23.07.1895 (1895 to 1941)	John Taylor (Merchant) Horace Grainger (Master Mariner) Catherine Mary McMillan (Spinster)	Vol 1168 Fol 227
30.06.1941 (1941 to 1941)	Catherine Mary McMillian	Vol 1168 Fol 227
30.06.1941 (1941 to 1941)	David Melville (Iron Turner)	Vol 1168 Fol 227 Now Vol 5253 Fol 149
09.07.1941 (1941 to 1978)	Ida Emma Wilhelmina Thomas (Married Woman)	Vol 5253 Fol 149 Now Vol 7761 Fol 105
24.05.1978 (1978 to 1985)	Timothy William Lincoln (Painter)	Vol 7761 Fol 105
07.02.1985 (1985 to 2005)	The Commissioner for Main Roads Now Roads & Traffic Authority of New South Wales	Vol 7761 Fol 105 Now 11/1000689
04.07.2005 (2005 to 2016)	Jeanette Noujaim	11/1000689
11.05.2016 (2016 to Date)	# JR Bankstown Pty Limited	11/1000689

4.2 Aerial Photographs

A review of aerial photographs taken from 1951 to current was carried out. The following is a summary of the observations made from the review;

Year	Description
1951	The site appeared to have been subdivided with some of the current boundaries identifiable and there appeared to have some houses built along Rookwood Road. The Stacey Street extension which connects to Joseph Street and forms the northern and eastern site boundaries was not constructed. The surrounding properties appeared to have been used for residential purposes with house constructed within the properties and no apparent agricultural land use. The Potts Hill reservoir to the north west of the site was constructed.
1970	The weatherboard house (Site Feature A), brick house (Site Feature B) and another weatherboard house (Site Feature G) were constructed on Nos 25 and 27 and the site appeared to be mainly used for residential. The land immediately to the north was vacant and the Stacey Street corridor was formed. Commercial development was evident to the north east. There was a general increase in residential houses on the western side of Joseph Street and south of the site.
1982	There were no significant changes to the site conditions since 1970 and the site was mainly used for residential. The houses immediately to the north of the site was demolished and the land cleared and the Stacey Street corridor was evident. There was a further increase in the density of residential dwellings across the region and the Chullora Business Centre which is situated to the north of the site was fully built up.
2003	Stacey Street was constructed forming the northern and eastern site boundaries and all the current house and structures were clearly evident with the rear portion of the property mainly cleared of trees with patchy bare ground. The site appeared to be mainly used for residential.
2007-2012	There was no significant change in site conditions since 2003. Scattered small trees were evident on the eastern portion of the site and the northern and eastern portion of the site appeared to be used as a storage yard. More items were progressively being stored and by 2012, the majority eastern portion of the site was used as a storage yard.

4.3 NSW EPA Records

A verification certificate obtained from the NSW Land Information System, Central Register of Restrictions for the site states that there are no statutory notices under the provisions of the Unhealthy Building Land Act issued by the NSW Environment Protection Authority. A copy of the certificate is presented in Appendix C.

4.4 Section 149 (2) Certificate

Copies of the Section 149 (2) certificates were obtained from Canterbury Bankstown Council to determine conditions applicable to the site in relation to the Contaminated Land Management Act. Our review of the certificates indicates;

- That the land to which the certificates relates is significantly contaminated land
- That the land to which the certificates relates is subject to a management order
- That the land to which the certificates relates is the subject of an approved voluntary management proposal
- That the land to which the certificates relates is subject to an ongoing maintenance
- That the land to which the certificates relates is the subject of a site audit statement.

Refer to the certificate in Appendix D for details.

5. POTENTIAL FOR CONTAMINATION

5.1 On-Site Source

Previous Agricultural Activities

Historical records and aerial photographs of the site as far back as 1950s indicate the site to have no obvious signs of agricultural activities.

Had parts of the subject site been used for agricultural activities in the past, common chemicals that are used in agricultural activities are Organochlorine Pesticides (OCP), Organophosphorus Pesticides (OPP), herbicides and fungicides. OCP is the most persistent of these chemicals, with residues lasting in the environment up to 20 years, whilst OPP, herbicides and fungicides are less persistent in the environment and therefore not considered significant. Fertilisers used in market gardens can also contain heavy metals which are more persistent in the environment.

Pesticide contamination if present from previous agricultural activities is not considered an issue as OCP is used in the agricultural activities would have biodegraded over the decades since the site was used for residential for at least the past 50 years.

Existing Fill and Surface Asbestos Sheets/Fragments

From the visual inspection of the subject site conducted by an environmental scientist, there did not appear to be any areas of buried fill. Some fill was encountered in BH 1 and 4 consisting of Gravelly Clayey Silt and Clayey Silt with thickness of 500mm and 200mm respectively. Some road base, and brick and tile fragments were encountered in the fill.

As the source of fill is unknown, it is possible for the fill to be contaminated with heavy metals (ie As, Cd, Cu, Cr, Pb, Zn, Hg and Ni), pesticides and chlorinated products (ie OCP, OPP and PCB) and hydrocarbons (TRH, BTEX and PAH). Contamination if exist is likely to be confined to the fill and therefore not considered significant.

Some asbestos fibro fragments were encountered sparsely scattered on the ground surface at the rear of the site (Site Feature K) in the vicinity of BH 4 with a bag of asbestos fibre sheeting dumped at the rear of the site. Therefore , the site is impacted by some surface asbestos fragments and there is a possibility that the upper fill material is impacted by asbestos fragments.

Existing Houses/Garages and Miscellaneous Stored Items

The site has a number of houses and garages (Site Features A, C and G) constructed out of asbestos sheetings and therefore there is a possibility of some surface asbestos fragments present on the ground surface around the existing buildings. It is also possible for old paints on the house to contain lead leading to lead contamination along the perimeter of the house from the weathering.

The rear portion of the site is being used as a storage area for miscellaneous items including old cars, trucks, scrap metals, white goods (eg washing machines, stove, fridges etc), demountable offices, automobile parts and broken TVs. It is possible for leakage or accidental spillage of mechanical fluids and solvents from the above items. Common contaminates associated may include Heavy Metals (eg As, Cd, Cu, Cr, Pb, Ni, Hg and Zn) and hydrocarbon products such as Total Recoverable Hydrocarbons (TRH), Benzene, Toluene, Ethyl Benzene and Xylene (BTEX) and Polycyclic Aromatic Hydrocarbons (PAH).

As the site is underlain by relatively impervious clayey soil, contamination if exist, is likely to be localised and confined to the upper subsurface profiles.

5.2 Off-Site Source

The adjoining properties to the north and south consist of residential properties and a school. In the absence of any visible signs of contaminating activities or manufacturing activities on adjoining properties, we consider the risk of contamination from off-site migration of contaminants into the subject site from runoff is considered low.

Based on the above, we consider the risk of off site migration of contaminants into the subject site from runoff of adjoining sites or groundwater flows is considered low.

6. INVESTIGATION METHODOLOGY

6.1 Fieldwork

Fieldwork for the investigation consisted of drilling four boreholes (BH 1 to BH 4) on the 17th August 2017. The boreholes were drilled using a truck mounted B80 drill rig equipped for site investigation purposes and these boreholes were drilled at accessible locations throughout the site.

The boreholes were initially drilled using spiral augers attached to a V-bit followed by Tungsten Carbide (TC) bit into bedrock to depths of about 2.93m to 4.2m respectively below existing ground surface. BH 4 and 5 were subsequently advanced into shale using NMLC diamond bit coring into the bedrock to obtain bedrock core to depths of about 7.0m to 6.6m below existing ground surface respectively. Borehole No 1 to 3 were drilled to refusal depths of between 3.7m to 4.2m below existing ground surface respectively.

The locations of the boreholes, which were established by off-set measurements from existing site boundaries and features, are indicated on Drawing No 2.

Prior to borehole drilling, underground services were checked using drawings supplied by Dial-Before-You-Dig and an underground services locator equipped with an electromagnetic device was engaged as an extra precautionary measure to avoid damage to underground services.

In order to assess the strength of the subsurface soil, Standard Penetration Testing (SPT) was carried out in the boreholes. Hand penetrometer testing was carried out on the recovered SPT split-tube clayey samples to augment the SPT results.

The strength of the bedrock in the augered boreholes was assessed by examining the bedrock fragments from the drilling and engineering judgement. Cored bedrock samples were carefully boxed on site before returning to our laboratory for testing.

The boreholes were observed for groundwater seepage, during and upon completion of spiral augering. The field test results, together with details of the subsurface profile encountered are presented on the Borehole and Cored Borehole Reports in Appendix A of this report and are accompanied by explanatory notes defining the terms and symbols used in their preparation.

6.2 Laboratory Testing

Geotechnical

The bedrock cored samples were Point Load tested in our laboratory to assess the strength of the bedrock material. The point load test is an in-direct tensile strength test which provides an approximate Unconfined Compressive Strength (UCS) value of the rock core sample based on a semi-empirical formula.

Prior to point load testing, the cored samples were photographed for inclusion in this report.

The Point Load Index test results are summarised on Laboratory Test Reports in Appendix B. Prior to point load testing, the cored samples were photographed for inclusion in this report.

7. RESULTS OF THE INVESTIGATION

7.1 Subsurface Conditions

Reference should be made to the Borehole and Cored Borehole Reports for details of the subsurface profile encountered. A summary of the subsurface profile encountered is as follows:

Topsoil and Topsoil/Fill

Topsoil and topsoil/fill was encountered on the surface in all boreholes except BH 1 and 4 consisting of Clayey Silt of low liquid limit. The thickness of the topsoil was found to range from 200mm to 300mm.

Fill

Fill was encountered on the surface of BH 1 and 4 comprising of Gravelly Clayey Silt and Clayey Silt. Some minor foreign inclusions including road base, and brick and tile fragments were encountered in the fill. The thickness of the fill in BH 1 and 4 was found to be about 500mm and 200mm respectively.

Natural Soil

Underlying the topsoil and fill in all boreholes, natural high plasticity Silty Clay was encountered. In general, the plasticity of the Silty Clay reduces to medium at lower depths with the inclusion of some ironstone bands.

Based on the SPT test results and hand penetrometer test results, the natural clay was generally assessed to be very stiff to hard. The natural clayey soil was found to have moisture content less than plastic limit.

Bedrock

Bedrock consisting of Shale was encountered in all boreholes at depths ranging from 1.4m to 2.1m below existing ground surface. Based on the disturbed samples from drilling, the upper Shale strata was subjectively assessed to be extremely weathered and have very low to low strength.

The cored samples indicate the upper Shale bedrock to be Highly Fractured to Fractured (ie defect spacing ranging from 30mm to 100mm) and low strength with the lower Siltstone bedrock unit improving to Fractured to Slightly Fractured (ie defect spacing ranging from 100mm to 300mm) and medium to high strength.

Groundwater

Groundwater was not encountered in any of the boreholes during the investigation.

7.2 Laboratory Results and Bedrock Assessment

The point load tests generally confirm our field classification of the rock strength. The bedrock quality may be classified to Class I (good quality) to V (poor quality) in accordance with Pells et al - 1996 based on UCS, degree of fracturing and allowable defects.

The following is a summary of the point load results and our assessment of the bedrock quality.

BH	Depth (m)		$I_{s(50)}$ (MPa)		Class	
	Start	End	Min.	Max	Based on Strength	Based on Defects & Strength
1	2.00	3.60	-	-	-	V*
	3.60	4.00	-	-	-	IV*
2	2.00	3.80	-	-	-	V*
	3.80	4.20				IV*
3	1.20	3.00	-	-	-	V*
	3.00	3.70				IV*
4	2.20	3.00	-	-	-	V*
	3.00	5.50	0.16	0.46	III	IV
	5.50	7.00	1.31	2.49	I	III
5	2.00	2.93	-	-	-	V*
	2.93	4.70	0.73	1.04	II-I	IV
	4.70	6.66	0.74	4.75	II-I	III

Note: * Subjective rock class assessment based on auger resistance and visual inspection of disturbed samples

Note that the strength of the bedrock was generally found to be higher than the assigned classification, however due to the fragmented nature of the bedrock encountered in the samples, the classification of the bedrock was downgraded (ie poorer quality).

Refer to the laboratory test reports in Appendix B for estimated Unconfined Compressive Strength (UCS) based on a semi-empirical correlation of 20 times the Point Load Strength Index.

8. COMMENTS AND RECOMMENDATIONS

8.1 Contamination Assessment

This report presents the results of a Phase 1 - Preliminary Contamination Assessment comprising of a site history appraisal and a visual site inspection to provide preliminary comments on potential subsurface soil contamination of the site. The conclusions presented in this report are professional opinions based solely upon visual observations of the site and its vicinity and our interpretation of the documentation made available. The quantitative level and extent of any contamination present could not be determined from this limited scope of work and the assessment has not undertaken any independent validation of the advice provided.

We understand that the proposed development will include the construction of two blocks of four-storey residential apartment buildings with one-level basement. We understand that proposed development will include excavation of up to about 3m for construction of basement and surplus fill will be generated from the excavation.

The Subject Site appeared to have been used primarily for residential purposes in the last 50 years and the site is situated away from industrial properties, service station sites or sites with high level of contaminating activities. The rear portion of the site appeared to be used as a storage yard within the last 10 years and in recent times has been used by an appliances repairer with abundant white goods stored on site at the time of our investigation. The rear of the site (ie No 27c) had some brick and tile stockpiles, a caravan, a bulk bag of asbestos fibro sheets/fragments and building debris scattered sparsely on the ground surface.

Our borehole investigation revealed the site to be generally underlain by natural clays overlying shale bedrock at depths of between 1.4m to 2.1m below existing ground surface. Some minor fill in BH 1 and 4 was encountered consisting of Gravelly Clayey Silt and Clayey Silt with thickness of about 500mm and 200mm respectively. The fill was found to have some minor foreign inclusions including road base, and brick and tile fragments.

Based on the results of this Phase 1 study, we consider the risk of significant soil chemical contamination within the site to be generally low and therefore the site is suitable for the proposed development except for the rear of the site (ie No 27c) where asbestos fibro fragments and building debris were encountered sparsely scattered on the ground surface.

To ensure suitability of the site for the proposed development, all asbestos impacted fill and surface asbestos should be isolated and disposed off site in accordance to Workcover requirements and other regulatory requireemnts.

In addition to the above, the following issues will need to be considered;

- Care should be taken during the demolition stage of development to ensure all asbestos material is removed by licensed contractors and disposed to a NSW EPA approved landfill site as Special Waste 'Asbestos'. Special care should be taken to ensure all fragments of asbestos are removed from site prior to construction.

- Site validation should be carried out on the site particularly in areas where numerous miscellaneous items including old cars, trucks, scrap metals, white goods (eg washing machines, stove, fridges etc), demountable offices, automobile parts and broken TVs were stored. Validation sampling should also be carried out in the garages and sheds to ensure these area are not impacted by contamination. Should contamination exist, site remediation will be required.

- The proposed development will involve basement excavation up to 3m deep over the majority of the site and this will result in surplus fill. All fill to be taken off site should be laboratory tested and characterised in accordance with NSW EPA guidelines (Reference 15). As asbestos impacted fill would be classified as "Special Waste – Asbestos".

As this study was based mainly of a Phase 1 desktop study and only limited boreholes were drilled, there remains the risk of unexpected finds. Should buried rubbish or potential contaminated material be encountered during construction, the material must be appropriately classified before removal. In the event where buried bonded asbestos fragments are encountered on the Subject Site during site excavation and construction, an unexpected asbestos finds protocol as detailed in Appendix E should be initiated.

8.2 Geotechnical Issues

8.2.1 Excavation Conditions and Vibration Issues

We understand that the proposed buildings will have a one-level basement with construction of the basement requiring up to about 3m depth of excavation. Our borehole investigation revealed the site to be generally underlain by natural clay overlying bedrock consisting of shale at depths of about 1.4m to 2.1m below existing ground surface.

Excavation into the upper clayey soil may be carried out using a conventional tracked excavator. The upper 1.0m of the low strength shale may still be carried out using the excavator but equipped with rock teeth attached to the bucket. A rock impact hammer will be necessary to penetrate through some stronger shale bands.

Should the above excavation method be found to be too difficult or slow, the shale may be excavated using a D8 sized bulldozer or equivalent, complimented with hydraulic rock breakers in confined areas. In view of the close proximity of the excavation works to surrounding structures, there is some risk of damage to nearby structures as a result of excavation works.

We recommend that dilapidation reports be carried out on buildings within close proximity to the proposed excavation prior to commencement of excavation works. The excavation works should be carefully monitored to ensure no excessive vibration is generated resulting in damage to neighbouring building and this may involve using geophones and electronic equipment at strategic locations. All excavation works be carried out by an experienced operator who is aware of factors affecting vibration and transmission of vibration such as orientation of hammer, duration of hammering, size of excavation bite and speed of vibration of the hammer.

Though groundwater was not encountered in the boreholes, groundwater seepage may still exist on the site, therefore some provision for dewatering by sump and pump should be allowed for during basement excavation.

8.2.2 Basement Supports

We understand that the proposed basement will be constructed within about 1.5m to 4.5m from the southern boundary, 0.5m to 6m from the northern boundary, within 3m from the eastern boundary and about 6.5m from the western boundary. The site was generally found to be underlain by clay overlying shale bedrock at relatively shallow depths of between 1.4m to 2.1m below existing ground surface.

Shoring may be avoided if the excavations are adequately battered to enable blockwork or Dincel retaining wall construction and the excavation is situated away from the zone of influence of the neighbouring residential dwellings. The zone of influence of excavation may be taken as the area below the 1 Vertical to 1 Horizontal load spread of the existing footings.

For blockwork retaining wall construction, the excavation should be battered to not steeper than 1 Vertical (V) to 1.5 Horizontal (H) for the clayey soil and 1 V to 0.5 H for the shale. Steeper slope batters of 1V to 1 H may be adopted in the clayey soil provided the batter surface is protected by shotcrete and the feasibility of this option may be further assessed by a suitably qualified geotechnical engineer during excavation works.

If shoring is required, a suitable shoring system may consist of closely spaced soldier pile wall system or contiguous pile wall system. For basement excavation within the zone of influence of the adjoining building footings, the shoring system should be designed using a rigid system such as a contiguous pile wall system. Basement excavation away from the zone of influence of adjoining building footings may adopt a less rigid system such as a soldier pile wall system.

Construction of contiguous piles would involve drilling a continuous line of piers along the edge of the basement excavation and these piers should be taken to the full height of the excavation and socketed a minimum of 0.5m below proposed excavation level to provide toe restraints. Construction of soldier pile walls would involve drilling a line of soldier piles at regularly spaced intervals to a minimum depth of 0.5m below excavation level followed by excavation and shotcreting. The shotcrete infill should be reinforced and designed to span laterally between the soldiers and it should cover the full height of the exposed excavation face to minimise the risk of potential problems associated with degradation and weathering of the face.

The basement retaining wall should be designed as a 'non-yielding' wall with permanent restraint provided by the building floor slabs based on typical lateral earth pressure diagram as indicated on Drawing No 3.

Temporary restraints such as anchors or internal bracing may be adopted to support the retaining wall for the short term with permanent restraint provided by the building floor slabs. Alternatively, the shoring walls may be designed as a cantilever wall system with piles taken to sufficient depths into shale to provide passive lateral resistance.

The use of anchors may not be possible due to presence of basements in adjoining buildings If anchors are feasible and required to provide temporary restraints, permission should be obtained from the adjoining property owners and various authorities including Council. Rock anchors should be inclined through the soil profile and into the bedrock. Preliminary design of any anchors should be based on the following criteria;

- Anchors should be taken into minimum Class IV shale. A maximum allowable bond stress between anchor grout zone and Class IV shale of 100kPa may be adopted,
- The bond length of the anchor should be in the range of 3m to 10m.
- All temporary anchors should be proof stressed to at least 1.5 times the design working load before releasing and locking off at the required working load. Sufficient anchor strand should be left protruding from the grips to allow lift off testing of the anchors during the operational life to enable periodic checks to be made on the support system.
- Anchors should be de-stressed once permanent lateral support is provided for the retaining wall.

Permanent subsurface drains should be provided at the back of the retaining wall, or full hydrostatic ground water pressures should be taken into account in the design. Surcharge due to adjacent structures or construction loads should be taken into account in the design.

8.2.3 Foundations

Excavation of the basement up to a depth of about 3.0m below existing ground surface is expected to encounter Shale at the base of the excavation. We recommend the building be supported on footings based on the following;

BH	Depth (m)		Class	Allowable Bearing Capacity (kPa)	Allowable Shaft Adhesion *1 (kPa)
	Start	End			
1	2.00	3.60	V*	700	50
	3.60	4.00	IV*	1000	100
2	2.00	3.80	V*	700	50
	3.80	4.20	IV*	1000	100
3	1.20	3.00	V*	700	50
	3.00	3.70	IV*	1000	100
4	2.20	3.00	V*	700	50
	3.00	5.50	IV	1000	100
	5.50	7.00	III	2500	250
5	2.00	2.93	V*	700	50
	2.93	4.70	IV	1500	150
	4.70	6.66	III	2500	250

Note: * =No allowance for shaft adhesion should be provided for pad footings.

For piles designed using Ultimate values based on "Limit State Design", the Ultimate End Bearing of 2.5 times the above Allowable values may be adopted. The ultimate bearing pressures should be used in conjunction with the appropriate "Geotechnical Strength Reduction Factor" (Øg) and this factor will depend on the amount and quality of geotechnical data, construction supervision/control and pile proof load testing. A "Geotechnical Strength Reduction Factor" of 0.5 may be adopted for both end bearing and shaft adhesion. A lower reduction factor may be adopted subject to additional investigations to more accurately assess the bedrock conditions.

Footings proportioned to the above allowable loads may expect settlement to be within acceptable limits of 1% or less of the width/diameter of footings. All footings should be founded on similar geological stratum to ensure even bearing, otherwise adequate articulation should be provided to accommodate some differential settlements.

8.2.4 Basement Drainage and Floor Slab

Some groundwater seepage into the excavation is likely to occur during and after the construction of the basement. Perimeter drains should be constructed to collect seepage from the cut faces. Provision of a sub floor drainage layer and a permanent sump and pump within the basement floor will also be required.

Slab on ground construction is considered feasible provided the slab has regularly spaced dowelled or keyed movement joints and is underlain by a compacted granular sub-base layer. This sub-base layer could also act as the floor drainage layer.

9. LIMITATIONS

The interpretation and recommendations submitted in this report are based in part upon data obtained from a limited number of boreholes. The nature and extent of variations between test locations may not become evident until construction.

Groundwater conditions are only briefly examined in this investigation and, groundwater conditions may vary seasonally.

In view of the above, the subsurface soil and rock conditions between the test locations may be found to be different or interpreted to be different from those expected. If such differences appear to exist, we recommend that this office be contacted without delay.

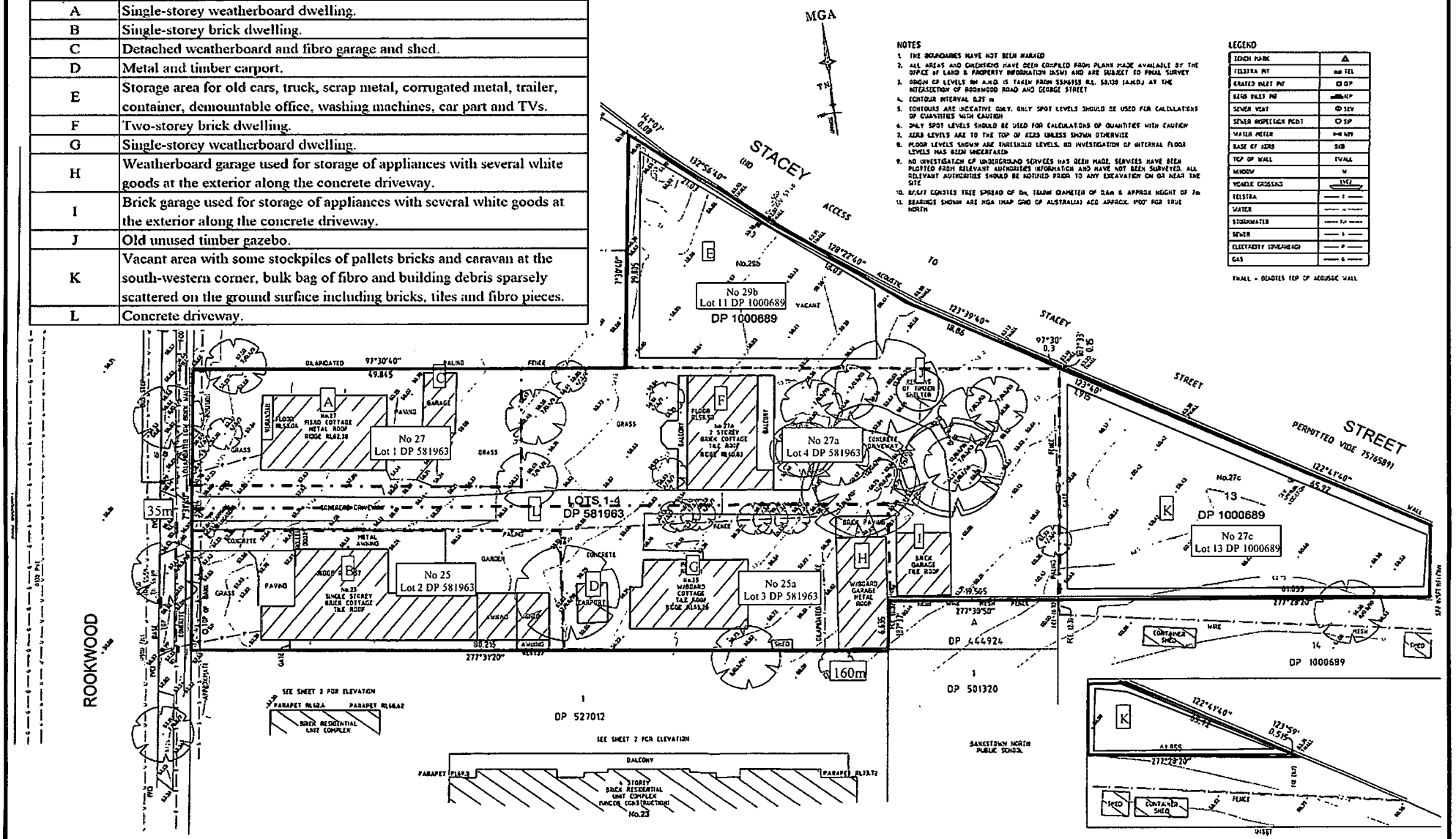
It should be recognised that this assessment is not intended to be a definitive or quantitative investigation of the environmental impacts of the subject property and operations. Opinions and recommendations presented herein apply to the site as it existed at the time of the site inspection and cannot apply to changes of which GeoEnviro Consultancy is not aware and has not had the opportunity to, such as future illegal dumping of rubbish.

Your attention is drawn to the attached "Important Information about Your Environmental Site Assessment" in Appendix E and "Explanatory Notes" in Appendix G. This document should be read in conjunction with our report. The statements presented in this document are intended to advise you of what should be your realistic expectations of this report and to present you with recommendations on how to minimise the risk associated with groundworks for this project. The document is not intended to reduce the level of responsibility accepted by GeoEnviro Consultancy Pty Ltd, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in to doing.

REFERENCE

1. *Pells, PJN, Mostyn, GM. And Walker, BF (1998) Foundation on shale and sandstone in the Sydney Region.*
2. *AS 2159-1995 "Piling – Design and Installation"*
3. *Australian Standard, AS 3600 -2009 "Concrete Structures"*
4. *1:100,000 Soil Landscape Map of Sydney – Soil Conservation Service of NSW; Sheet 9029-9129*
5. *1:100,000 Geological Map of Sydney– Geological Series Sheet 9029-9129 (Edition 1) 1985*
6. *Australian & New Zealand Guidelines for the Assessment and Management of Contaminated Sites, Australian and New Zealand Conservation Council and National Health and Medical Research Council, 1992.*
7. *Assessment of Orchard and Market Garden Contamination - Contaminated Sites Discussion Paper, NSW EPA 1999.*
8. *Health Based Soil Investigation Levels, National Environmental Health Forum Monographs Soil Series No. 1 – 1996*
9. *National Environment Protection (Assessment of Site Contamination) Measure 1999 (including updated Schedule B1 – 2013)*
10. *Guidelines for Assessment Service Station Sites – NSW EPA 1994*
11. *Guidelines for the NSW Auditor Scheme, NSW EPA*
12. *Department of Land and Water Conservation – "Site Investigation for Urban Salinity".2002*
13. *Salinity Code of Practice – Western Sydney Regional Organisation of Councils Ltd – 2002*
14. *What do all the numbers mean? A guide for the interpretation of soil test results. – Department of Conservation and Land Management, 1992*
15. *Part 1 – Classifying Waste – 2014, NSW EPA*
16. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 – ANZECC.*

Site Feature	Description
A	Single-storey weatherboard dwelling.
B	Single-storey brick dwelling.
C	Detached weatherboard and fibro garage and shed.
D	Metal and timber carport.
E	Storage area for old cars, truck, scrap metal, corrugated metal, trailer, container, demountable office, washing machines, car part and TVs.
F	Two-storey brick dwelling.
G	Single-storey weatherboard dwelling.
H	Weatherboard garage used for storage of appliances with several white goods at the exterior along the concrete driveway.
I	Brick garage used for storage of appliances with several white goods at the exterior along the concrete driveway.
J	Old unused timber gazebo.
K	Vacant area with some stockpiles of pallets bricks and caravan at the south-western corner, bulk bag of fibro and building debris sparsely scattered on the ground surface including bricks, tiles and fibro pieces.
L	Concrete driveway.



Legend

A — Site Feature

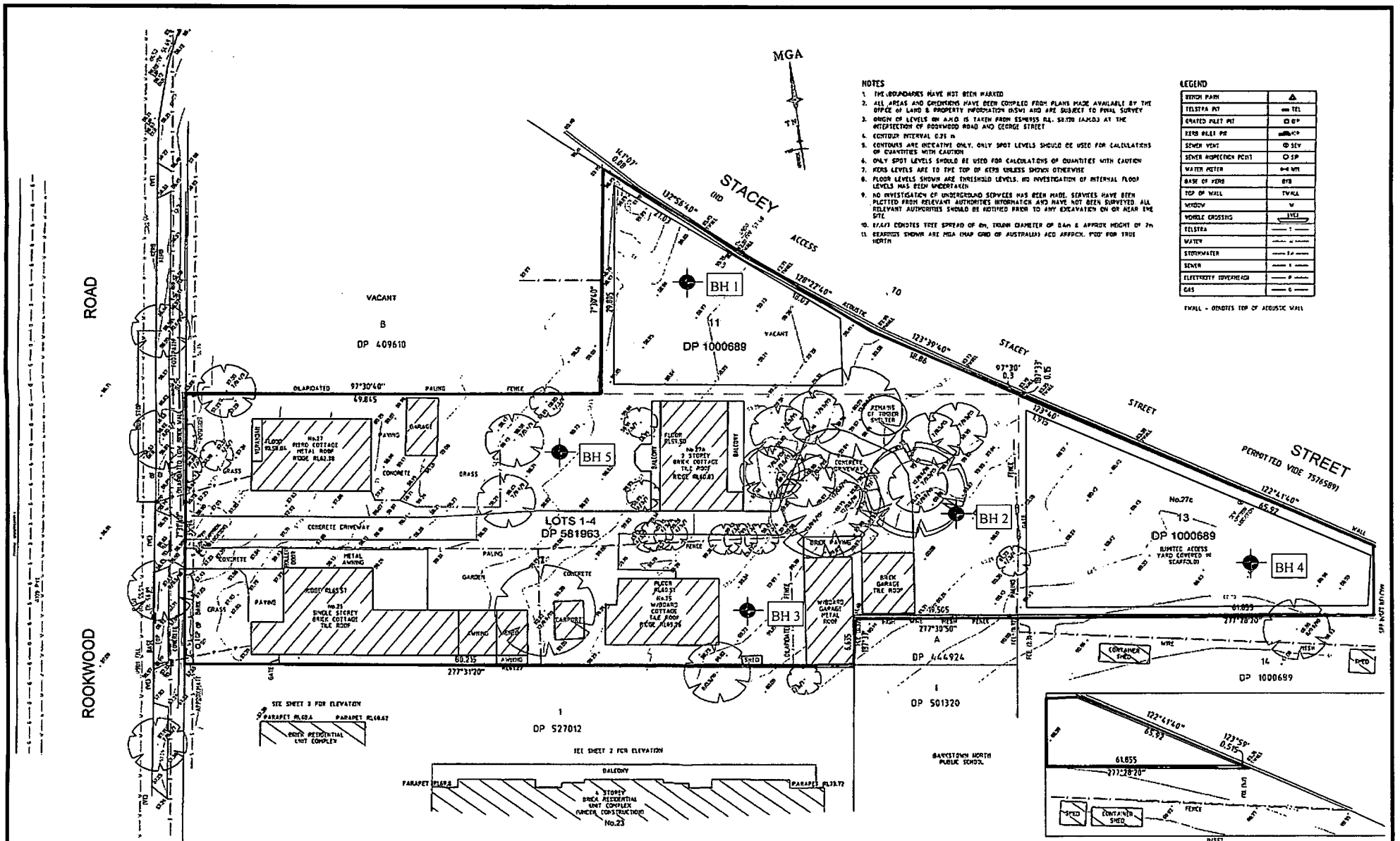
Subject Site

GeoEnviro Consultancy

Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia

Tel: (02) 96798733 Fax: (02) 96798744

Drawn By: AT	Date: 28/8/17	Zhinar Architects	
Checked By: SL	Date: 28/8/17	25-29 Rookwood Road Yagoona	
Revision By:	Date:	Site Features Plan	
Scale: Not to Scale	A3	Project No: JC17306A	Drawing No: 1

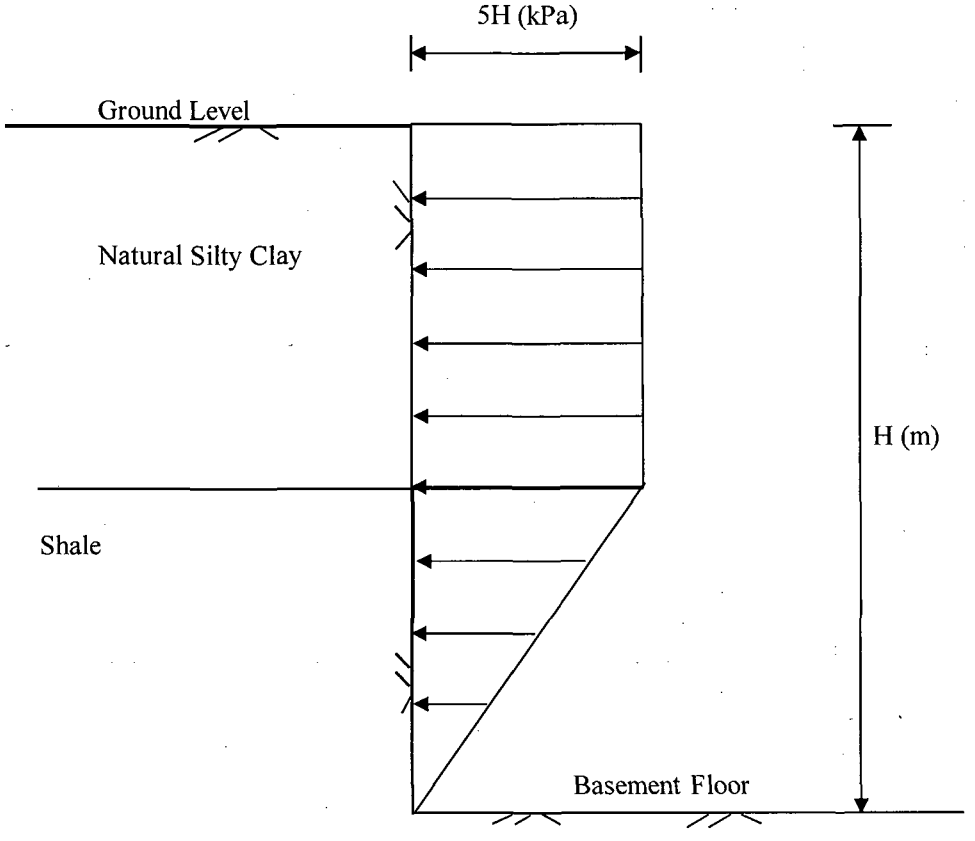


Legend

- Borehole
- Subject Site

GeoEnviro Consultancy
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Drawn By: AT	Date: 28/8/17	Zhinar Architects	
Checked By: SL	Date: 28/8/17	25-29 Rookwood Road Yagoona	
Revision By:	Date:	Borehole Location Plan	
Scale: Not to Scale	A3	Project No: JC17306A	Drawing No: 2



Note: **1) This diagram should be interpreted in conjunction with the text of our report referenced JC17306A-r1**

2) Additional surcharge loads from adjacent structures should be considered

GeoEnviro Consultancy Pty Ltd	Drawn: AT	Date: 5/9/17	**Zhinar Architects**
	Checked By: SL	Date: 5/9/17	**25-29 Rookwood Rd Yagoona**
	Revision		**Typical Lateral Earth Pressure Diagram**
	Scale: Proportional	A4	Job No : JC17306A-r1 / Drawing No : 3

APPENDIX A
Borehole and Cored Borehole Reports

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Borehole Report

Borehole no: 1

Client: Zhinar Architects

Job no: JC17306A

Project: Proposed Residential Apartment Building

Date: 17/8/17

Location: 25-29 Rookwood Road Yagoona

Logged by: AT

Drill Model and Mounting: B80 Slope: 90 deg R.L. Surface:

Hole Diameter: 100mm Bearing: - Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
V - BIT	NIL	DRY					Fill: Gravelly Clayey Silt: low liquid limit, brown grey with some road base	D			
				1.0		CH	Silty Clay: high plasticity, light brown mottled red	<PL	VSt		
			3,4,7 N=11			CI	Silty Clay: medium plasticity, grey brown with some ironstaining and ironstone bands		- H	380 420	V bit refusal at 1.8m
TC				2.0			Shale: grey brown, very low to low strength, extremely weathered				
				3.0			As above but low strength, grey				TC bit refusal at 4.0m
				4.0			End of BH 1 at 4.0m				
				5.0							
				6.0							
				7.0							
				8.0							

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Borehole Report

Borehole no: 2

Client: Zhinar Architects
Job no: JC17306A

Project: Proposed Residential Apartment Building
Date: 17/8/17

Location: 25-29 Rookwood Road Yagoona
Logged by: AT

Drill Model and Mounting: B80 | Slope: 90 deg | R.L. Surface:

Hole Diameter: 100mm | Bearing: - | Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
V - B I T	N I L	D R Y					Topsoil: Clayey Silt: low liquid limit, brown	D		-	-
						CH	Silty Clay: high plasticity, red brown	<PL			
			4,8,17 N-25	1.0		CI	Silty Clay: medium plasticity, grey mottled red with some ironstone bands		H	510 >600	
				2.0							V bit refusal at 1.9m
T C							Shale: grey brown, very low to low strength, extremely weathered				
				3.0							
				4.0			As above but low strength, grey				TC bit refusal at 4.2m
							End of BH 2 at 4.2m				
				5.0							
				6.0							
				7.0							
				8.0							

GeoEnviro Consultancy Pty Ltd
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Borehole Report

Borehole no: 3

Client: Zhinar Architects

Job no: JC17306A

Project: Proposed Residential Apartment Building

Date: 17/8/17

Location: 25-29 Rookwood Road Yagoona

Logged by: AT

Drill Model and Mounting: B80 | Slope: 90 deg | R.L. Surface:

Hole Diameter: 100mm | Bearing: - | Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description (Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component)	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
V - BIT	NIL	DRY					Topsoil: Clayey Silt: low liquid limit, brown	D			
						CH	Silty Clay: high plasticity, red brown	<PL			
				1.0		CI	Silty Clay: medium plasticity, grey brown mottled red with ironstaining and ironstone bands		H	>600	SPT bouncing at 1.27m
			6,12 /120mm N>12				Shale: grey brown, very low to low strength, extremely weathered				V bit refusal at 1.4m
TC				2.0							
				3.0			As above but low strength, grey				TC bit refusal at 3.7m
				4.0			End of BH 3 at 3.7m				
				5.0							
				6.0							
				7.0							
				8.0							

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
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Borehole Report

Borehole no: 4

Client: Zhinar Architects

Job no: JC17306A

Project: Proposed Residential Apartment Building

Date: 17/8/17

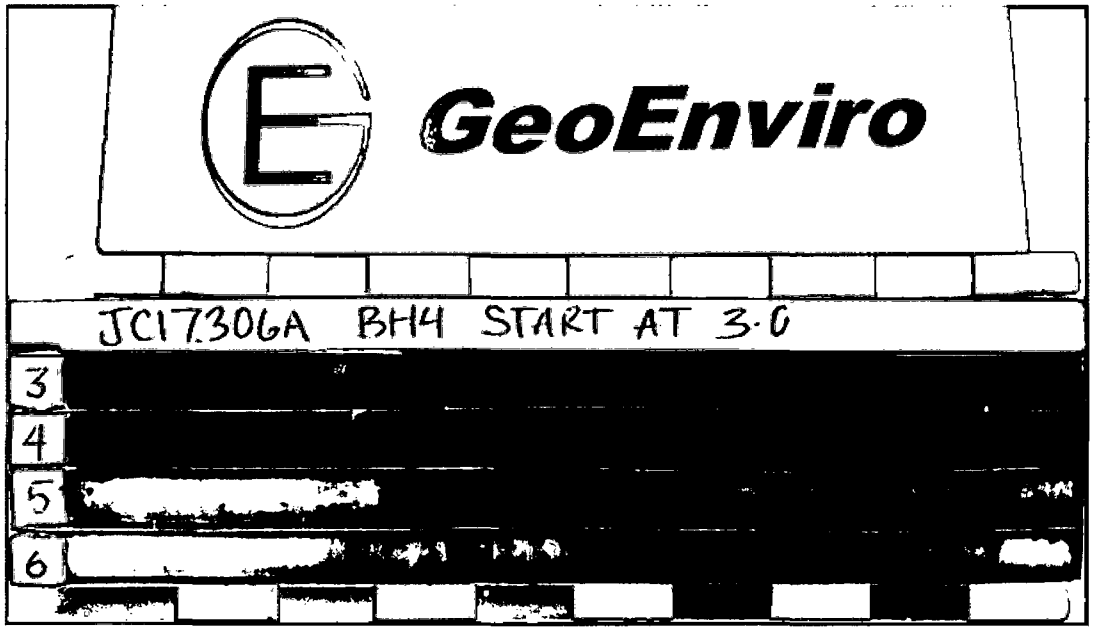
Location: 25-29 Rookwood Road Yagoona

Logged by: AT

Drill Model and Mounting: B80 | Slope: 90 deg | R.L. Surface:

Hole Diameter: 100mm | Bearing: - | Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
V - BIT	NIL	DRY					Fill: Clayey Silt: low liquid limit, brown with gravel, brick and tile pieces	D			
						CH	Silty Clay: high plasticity, red brown	<PL			
						CI	Silty Clay: medium plasticity, grey brown with ironstaining and ironstone bands				
			2,11,16 N=27	1.0					(H)	>600 >600	
				2.0							V bit refusal at 2.1m
TC							Shale: grey brown, very low to low strength, extremely weathered				
				3.0							
							Refer to Cored BH 4 below 3.0m				
				4.0							
				5.0							
				6.0							
				7.0							
				8.0							



Photograph 1: Cored Borehole No 4

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Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Cored Borehole Report

Borehole no: 4

Client: Zhinar Architects
Job no: JC17306A

Project: Proposed Residential Apartment Building
Date: 17/8/17

Location: 25-29 Rookwood Road Yagoona
Logged by: AT

Drill Model and Mounting: B80 Slope: R.L Surface:
Hole Diameter: 100mm Bearing: Datum:

Method	Support	Barrel Lift	Water Loss/ Level	Depth(m)	Graphic Log	Core Description Rock type, grain characteristics, colour, structure, minor components. Start Coring BH 4 at 3.0m	Weathering	Strength	Point Load Index Strength Is(50) VL M VH EL L H EH	Defect Details: Defect Spacing (mm) 300 50 10 500 100 30	Defect Details: Description type, inclination, thickness, planarity, roughness, coating
NMLC	NIL		RETURN FULL	4 5		Shale: grey brown with ironstaining	EW -DW	L	X		XWS: 15mm.t XWS: 25mm.t Joint: 45° XWS: 15mm.t Cr: 90mm.t XWS: 50mm.t CS: 300mm.t
								M	X		
				6 7		Siltstone: grey	DW	H	X X X X		
				8 9 10 11		End of BH 4 at 7.0m					All defects not described are either bedding partings or extremely weathered seams.

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
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Borehole Report

Borehole no: 5

Client: Zhinar Architects
Job no: JC17306A

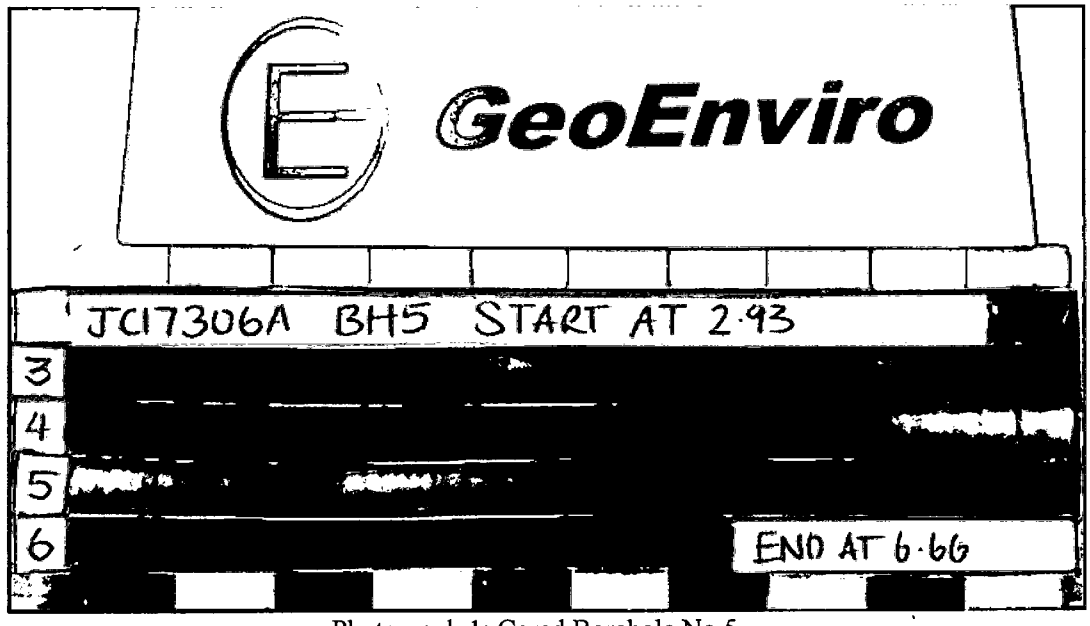
Project: Proposed Residential Apartment Building
Date: 17/8/17

Location: 25-29 Rookwood Road Yagoona
Logged by: AT

Drill Model and Mounting: B80 Slope: R.L. Surface:

Hole Diameter: 100mm Bearing: Datum:

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
V	NIL	DRY					Topsoil/Fill: Clayey Silt: low liquid limit, brown with some sand	D			
						CH	Silty Clay: high plasticity, red brown	<PL			
			4,8,14 N=22	1.0		CI	Silty Clay: medium plasticity, grey mottle red with ironstone bands		H	>600	
				2.0							V bit refusal at 2.0m
TC							Shale: grey brown, low strength, extremely weathered				
				3.0			Refer to Cored BH 5 below 2.93m				
				4.0							
				5.0							
				6.0							
				7.0							
				8.0							



Photograph 1: Cored Borehole No 5

GeoEnviro Consultancy Pty Ltd
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Tel: (02) 96798733 Fax: (02) 96798744

Cored Borehole Report

Borehole no: 5

Client: Zhinar Architects
Job no: JC17306A
Project: Proposed Residential Apartment Building
Date: 17/8/17
Location: 25-29 Rookwood Road Yagoona
Logged by: AT

Drill Model and Mounting: B80 Slope: R.L Surface:
Hole Diameter: 100mm Bearing: Datum:

Method	Support	Barrel Lift	Water Loss/ Level	Depth(m)	Graphic Log	Core Description Rock type, grain characteristics, colour, structure, minor components.	Weathering	Strength	Point Load Index Strength Is(50) VL L M H VH EH EL 500 100 30	Defect Details Defect Spacing (mm) 300 50 10	Description type, inclination, thickness, planarity, roughness, coating
				3		Start Coring BH 5 at 2.93m					
NMLC	NIL		RETURN FULL	4		Shale: grey brown with ironstaining	EW	L	X		XWS: 15mm.t CS: 50mm.t CS: 10mm.t
				5		Siltstone: grey with some ironstaining	EW - DW	M	X X		
				6		As above but grey	DW	H - VH	X X		Be: 2mm.t Be: 2mm.t
				7				M - H	X X		
				8		End of BH 5 at 6.66m					All defects not described are either bedding partings or extremely weathered seams.
				9							
				10							

APPENDIX B
Laboratory Test Reports - Geotechnical

GeoEnviro Consultancy Pty Ltd
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Test Results

Client; Zhinar Architects — Job Number: JC17306A
Project: Proposed Residential Apartment Building — Date: 29/8/17
Location: 25-29 Rookwood Road Yagoona — Report No: R01A

Test Method : RTA T223

BH 4 Depth (m)	$I_{S(50)}$ Mpa	ESTIMATED (U.C.S) Mpa
3.50-3.55	0.16	3.1
5.40-5.45	0.46	9.1
5.80-5.86	1.31	26.1
6.20-6.26	1.57	31.4
6.50-6.55	1.40	28.0
6.90-6.95	2.49	49.9

BH 5 Depth (m)	$I_{S(50)}$ Mpa	ESTIMATED (U.C.S) Mpa
3.80-3.84	1.04	20.75
4.10-4.15	0.73	14.62
4.50-4.55	0.80	15.97
4.90-4.95	2.22	44.31
5.30-5.35	4.75	94.98
5.70-5.76	0.74	14.90
6.20-6.25	1.32	26.48
6.50-6.55	1.33	26.54

Notes:

1. In the above table testing was completed in the Axial direction
2. The Estimated Unconfined Compressive Strength (Estimated U.C.S) was calculated from the point load strength Index by the following approximate relationship and rounded off to the nearest number:

   $U.C.S = 20\ I_{S(50)}$

APPENDIX C
NSW DEC and Groundwater Bore Searches