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WARRIMAC PTY LTD

Geotechnical Investigation

16 Macpherson Street, Warriewood NSW

E25541.G03
25 November 2022

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Revision	Details	Date	Amended By
	Original	25 November 2022	

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1. Introduction

1.1 Background

At the request of Mr. Will Allen of Warrimac Pty Ltd (the Client), EI Australia (EI) has carried out a Geotechnical Investigation (GI) for the proposed development at 16 Macpherson Street, Warriewood NSW (the Site).

This GI report has been prepared to provide advice and recommendations to assist in the preparation of designs for the proposed development. The investigation has been carried out in accordance with the agreed scope of works outlined in EI's proposal referenced P20194.3, dated 23 June 2022, and with the Client's signed authorisation to proceed, dated 29 July 2022.

1.2 Proposed Development

The following documents, supplied by the Client, were used to assist with the preparation of this GI report:

- Draft Subdivision Plan prepared by Bureau SRH – Sheet SK002, Revision 01, 22 December 2021.
- Site survey plan prepared by LTS Lockley Surveyors – Referenced 51644 001DT, Sheets 1 to 6 of 6, dated 8 February 2022. The datum in the survey plan is in Australian Height Datum (AHD), hence all Reduced Levels (RL) mentioned in this report are henceforth in AHD.

Based on email correspondence with the client, EI understands that the proposed development involves the demolition of the existing site structures and the construction of 29 townhouses including internal roads. Townhouses are likely to be two-storey dwellings with no proposed basement. It is noted that the site level likely needs to be filled about 1 to 2m due to flood requirements.

1.3 Objectives

The objective of the GI was to assess site surface and subsurface conditions at nine borehole and five test pit locations, and to provide geotechnical advice and recommendations addressing the following:

- Earthworks;
- Groundwater considerations;
- Excavation support requirements, including geotechnical design parameters for retaining walls and shoring systems;
- Building foundation options, including;
  - Engineering design parameters.
  - Earthquake loading factor in accordance with AS1170.4:2007.
- The requirement for additional geotechnical works.

1.4 Scope of Works

The scope of works for the GI included:

- Preparation of a Work Health and Safety Plan;
- Review of relevant geological maps for the project area;
- Site walkover inspection by a Geotechnical Engineer to assess topographical features and site conditions;
- Scanning of proposed borehole locations for buried conductive services using a licensed service locator with reference to Dial Before You Dig (DBYD) plans;
- Auger drilling of nine boreholes (BH1M, BH2, BH3M, BH4, BH5, BH6, BH7, BH8M and BH9) by a track-mounted drill rig using solid flight augers equipped with a 'Tungsten-Carbide' (T-C) bit. An additional five test pits (TP1, TP2, TP3, TP4 and TP5) were conducted by the tracked drill rig using a large diameter solid flight auger. The boreholes and test pits were auger drilled to depths as shown in **Table1-1** below:

Table 1-1 Augering and Rock Coring Depths

Borehole ID	Augering	
	Depth (m)	RL (m AHD)
BH1M	6.00	-1.00
BH2	6.00	-1.20
BH3	6.00	-1.60
BH4	6.45	-1.55
BH5	6.45	-1.55
BH6	6.45	-1.05
BH7	6.45	-1.55
BH8M	6.45	-1.64
BH9	6.45	-1.55
TP1	1.20	3.80
TP2	1.20	3.30
TP3	1.00	3.90
TP4	1.50	3.20
TP5	1.00	3.70

- Standard Penetration Testing (SPT) was carried out (as per AS 1289.6.3.1-2004), where possible, during auger drilling of the boreholes to assess soil strength/relative densities.
- Measurements of groundwater seepage/levels, where possible, in the augered sections of the boreholes during and shortly after completion of auger drilling;

    - The approximate surface levels shown on the borehole logs were interpolated from spot levels shown on the supplied survey plan. Approximate borehole locations are shown on **Figure 2**;

- Three Dynamic Cone Penetrometer (DCP) tests were carried out adjacent to test pit TP1, TP3 and TP4 and were carried out to depths of 1.2m (RL 3.8m), 1.0m (RL 3.9m) and 1.5m BEGL (RL 3.2m), respectively;
- Borehole BH1M and BH8M were converted into groundwater monitoring wells with a depth of 5.1m BEGL (RL -0.1m) and 5.9m (RL -1.1m) respectively, to allow for long-term groundwater monitoring.
- Boreholes BH2, BH3, BH4, BH5, BH6 and BH7 and test pits TP1, TP2, TP3, TP4 and TP5 were backfilled with drilling spoils to surface upon completion;
- Soil samples were sent to STS Geotechnics Pty Ltd (STS) and SGS Australia (SGS), which are National Australian Testing Authority (NATA) accredited laboratories, for testing and storage.
- Preparation of this GI report.

EI's Geotechnical Engineer was present full-time onsite to set out the borehole locations, direct the testing and sampling, log the subsurface conditions and record groundwater levels.

1.5 Constraints

The GI was limited by the intent of the investigation. The discussions and advice presented in this report are intended to assist in the preparation of initial designs for the proposed development. Further geotechnical inspections should be carried out during construction to confirm the geotechnical and groundwater models, and the design parameters provided in this report.

2. Site Description

2.1 Site Description and Identification

The site identification details and associated information are presented in **Table 2-1** below while the site locality is shown on **Figure 1.** An aerial photograph of the site is presented in **Plate 1** below.

Table 2-1 Summary of Site Information

Information	Detail
Street Address	16 Macpherson Street, Warriewood NSW
Lot and Deposited Plan (DP) Identification	Lot 4 in DP 553816
Brief Site Description	At the time of our investigation, the site was occupied by a single storey brick dwelling to the south west and a demountable site shed with plastic greenhouse structures to the north east which has been used for a commercial nursery business. The remainder of the property has exposed dirt and many large trees, which are predominately located along boundary with Brands Lane.
Site Area	The site area is approximately 1.012ha (based on the provided survey plan referenced above).

Plate 1: Aerial photograph of the site (source: SIXMaps, accessed 7/9/22)

2.2 Local Land Use

The site is situated within an area of residential use. Current uses on surrounding land at the time of our presence on site are described in **Table 2-2** below. For the sake of this report, the site boundary adjacent to Macpherson Street shall be adopted as the Southern site boundary.

Table 2-2 Summary of Local Land Use

Direction Relative to Site	Land Use Description
North	Narrabeen Creek flows from Kuringgai National Park to Narrabeen Lagoon, forming an integral part of the reclaimed and regenerated Warriewood wetlands. Narrabeen creek flows through the middle of Warriewood valley and Mullet creek at its southern edge. The creek in this location is densely vegetated with trees.
East	Brands Lane a two lane asphalt road which becomes a single lane unpaved (dirt) roadway as you travel to the north. Beyond Brads Lane is two-storey residential apartment building, with at least one basement level.
South	Macpherson Street a two lane asphalt road with parking bays on either side of the road. Beyond Macpherson Street is a two-storey residential townhouse with surface parking at the southern end of the property.
West	49 to 79 Chambers Circuit, comprising of a series of two-storey rendered townhouse dwellings. The main structures are off set approximately 3.2 to 3.7m from the site boundary.

2.3 Regional Setting

The site topography and geological information for the locality is summarised in **Table 2-3** below**.**

Table 2-3 Topographic and Geological Information

Attribute	Description
Topography	The site is located on the high north side of the Macpherson Street within gently (0° to 5°) east dipping topography with site levels varying from R.L. 5.59m at the north west site corner to R.L. 4.36m at the north eastern site corner.
Regional Geology	Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Sydney 1:100,000 Geological Series Sheet 9130 (DMR 1983) indicates the site to be underlain by silty to peaty quartz sand, silt and clay with ferruginous and humic cementation in places and common shell layers. This is underlain by Newport formation, which consists of interbedded laminate, shale, and quartz to lithic quartz sandstone.

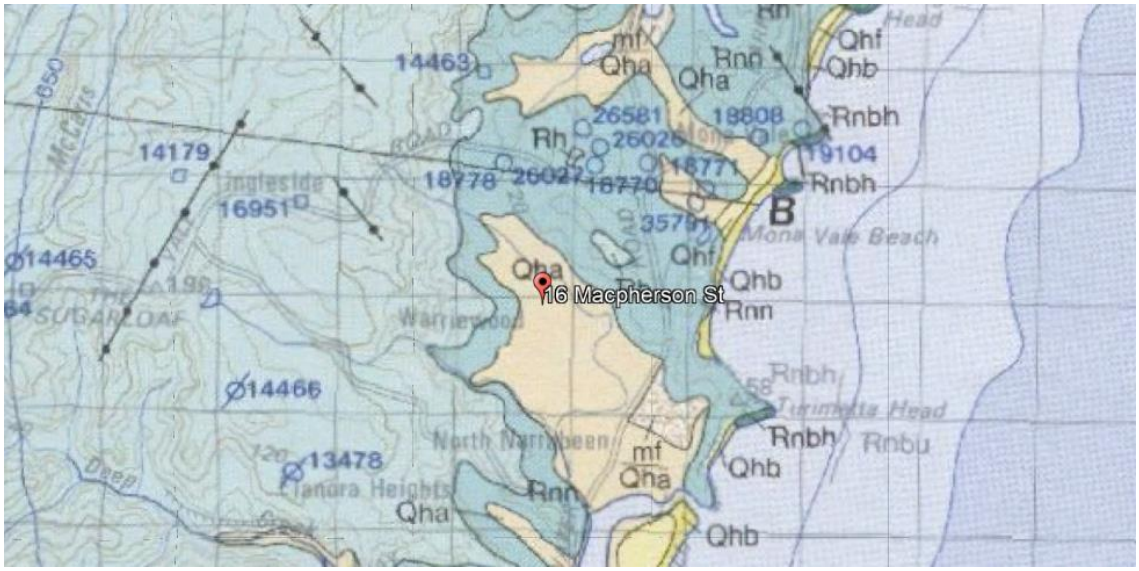

Plate 2: Excerpt of geological map showing location of site.

3. Investigation Results

3.1 Stratigraphy

For the development of a site-specific geotechnical model, the stratigraphy observed in the GI has been grouped into two geotechnical units. A summary of the subsurface conditions across the site, interpreted from the assessment results, is presented in **Table 3-1** below. More detailed descriptions of subsurface conditions at each borehole location are available on the borehole logs presented in **Appendix A**. The details of the methods of soil and rock classifications, explanatory notes and abbreviations adopted on the borehole logs are also presented in **Appendix A.**

Table 3-1 Summary of Subsurface Conditions

Unit	Material[2]	Depth to Top of Unit (m BEGL)[1]	RL of Top of Unit (m AHD)[1]	Observed Thickness (m)	Comments
1	Topsoil / Fill	0.00	4.4 to 5.4	0.2 to 0.8	A concrete pavement of 100mm was encountered within borehole BH6 only. Fill varied in nature in all locations with material varying from gravelly sandy clay and sandy clay to silty sand. No SPT tests were conducted within the fill. DCP's conducted adjacent to the test pits recovered DCP blows counts between 0 and 4. The fill is assessed to be poorly compacted and uncontrolled.
2a	Very soft to firm/ very loose to loose Alluvial Soil	0.2 to 0.8	3.8 to 5.1	2.5 to 3.9 [3]	Very soft to firm, medium to high plasticity sandy/silty clay and very loose to loose clayey sand. SPT N ranging from 0 to 8. Observed in BH1M, BH2, and BH3 up to termination depth (6.0m BEGL), and in the upper 3.0m to 4.5m BEGL in BH4 to BH9.
2b	Stiff to Very Stiff/ Medium Dense Alluvial Soil	3 to 4.5	0.3 to 2.4	- [4]	Stiff to very stiff silty/sandy clay and medium dense clayey sand. SPT N ranging from 8 to 25. Unit 2b was not observed in BH1M, BH2, and BH3. We note that no bedrock was observed up to termination depth of 6.45m BEGL.

Note 1 Approximate depth and level at the time of our assessment. Depths and levels may vary across the site.
Note 2 For more detailed descriptions of the subsurface conditions, reference should be made to the borehole logs attached to **Appendix A.**
Note 3 Observed up to termination depth in BH1M, BH2, and BH3.
Note 4 Observed up to termination depth in BH4 to BH9.

3.2 Groundwater Observations

Groundwater seepage was observed during auger drilling of all boreholes and test pits TP1, TP2 and TP3. Following their completion, groundwater monitoring wells were installed in BH1M and BH8M. The groundwater levels were then measured within investigation locations as per **Table 3-2** below:

Table 3-2 Groundwater Levels

Borehole ID	Measurement Date	Depth to Groundwater Seepage (m BEGL)	Groundwater Seepage RL (m AHD)
BH1M	19/8/22	1.20	3.80
BH2	19/8/22	0.70	4.10
BH3	19/8/22	0.70	3.70
BH4	19/8/22	1.50	3.40
BH5	19/8/22	0.90	4.00
BH6	19/8/22	0.90	4.50
BH7	19/8/22	0.90	4.00
BH8M	19/8/22	0.90	3.90
BH9	19/8/22	2.20	2.70
TP1	19/8/22	1.10	3.90
TP2	19/8/22	0.70	3.80

3.3 Test Results

Nine soil samples were selected for laboratory testing to assess the following:

- Atterberg Limits and Linear Shrinkage
- Soil aggressivity (pH, chloride and sulfate content and electrical conductivity).

A summary of the soil test results is provided in **Table 3-3** below. Laboratory test certificates are presented in **Appendix B**.

Table 3-3 Summary of Soil Laboratory Test Results

Test/ Sample ID		BH2_1.5-1.95	BH4_3.0-3.45	BH6_4.7-4.95	BH8M_6.0-6.45	BH3_3.0-3.45	BH5_0.5-0.95	BH7_4.5-4.95	BH9_6.0-6.45	BH1M_1.5-1.95
Unit		2	2	2	2	2	2	2	2	2
Material Description [1]		Silty Clay	Sandy Clay	Silty Clay	Silty Clay	Silty Clay	Clayey Sand	Sandy Clay	Silty Clay	Sandy Clay
Aggressivity	Chloride Cl (ppm)	-	-	-	-	39	7.5	4.4	9.9	14
	Sulfate SO_4 (ppm)	-	-	-	-	84	39	39	43	11
	pH	-	-	-	-	4.9	5.8	4.6	5.1	4.6
	Electrical Conductivity (µS/cm)	-	-	-	-	81	31	29	35	28
	Moisture Content (%)	-	-	-	-	49.7	14.3	12.9	16.8	28.2
Attergerg Limits	Liquid Limit (%)	77	32	60	34	-	-	-	-	-
	Plastic Limit (%)	37	18	22	17	-	-	-	-	-
	Plasticity Index (%)	40	14	38	17	-	-	-	-	-
	Linear Shrinkage (%)	N/A	9	17	9	-	-	-	-	-

Note 1 More detailed descriptions of the subsurface conditions at each borehole location are available on the borehole logs presented in **Appendix A**.

The Atterberg Limits result on the selected clay sample indicated clays to be of low to high plasticity and of low to high shrink-swell potential.

The assessment indicated low permeability soil was present below the groundwater table. In accordance with Tables 6.4.2(C) and 6.5.2(C) of AS 2159:2009 'Piling – Design and Installation', the results of the pH, chloride and sulfate content and electrical conductivity of the soil provided the following exposure classifications:

- 'Moderate' for buried concrete structural elements; and
- 'Mild' for buried steel structural elements.

4. Recommendations

4.1 Geotechnical Issues

Based on the results of the assessment, we consider the following to be the main geotechnical issues for the proposed development:

- Presence of very soft to firm clays and very loose to loose sands;
- Presence of shallow groundwater;
- Designing for flood levels; and
- Foundation design for building loads.

4.2 Existing Fill

Based on the investigation results, the site is covered by a layer of fill between 0.5m and 1.0m deep. Based on DCP and SPT tests within the fill, it appears that it has generally been poorly compacted. However, the DCP and SPT tests do not give a precise determination of in-situ densities, since they are affected by friction during driving, the presence of gravel, and the changes in moisture content. Based on available information, the fill on site is not considered to be 'controlled fill'. AS2870 defines 'controlled' fill as material that has been placed and compacted in layers by compaction equipment within a defined moisture range, to a defined density requirement, and placed in accordance with AS3798.

4.3 Subgrade Preparation and Engineered Fill

4.3.1 Subgrade Preparation

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

- Fill should be fully excavated down to surface of the alluvial soils (above the water table), and stockpiled separately since these materials are not suitable for re-use as engineered fill. Such excavation may need to be carried out with the excavation sides battered at an angle of no steeper than 1 Vertical to 1 Horizontal. The new fill must be 'keyed-in' the sides of these batters.
- An initial rock layer would then be placed and worked/rolled with suitably sized equipment to densify the sand below and achieve a stable initial working platform under proof rolling, for placement and efficient compaction of the remaining fill.
- The first placed layer should comprise a layer of coarse durable rock material ranging up to small boulder sizes, say 300mm maximum dimension, whereby the granular interlocking of the larger rock particles will carry the fill weight above and transfer the applied surcharge pressures to the sand below by direct contact. The rock layer will be at least 300mm thick.
- The footprint of the rock layer/working platform should be extended beyond the nominal limits of the building platforms so that a reasonably uniform footing surface can be prepared for support of the retaining walls around the edges of the building platform fill.
- The remaining fill can be of a general nature but should be specified as at least "select fill" quality, for normal earthworks. Such materials would normally be low plasticity clayey sands, excavated shale or sandstone, run of crusher material from a rock quarry, ridge gravel and other commercial sources. Council documents may provide guidance for material suitability as select fill.

- To facilitate placement of the upper fill materials, the rock layer/working platform should be "blinded" by spreading rock fines and compacting into the voids to create a tight surface to receive the select fill.
- The select fill material should be suitably graded with a maximum particle size of 75mm, and capable of being compacted in thin layers with light compactor equipment or track rolling, or a combination. Efficient placement during the fill process will require control of the fill moisture content by drying or wetting to as close to optimum (OMC) as is practicable.
- Supervision and compaction control testing of the filling will need to be carried out by a NATA registered geotechnical materials laboratory, using suitably trained and experienced geotechnicians, for verification of compliance with the engineering specification, to achieve at least 95% standard compaction for the fill which support of residential lots, and 98% standard compaction for the fill supporting pavements.

If suspended floor slabs and pavement are designed, then it would be unnecessary to complete any particular subgrade preparation other than stripping of root affected soils from the footprint of the proposed building structures and replaced with surface levelling compacted fill for the floor slab formwork.

It should be noted, due to site being located within a flood plain, lime stabilisation of subgrade and fill materials is unsuitable due to the leaching of the lime and subsequent softening of subgrade and fill materials with time.

4.3.2 Engineered Fill Specifications

Any fill used to backfill unstable subgrade areas, raise surface levels or backfill service trenches should be engineered fill. Materials preferred for use as engineered fill are well-graded granular materials, such as ripped or crushed sandstone, free of deleterious substances and having a maximum particle size not exceeding 75 mm. Such fill should be compacted in layers not greater than 200 mm loose thickness, to a minimum density of 95% to 98% of SMDD, depending on its application. Efficient placement during the fill process will require control of the fill moisture content by drying or wetting to as close to optimum (OMC) as is practicable.

The existing low plasticity clayey soils excavated may be reused as engineered fill, provided unsuitable ('over wet' and 'over sized') material and any deleterious material is removed.

Density tests should be regularly carried out on the fill to confirm the above specifications are achieved. The frequency of density testing should be at least one test per layer per material type per 2500 m^2 or 1 test per 500m^3 distributed reasonably evenly throughout full depth and area or 3 tests per lot, whichever requires the most tests. We recommend that at least Level 1 control of fill compaction, as defined in AS3798-2007, be adhered to on this Site. Preferably, the geotechnical inspection and testing authority (GITA) should be engaged directly on behalf of the client and not by the earthworks subcontractor.

We recommend that the engineered fill layers extend a horizontal distance of at least 1m beyond the design geometry. The roller must extend over the edge of each placed layer in order to seal the batter surface. On completion of filling, the excess under-compacted edge fill should be trimmed back to the design geometry. Alternatively, edge retaining walls may be required to be constructed ahead of bulk filling.

The 'tying in' of engineered fill to temporary cut batter slopes can be achieved by locally benching the cut slopes in no greater than 0.4m high steps. This can be carried out progressively as the height of engineered fill increases.

For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness.

During construction of the fill, platform runoff should be enhanced by providing suitable falls to reduce ponding of water on the surface of the fill. Ponding of water may lead to softening of the fill and subsequent delays in the earthworks program. A poorly drained subgrade may become un-trafficable when wet. We recommend that if soil softening occurs, the subgrade be over-excavated to below the affected soil, and then replaced with engineered fill as specified above.

4.4 Foundation Design

Subject to adequate compliance with the engineering specification (based on the recommendations in **Section 4.3**), the controlled engineered fill at final building platform level will be capable of supporting individual shallow pad footings, strip footings or a raft slab, as preferred by the building designer. Whilst a notional allowable bearing pressure of at least 100kPa for these footing types would be anticipated, the Level 1 geotechnical certification report for the filling should confirm the recommended design bearing pressure suitable for the completed fill platform.

If the procedure outlined in **Section 4.3** is adopted, we do not anticipate any requirement for a geotextile or geogrid layer for separating or strengthening the natural ground or the fill layers. However, these additional components of the fill design are available for consideration if required, based on performance of the natural ground, the imported fill and/or the plant/equipment selected by the contractor to undertake the work, or as an alternative design for the ground preparation and filling.

Piered or piled footings are also suitable if extended through the fill platform. These footing systems may be precluded by adoption of the rock working platform discussed in Section 4.5. If they are preferred for supporting the future dwellings, in lieu of the alternative shallow footing systems, an alternative design/methodology for constructing the fill platform may need to be considered without the rock layer/working platform.

Confirmation of the ground conditions for the deepened footings is recommended by a geotechnical engineer's inspection during the pier drilling/pile installations.

4.5 Pavement Design

The design of new pavements will depend on subgrade preparation, subgrade drainage, the nature and composition of fill excavated or imported to the site, as well as vehicle loadings and use. Various alternative types of construction could be used for the pavements. Concrete construction would undoubtedly be the best in areas where heavy vehicles manoeuvre such as trucks turning and manoeuvring. Flexible pavements may have a lower initial cost, but maintenance will be higher. These factors should be considered when making the final choice.

It should be noted that due to the presence of water, lime stabilisation is not considered as suitable option for the stiffening of the subgrade.

Assuming an appropriate select fill layer comprising of good quality, well graded granular material (such as unbound base or ripped, crushed sandstone with CBR greater than 10%, a maximum particle size of 60mm, well graded and Plastic Index less than 10, compacted to at least 98% of SMDD) will be placed beneath the pavement, the CBR specification of this select fill shall be used to design flexible pavements.

Further soaked CBR tests may be carried out on representative samples of the subgrade to obtain a large population of values to enable a proper statistical analysis to be performed and possibly an increase in the design CBR value. However, it should be borne in mind that even with more test values being obtained there will still be isolated pavement areas where the risk of

potential failure and higher maintenance will occur due to the subgrade having a lower CBR value than the statistical characteristic value opted for design purposes.

We recommend that in situ density tests be completed on the proof rolled and prepared subgrade to confirm that at least 98% Standard Maximum Dry Density (SMDD) has been achieved. If the existing fill is removed and replaced with imported fill, the CBR of the imported material may be taken into account. These design values should be confirmed by inspection and Dynamic Cone Penetration (DCP) testing of the subgrade following proof rolling.

All upper (base) course should be crushed rock to RMS QA specification 3051 (2013) unbound base and compacted to at least 100% of SMDD. All lower (sub-base) course should be crushed rock to RMS QA specification 3051 (2013) unbound base or ripped/crushed sandstone with CBR greater than 40%, maximum particle size of 60mm, well graded and Plastic Index less than 10. All lower course material should be compacted to an average of no less than 100% of SMDD, but with a minimum acceptance value of 98% of SMDD.

Concrete pavements should have a sub-base layer of at least 100mm thickness of crushed rock to RMS QA specification 3051 (2013) unbound base material (or equivalent good quality and durable fine crushed rock) which is compacted to at least 100% SMDD. Concrete pavements should be designed with an effective shear transmission of all joints by way of either doweled or keyed joints.

Careful attention to subsurface and surface drainage is required in view of the effect of moisture on the clay soils. Pavement levels will need to be graded to promote rapid removal of surface water so ponding does not occur on the surface of pavements. The drainage trenches should be excavated with a uniform longitudinal fall to appropriate discharge points so as to reduce the risk of water ponding. The capacity of the stormwater collection system from the pavement should be checked and upgraded if necessary. In order to protect the pavement edge, subsoil drains should be provided along the perimeter of all proposed new external pavement areas, particularly in those areas of cut, with invert levels of at least 200mm below subgrade level.

The long-term successful performance of the pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance programme should not be limited to routine compaction density testing only. Other important factors associated with the earthworks includes subgrade preparation, selection of fill materials, control of moisture content and drainage, etc.

5. Further Geotechnical Inputs

Below is a summary of the previously recommended additional work that needs to be carried out:

- Level 1 compaction testing by a GTA;
- Proof roll inspections of existing subgrade and subsequent layers (if required);
- Design of working platforms (if required) for construction plant by an experienced and qualified geotechnical engineer;
- Geotechnical inspections of all new footings/piles by an experienced geotechnical professional before concrete or steel are placed to verify their bearing capacity and the in-situ nature of the founding strata; and

We recommend that a meeting be held after initial structural design has been completed to confirm that our recommendations have been correctly interpreted. We also recommend a meeting at the commencement of construction to discuss the primary geotechnical issues and inspection requirements.

6. Statement of Limitations

This report has been prepared for the exclusive use of Will Allen and Warrimac Pty Ltd who is the only intended beneficiary of EI's work. The scope of the assessment carried out for the purpose of this report is limited to those agreed with Will Allen and Warrimac Pty Ltd

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the geotechnical industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on a limited investigation of conditions, with specific sampling and test locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during construction. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

We draw your attention to the document "Important Information", which is included in **Appendix C** of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by EI, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

Should you have any queries regarding this report, please do not hesitate to contact EI.

References

AS1289.6.3.1:2004, *Methods of Testing Soils for Engineering Purposes,* Standards Australia.

AS1726:2017, *Geotechnical Site Investigations*, Standards Australia.

AS2159:2009, *Piling – Design and Installation*, Standards Australia.

AS3600:2009, *Concrete Structures,* Standards Australia

AS 3798-2007, Guidelines on earthworks for commercial and residential developments, Standards Australia.

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Abbreviations

AHD	Australian Height Datum
AS	Australian Standard
BEL	Bulk Excavation Level
BEGL	Below Existing Ground Level
BH	Borehole
DBYD	Dial Before You Dig
DP	Deposited Plan
EI	EI Australia
GI	Geotechnical Investigation
NATA	National Association of Testing Authorities, Australia
RL	Reduced Level
SPT	Standard Penetration Test
T-C	Tungsten-Carbide
UCS	Unconfined Compressive Strength

Figures

Magnetic North

Site North

MACPHERSON STREET

NARRABEEN CREEK

BRANDS LANE

BH1M

BH2

BH3

BH4

BH5

BH6

BH7

BH8M

BH9

TP1

TP2

TP3

TP4

TP5

0 10 50 100 200

Approx. Scale (m) - 1:400

Map Source: LTS Surveyors - Ref No. 51644 001DT, Rev 0, Dated 22/02/2021

LEGEND (All Locations are Approximate)

- Site boundary
- Borehole locations
- Monitoring well locations
- Test pit locations

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Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088

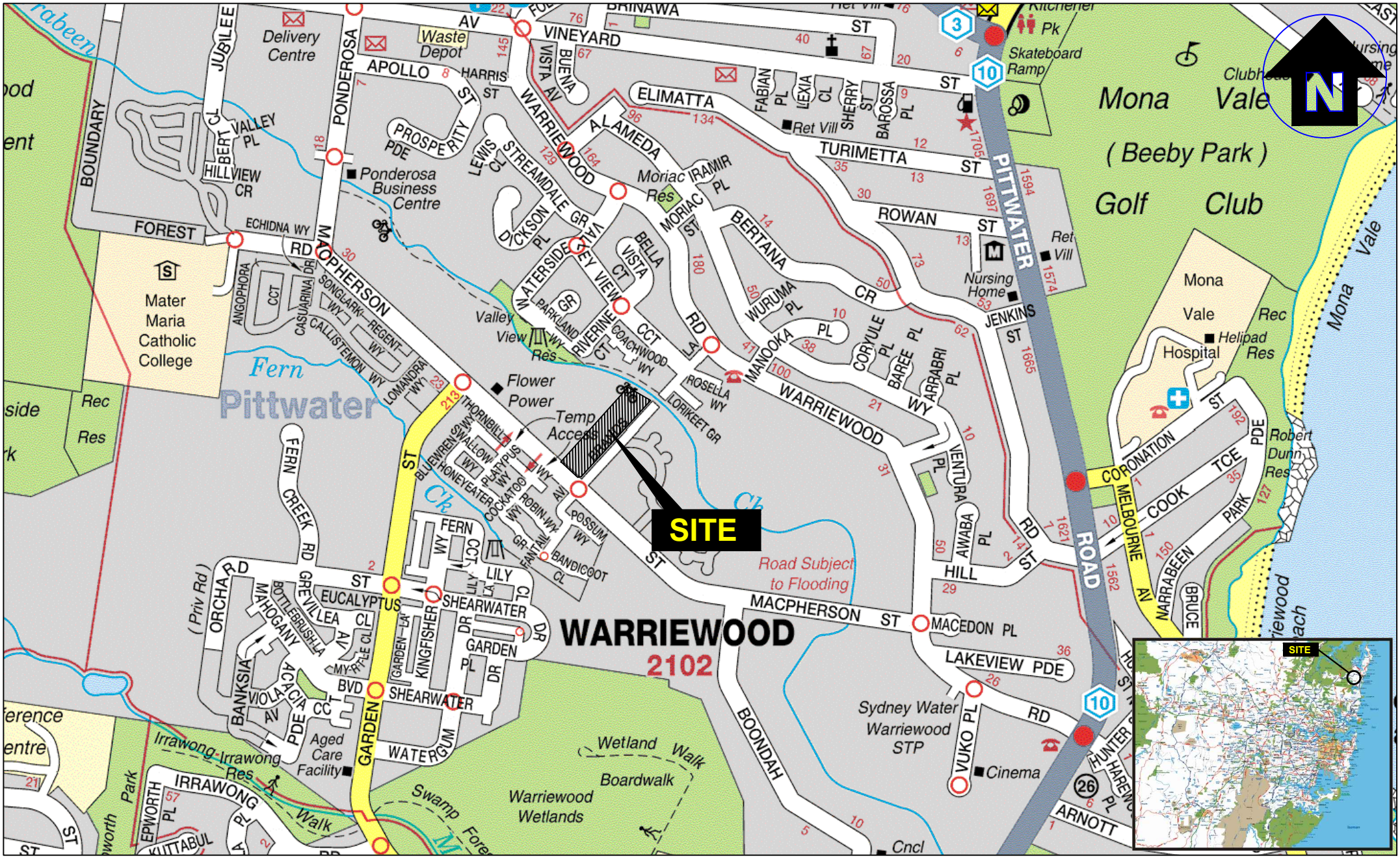
Drawn:	J.O.
Approved:	S.K.
Date:	25/11/22

Warrimac Pty Ltd
Geotechnical Investigation
16 Macpherson Street, Warriewood NSW

Borehole Location Plan

Figure: 2

Project: E25541.G03



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Drawn:	J.O.
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Scale:	Not To Scale

Warrimac Pty Ltd
Geotechnical Investigation
16 Macpherson Street, Warriewood NSW

Site Locality Plan

Figure:
1

Project: E25541.G03

Appendix A – Borehole Logs And Explanatory Notes

BOREHOLE LOG

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BH NO. BH1M

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date Started**	19/08/2022
Position	Refer to Figure 2	**Date Completed**	19/08/2022
Job No.	E25541.G03	**Logged By** JL	**Date** 19/08/2022
Client	Warrimac Pty Ltd	**Reviewed By** AC	**Date** 19/09/2022

Drilling Contractor	Geosense	**Surface RL**	≈5.10 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	5.10				-	TOPSOIL: Gravelly Sandy CLAY; low plasticity, brown, gravels is fine to medium-grained, sub-angular, sand is fine to medium-grained, trace silt and rootlets, no odour.		-	FILL/TOPSOIL
				0.50								
				4.60	SPT 0.50-0.95 m 4,5,4 N=9			-	Silty CLAY; low to medium plasticity, brown and red-brown mottled dark grey, trace glass fragments, gravels, silt and rootlets, no odour.	W (<PL)	St	ALLUVIAL SOIL
			1	*1.10*								
				4.00				SC	Clayey SAND; fine to medium-grained, trace silt, no odour.	W		
				1.50								
				3.60	SPT 1.50-1.95 m 1,2,2 N=4			CI-CH	Sandy CLAY; medium to high plasticity, grey-brown, trace silt, no odour.	W (>PL)	S	
			2									
			3	*3.30*	SPT 3.00-3.45 m 0,0,8 N=8							
				1.80				SC	Clayey SAND; fine to medium-grained, grey, trace silt, no odour.			
			4		DS 4.30-4.50 m					W	L	
			5									
			6	*6.00*	DS 5.80-6.00 m				Hole Terminated at 6.00 m Target Depth Reached.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

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BH NO. BH2

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date Started**	19/08/2022
Position	Refer to Figure 2	**Date Completed**	19/08/2022
Job No.	E25541.G03	**Logged By** JL	**Date** 19/08/2022
Client	Warrimac Pty Ltd	**Reviewed By** AC	**Date** 19/09/2022

Drilling Contractor	Geosense	**Surface RL**	≈4.90 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	4.90				-	FILL: Sandy CLAY; low plasticity, dark grey/brown, sand is fine to medium-grained, trace silt and rootlets, no odour.	W (<PL)	-	FILL
				0.80	SPT 0.50-0.95 m 1,2,1 N=3							
			1	4.10				CI	Silty CLAY; medium plasticity, dark grey, trace sand and rootlets, no odour.		S	ALLUVIAL SOIL
				1.50								
				3.40	SPT 1.50-1.95 m 0,0,0 N=0			CH	Silty CLAY; high plasticity, dark grey-brown, no odour.			
			2									
			3	*3.10*					From 3.10m, dark grey.	W (>PL)	VS	
				1.80	SPT 3.00-3.45 m 0,0,0 N=0							
			4	*4.50*								
				0.40	SPT 4.50-4.95 m 1,2,1 N=3			CI	Sandy CLAY; medium plasticity, dark grey.		S	
			5	*5.50*								
				-0.60				CI-CH	Silty CLAY; medium to high plasticity, dark grey, no odour.			
			6	*6.00*					Hole Terminated at 6.00 m Target Depth Reached.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

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Practical Solutions for Built Environments

BH NO. BH3

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date Started**	19/08/2022
Position	Refer to Figure 2	**Date Completed**	19/08/2022
Job No.	E25541.G03	**Logged By** JL	**Date** 19/08/2022
Client	Warrimac Pty Ltd	**Reviewed By** AC	**Date** 19/09/2022

Drilling Contractor	Geosense	**Surface RL**	≈4.50 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	4.50				-	FILL: Gravelly Sandy CLAY; low plasticity, dark grey, gravel is fine to medium-grained, sub-angular to sub-rounded, pale grey and red mottled brown, sand is fine to medium-grained trace silt and rootlets, no odour.	W (<PL)	-	FILL
				0.60	SPT 0.50-0.95 m 3,3,3 N=6			CL	Silty CLAY; low plasticity, dark grey, trace rootlets, no odour.		F	ALLUVIAL SOIL
			1	*1.50*	SPT 1.50-1.95 m 0,0,0 N=0			CI-CH	Silty CLAY; medium to high plasticity, dark grey/brown, no odour.			
			2	*3.00*	SPT 3.00-3.45 m 0,0,0 N=0				From 3.0m, dark grey.	W (>PL)	VS	
			3	*4.50*	SPT 4.50-4.95 m 4,0,1 N=1			CI	Sandy CLAY; medium plasticity, dark grey, sand is fine to medium-grained, trace silt, no odour.			
			4	*5.00*				CI-CH	Silty CLAY; medium to high plasticity, dark grey, no odour.			
			5	*6.00*					Hole Terminated at 6.00 m Target Depth Reached.			
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

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BH NO. BH4

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date Started**	19/08/2022
Position	Refer to Figure 2	**Date Completed**	19/08/2022
Job No.	E25541.G03	**Logged By** JL	**Date** 19/08/2022
Client	Warrimac Pty Ltd	**Reviewed By** AC	**Date** 19/09/2022

Drilling Contractor	Geosense	**Surface RL**	≈5.00 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	5.00				-	FILL: Silty SAND; medium to coarse-grained, grey, with fine-grained, sub-angular to angular orange gravels, no odour.	M	-	FILL
				0.50								
				4.50	SPT 0.50-0.95 m 1,1,1 N=2			SC	Clayey SAND; medium-grained, grey, trace silt, no odour.	M	VL	ALLUVIAL SOIL
			1	*1.10*								
				3.90				CI-CH	Sandy CLAY; medium to high plasticity, grey-brown, trace silt and rootlets, no odour.			
					SPT 1.50-1.95 m 1,2,3 N=5						F	
			2									
				3.00								
			3	2.00	SPT 3.00-3.45 m 4,5,3 N=8			CL-CI	Sandy CLAY; low to medium plasticity, yellow-brown mottled grey, trace silt, no odour.	W (>PL)		
											St	
			4									
					SPT 4.50-4.95 m 3,4,5 N=9							
			5									
					DS 5.80-6.00 m							
			6		SPT 6.00-6.45 m 1,2,4 N=6						F	
				6.45								
									Hole Terminated at 6.45 m Target Depth Reached.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

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Practical Solutions for Built Environments

BH NO. BH5

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date Started**	19/08/2022
Position	Refer to Figure 2	**Date Completed**	19/08/2022
Job No.	E25541.G03	**Logged By** JL	**Date** 19/08/2022
Client	Warrimac Pty Ltd	**Reviewed By** AC	**Date** 19/09/2022

Drilling Contractor	Geosense	**Surface RL**	≈5.00 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	5.00				-	FILL: Sandy CLAY; low plasticity, dark grey, sand is fine to medium-grained, trace silt, no odour.		-	FILL
				0.40								
				4.60	SPT 0.50-0.95 m 2,1,0 N=1			SC	Clayey SAND; fine to medium-grained, grey-brown to dark grey, trace silt, no odour.	M		ALLUVIAL SOIL
			1								VL	
				1.30						W		
				3.70	SPT 1.50-1.95 m 0,1,3 N=4			CI-CH	Sandy CLAY; medium to high plasticity, orange-brown mottled grey-brown, trace silt, no odour.	W (>PL)	F	
			2									
				3.00								
			3	2.00	SPT 3.00-3.45 m 3,9,6 N=15			SC	Clayey SAND; fine to medium-grained, grey to pale grey, trace silt, no odour.	W	MD	
			4									
				4.50								
				0.50	SPT 4.50-4.95 m 3,8,11 N=19			CI	Silty CLAY; medium plasticity, grey-brown mottled orange-brown, trace sand, no odour.	W (=PL)	VSt	
			5									
			6		SPT 6.00-6.45 m 5,7,9 N=16							
				6.45								
									Hole Terminated at 6.45 m Target Depth Reached.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

BH NO. BH6

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date Started**	19/08/2022
Position	Refer to Figure 2	**Date Completed**	19/08/2022
Job No.	E25541.G03	**Logged By** JL	**Date** 19/08/2022
Client	Warrimac Pty Ltd	**Reviewed By** AC	**Date** 19/09/2022

Drilling Contractor	Geosense	**Surface RL**	≈5.40 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	*0.10*				-	CONCRETE; 100mm thick.	-	-	PAVEMENT
				5.30 *0.30*				-	FILL: Sandy CLAY; low plasticity, dark grey, sand is fine to medium-grained, trace gravels and silt, no odour.	W (<PL)	-	FILL
				5.10				SC	Clayey SAND; fine to medium-grained, grey-brown, trace silt, no odour.	M	VL	ALLUVIAL SOIL
			1		SPT 0.50-0.95 m 1,1,1 N=2					W		
				1.40 4.00				CI-CH	CLAY; medium to high plasticity, grey-brown, trace silt, no odour.		F	
			2		SPT 1.50-1.95 m 1,2,4 N=6							
			3		SPT 3.00-3.45 m 1,3,10 N=13					W (>PL)		
				3.40 2.00				CI	Sandy CLAY; medium plasticity, grey to dark grey, sand is fine to medium-grained, trace silt.		St	
			4		SPT 4.50-4.95 m 4,6,9 N=15							
				4.70 0.70				CI	Silty CLAY; medium plasticity, grey-brown mottled orange-brown, trace sand, no odour.	W (=PL)		
			5									
				6.00 -0.60				CI	Sandy CLAY; medium plasticity, grey, trace silt, no odour.		VSt	
			6		SPT 6.00-6.45 m 10,9,12 N=21							
				6.45					Hole Terminated at 6.45 m Target Depth Reached.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

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BH NO. BH7

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date Started**	19/08/2022
Position	Refer to Figure 2	**Date Completed**	19/08/2022
Job No.	E25541.G03	**Logged By** JL	**Date** 19/08/2022
Client	Warrimac Pty Ltd	**Reviewed By** AC	**Date** 19/09/2022

Drilling Contractor	Geosense	**Surface RL**	≈4.90 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	4.90				-	FILL: Sandy CLAY; low plasticity, dark grey, sand is fine to medium-grained, trace sub-angular gravel and silt, no odour.	W (<PL)	-	FILL
				0.40								
			1	4.50	SPT 0.50-0.95 m 3,2,3 N=5			SC	Clayey SAND; fine to medium-grained, grey-brown, trace silt, no odour.	M		ALLUVIAL SOIL
										W	L	
				1.40								
			2	3.50	SPT 1.50-1.95 m 1,3,4 N=7			CI-CH	Sandy CLAY; medium to high plasticity, grey-brown mottled orange-brown, trace silt, no odour.	W (=PL)	F	
			3	*3.20*	SPT 3.00-3.45 m 5,8,8 N=16			CI	Sandy CLAY; medium plasticity, grey, trace silt, no odour.		VSt	
				1.70								
			4									
					SPT 4.50-4.95 m 1,4,4 N=8					W (>PL)		
			5								St	
			6		SPT 6.00-6.45 m 1,3,6 N=9							
				6.45					Hole Terminated at 6.45 m Target Depth Reached.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

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Practical Solutions for Built Environments

BH NO. BH8M

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date Started**	19/08/2022
Position	Refer to Figure 2	**Date Completed**	19/08/2022
Job No.	E25541.G03	**Logged By** JL	**Date** 19/08/2022
Client	Warrimac Pty Ltd	**Reviewed By** AC	**Date** 19/09/2022

Drilling Contractor	Geosense	**Surface RL**	≈4.90 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	4.90				-	FILL: Silty SAND; medium-grained, dark grey, trace clay and fine to medium-grained, sub-angular gravels, no odour.	M	-	FILL
				0.70	SPT 0.50-0.95 m 2,1,1 N=2			CL	Sandy CLAY; low plasticity, grey, sand is fine to medium-grained, trace silt, no odour.		VS	ALLUVIAL SOIL
			1	4.20								
				1.50	SPT 1.50-1.95 m 1,3,4 N=7			CI-CH	Sandy CLAY; medium to high plasticity, brown and grey-brown, trace silt, no odour.	W (=PL)	F	
			2	3.40								
				3.00	SPT 3.00-3.45 m 3,4,5 N=9			SC	Clayey SAND; fine to medium-grained, grey, trace silt, no odour.	W	L	
			3	1.90								
				4.50	SPT 4.50-4.95 m 5,8,10 N=18			CI	Silty CLAY; medium plasticity, grey, trace fine-grained sand, no odour.	W (=PL)	VSt	
			4	0.40								
					SPT 6.00-6.45 m 3,4,5 N=9						St	
			5	*6.45*					Hole Terminated at 6.45 m Target Depth Reached.			
			6									
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

BOREHOLE LOG

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Practical Solutions for Built Environments

BH NO. BH9

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date Started**	19/08/2022
Position	Refer to Figure 2	**Date Completed**	19/08/2022
Job No.	E25541.G03	**Logged By** JL	**Date** 19/08/2022
Client	Warrimac Pty Ltd	**Reviewed By** AC	**Date** 19/09/2022

Drilling Contractor	Geosense	**Surface RL**	≈5.00 m AHD
Drill Rig	Comacchio Geo 205	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	5.00				-	FILL: SAND; medium to coarse-grained, pale brown to orange-brown, trace sub-angular gravel and silt, no odour.	M	-	FILL
				0.60	SPT 0.50-0.95 m 4,2,3 N=5			CL-CI	Silty CLAY; low to medium plasticity, dark grey, trace rootlets, no odour.	W (<PL)	F	ALLUVIAL SOIL
			1	4.40 *1.50*								
				3.50	SPT 1.50-1.95 m 3,2,1 N=3			CI-CH	CLAY; medium to high plasticity, grey-brown, trace silt, no odour.	W (<PL)		
			2									
			3		SPT 3.00-3.45 m 2,1,3 N=4						S	
			4	*4.00* 1.00				CI	Silty CLAY; medium plasticity, grey, trace fine-grained sand, no odour.	W (=PL)		
				4.70 0.30	SPT 4.50-4.95 m 10,15,10 N=25				From 4.7 - 4.95m, clayey sand, grey, trace silt.		VSt	
			5									
			6		SPT 6.00-6.45 m 5,8,9 N=17							
				6.45					Hole Terminated at 6.45 m Target Depth Reached.			
			7									
			8									
			9									
			10									

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

TEST PIT LOG

TP NO. TP1

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date**	19/08/2022
Position	Refer to Figure 2	**Logged By** JL	**Date** 19/08/2022
Job No.	E25541.G03	**Reviewed By** AC	**Date** 19/09/2022
Client	Warrimac Pty Ltd		

Contactor **Surface RL** ≈4.50 m AHD

Machine **Bucket Size**

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	4.50 *0.20* 4.30 *0.80* 3.70 1 *1.20*	DS 0.30-0.80 m TP1 0.80-1.20 m			- CL-CI SC	FILL: Gravelly Sandy CLAY; low plasticity, brown, gravel is fine to medium-grained sub-angular, sand is fine to medium-grained, trace silt. FILL: Silty CLAY; low to medium plasticity, black. Clayey SAND; fine to medium-grained, grey, trace silt, no odour. Hole Terminated at 1.20 m Target Depth Reached.	W (<PL) M W	- VS VL	FILL ALLUVIAL SOIL

This test pit log should be read in conjunction with EI Australia's accompanying standard notes.

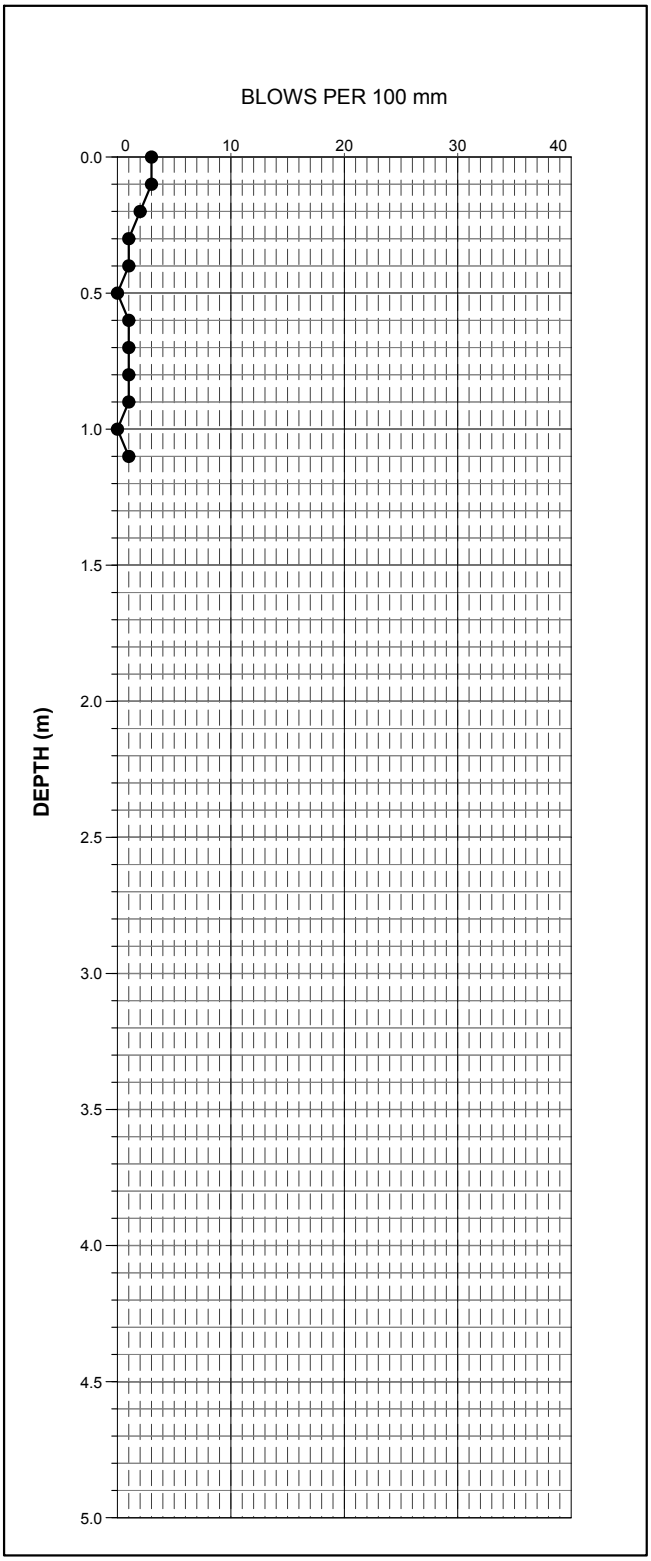
DYNAMIC CONE PENETROMETER TEST RESULTS

DCP NO. TP1

Project	Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date**	19/08/2022
Position	Refer to Figure 2	**Logged By** JL	**Date** 19/08/2022
Job No.	E25541.G03	**Reviewed By** AC	**Date** 19/09/2022
Client	Warrimac Pty Ltd		

Contactor		**Surface RL**	≈4.50 m AHD
Machine		**Bucket Size**	

DEPTH (m)	NO OF BLOWS PER 100 mm
0.00-0.1	3
0.10-0.2	3
0.20-0.3	2
0.30-0.4	1
0.40-0.5	1
0.50-0.6	0
0.60-0.7	1
0.70-0.8	1
0.80-0.9	1
0.90-1	1
1.00-1.1	0
1.10-1.2	1



Termination Remark
Target Depth Reached.

Final Depth (m)	1.20

This DCP log should be read in conjunction with EI Australia's accompanying standard notes.

TEST PIT LOG

TP NO. TP2

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date**	19/08/2022
Position	Refer to Figure 2	**Logged By** JL	**Date** 19/08/2022
Job No.	E25541.G03	**Reviewed By** AC	**Date** 19/09/2022
Client	Warrimac Pty Ltd		

Contactor	**Surface RL** ≈4.50 m AHD
Machine	**Bucket Size**

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	4.50	DS 0.20-0.60 m			-	FILL: Gravelly Sandy CLAY; low plasticity, dark grey, gravel is fine to medium-grained, sub-angular to sub-rounded, pale grey and red mottled brown, sand is fine to medium-grained trace silt and rootlets, no odour.	W (<PL)		FILL
				0.60								
			1	3.90	DS 0.60-1.20 m			CL	Silty CLAY; low plasticity, dark grey, trace sand, no odour.	W (>PL)	-	ALLUVIAL SOIL
				1.20					Hole Terminated at 1.20 m Target Depth Reached.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This test pit log should be read in conjunction with EI Australia's accompanying standard notes.

TEST PIT LOG

TP NO. TP3

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date**	19/08/2022
Position	Refer to Figure 2	**Logged By** JL	**Date** 19/08/2022
Job No.	E25541.G03	**Reviewed By** AC	**Date** 19/09/2022
Client	Warrimac Pty Ltd		

Contactor	**Surface RL** ≈5.00 m AHD
Machine	**Bucket Size**

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	▽	0	5.00 ***0.20*** 4.80	DS 0.10-0.20 m DS 0.20-1.00 m			- SC	FILL: Gravelly Sandy CLAY; low plasticity, dark grey, gravel is fine to medium-grained, sub-angular to sub-rounded, red-brown, sand is fine to medium-grained, trace silt, no odour. Clayey SAND; medium-grained, brown, trace silt, no odour.	W (<PL) M W	- VL	FILL ALLUVIAL SOIL
			1	*1.00*					Hole Terminated at 1.00 m Target Depth Reached.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This test pit log should be read in conjunction with EI Australia's accompanying standard notes.

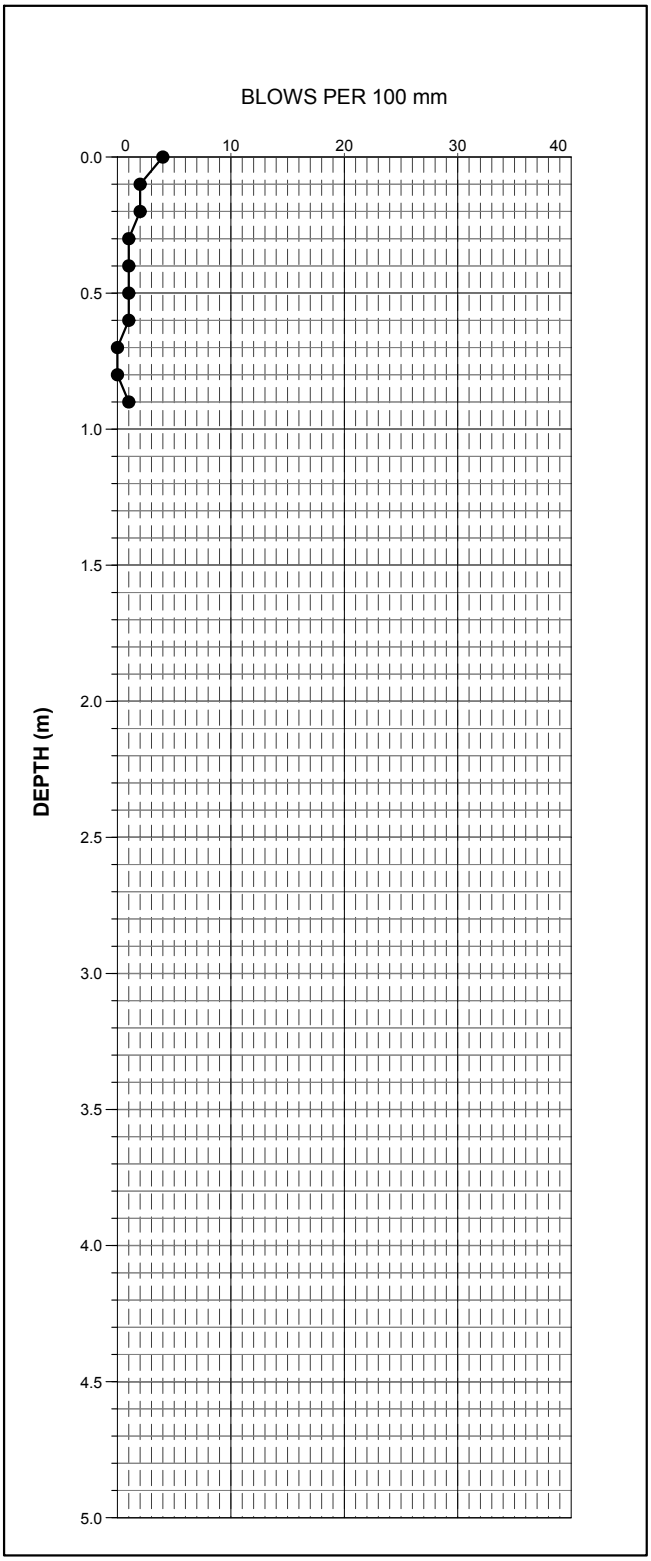
DYNAMIC CONE PENETROMETER TEST RESULTS

DCP NO. TP3

Project	Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date**	19/08/2022
Position	Refer to Figure 2	**Logged By** JL	**Date** 19/08/2022
Job No.	E25541.G03	**Reviewed By** AC	**Date** 19/09/2022
Client	Warrimac Pty Ltd		

Contactor		**Surface RL**	≈5.00 m AHD
Machine		**Bucket Size**	

DEPTH (m)	NO OF BLOWS PER 100 mm
0.00-0.1	4
0.10-0.2	2
0.20-0.3	2
0.30-0.4	1
0.40-0.5	1
0.50-0.6	1
0.60-0.7	1
0.70-0.8	0
0.80-0.9	0
0.90-1	1



Termination Remark
Target Depth Reached.

Final Depth (m)	1.00

This DCP log should be read in conjunction with EI Australia's accompanying standard notes.

TEST PIT LOG

TP NO. TP4

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date**	19/08/2022
Position	Refer to Figure 2	**Logged By** JL	**Date** 19/08/2022
Job No.	E25541.G03	**Reviewed By** AC	**Date** 19/09/2022
Client	Warrimac Pty Ltd		

Contactor **Surface RL** ≈4.70 m AHD

Machine **Bucket Size**

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-		0	4.70	DS 0.10 m			-	FILL: Gravelly Clayey SAND; medium to coarse-grained, grey to dark grey, gravel is fine to medium-grained, sub-angular to sub-rounded, grey and red-grey, trace silt.	M	-	FILL
				0.50								
				4.20				CL	Sandy CLAY; low plasticity, brown and grey-brown, trace silt.	W (<PL)	S	ALLUVIAL SOIL
			1		DS 0.80-1.50 m							
				1.50							F	
									Hole Terminated at 1.50 m Target Depth Reached.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This test pit log should be read in conjunction with EI Australia's accompanying standard notes.

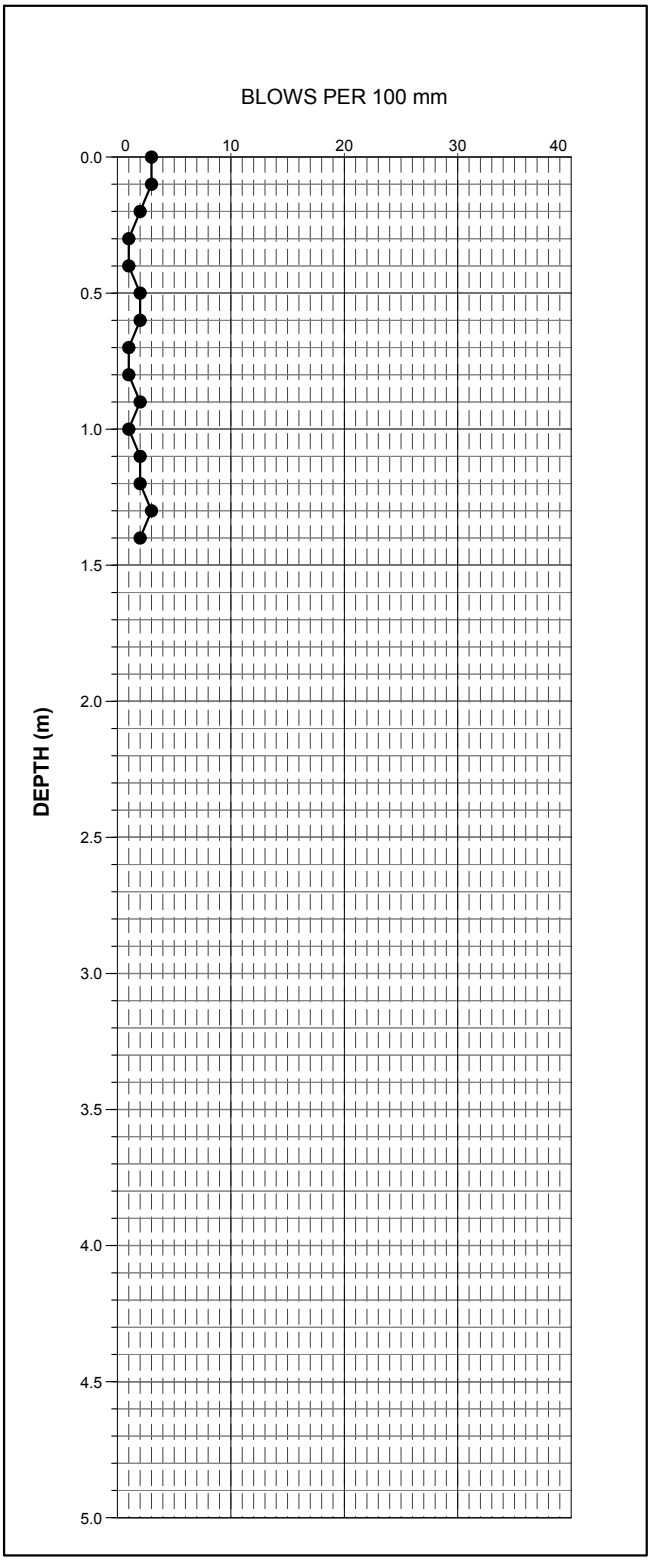
DYNAMIC CONE PENETROMETER TEST RESULTS

DCP NO. TP4

Project	Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date**	19/08/2022
Position	Refer to Figure 2	**Logged By** JL	**Date** 19/08/2022
Job No.	E25541.G03	**Reviewed By** AC	**Date** 19/09/2022
Client	Warrimac Pty Ltd		

Contactor		**Surface RL**	≈4.70 m AHD
Machine		**Bucket Size**	

DEPTH (m)	NO OF BLOWS PER 100 mm
0.00-0.1	3
0.10-0.2	3
0.20-0.3	2
0.30-0.4	1
0.40-0.5	1
0.50-0.6	2
0.60-0.7	2
0.70-0.8	1
0.80-0.9	1
0.90-1	2
1.00-1.1	1
1.10-1.2	2
1.20-1.3	2
1.30-1.4	3
1.40-1.5	2



Termination Remark
Target Depth Reached.

Final Depth (m)	1.50

This DCP log should be read in conjunction with EI Australia's accompanying standard notes.

TEST PIT LOG

TP NO. TP5

Project	Proposed Residential Redevelopment	**Sheet**	1 of 1
Location	16 Macpherson Street, Warriewood NSW	**Date**	19/08/2022
Position	Refer to Figure 2	**Logged By** JL	**Date** 19/08/2022
Job No.	E25541.G03	**Reviewed By** AC	**Date** 19/09/2022
Client	Warrimac Pty Ltd		

Contactor **Surface RL** ≈4.70 m AHD

Machine **Bucket Size**

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	-	GWNE	0	4.70	TP5 0.00-0.30 m			-	FILL: SAND; medium to coarse-grained, pale brown to orange-brown, trace sub-angular gravel, no odour.	M		FILL
				0.30								
				4.40	TP5 0.30-0.80 m			-	FILL: Silty CLAY; low to medium plasticity, dark grey, trace rootlets and sub-angular gravels.	W (<PL)	-	
				0.80								
			1	3.90	TP5 0.80-1.00 m			CL-CI	Sandy CLAY; low to medium plasticity, grey.	W (<PL)		ALLUVIAL SOIL
				1.00					Hole Terminated at 1.00 m Target Depth Reached.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

This test pit log should be read in conjunction with EI Australia's accompanying standard notes.

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT LOGS

DRILLING/EXCAVATION METHOD

HA	Hand Auger	**ADH**	Hollow Auger	**NQ**	Diamond Core - 47 mm
DT	Diatube Coring	**RT**	Rotary Tricone bit	**NMLC**	Diamond Core - 52 mm
NDD	Non-destructive digging	**RAB**	Rotary Air Blast	**HQ**	Diamond Core - 63 mm
AD*	Auger Drilling	**RC**	Reverse Circulation	**HMLC**	Diamond Core - 63 mm
***V**	V-Bit	**PT**	Push Tube	**EX**	Tracked Hydraulic Excavator
***T**	TC-Bit, e.g. AD/T	**WB**	Washbore	**HAND**	Excavated by Hand Methods

PENETRATION RESISTANCE

L	**Low Resistance**	Rapid penetration/ excavation possible with little effort from equipment used.
M	**Medium Resistance**	Penetration/ excavation possible at an acceptable rate with moderate effort from equipment used.
H	**High Resistance**	Penetration/ excavation is possible but at a slow rate and requires significant effort from equipment used.
R	**Refusal/Practical Refusal**	No further progress possible without risk of damage or unacceptable wear to equipment used.

These assessments are subjective and are dependent on many factors, including equipment power and weight, condition of excavation or drilling tools and experience of the operator.

WATER

Standing Water Level **Partial water loss**

Water Seepage **Complete Water Loss**

GWNO	GROUNDWATER NOT OBSERVED - Observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave-in of the borehole/ test pit.
GWNE	GROUNDWATER NOT ENCOUNTERED - Borehole/ test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/ test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following a 150mm seating drive
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported, N is not reported
RW	Penetration occurred under the rod weight only, N<1
HW	Penetration occurred under the hammer and rod weight only, N<1
HB	Hammer double bouncing on anvil, N is not reported
Sampling	
DS	Disturbed Sample
ES	Sample for environmental testing
BDS	Bulk disturbed Sample
GS	Gas Sample
WS	Water Sample
U50	Thin walled tube sample - number indicates nominal sample diameter in millimetres
Testing	
FP	Field Permeability test over section noted
FVS	Field Vane Shear test expressed as uncorrected shear strength (sv= peak value, sr= residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket Penetrometer test expressed as instrument reading in kPa
WPT	Water Pressure tests
DCP	Dynamic Cone Penetrometer test
CPT	Static Cone Penetration test
CPTu	Static Cone Penetration test with pore pressure (u) measurement

GEOLOGICAL BOUNDARIES

———— = Observed Boundary (position known)

– – – – – – – – – – = Observed Boundary (position approximate)

– –?– –?– –?– – = Boundary (interpreted or inferred)

ROCK CORE RECOVERY

TCR=Total Core Recovery (%)

$$= \frac{Length\ of\ core\ recovered}{Length\ of\ core\ run} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum Axial\ lengths\ of\ core > 100mm}{Length\ of\ core\ run} \times 100$$

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT LOGS

	FILL		ORGANIC SOILS (OL, OH or Pt)		CLAY (CL, CI or CH)
	COUBLES or BOULDERS		SILT (ML or MH)		SAND (SP or SW)
	GRAVEL (GP or GW)	Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay			

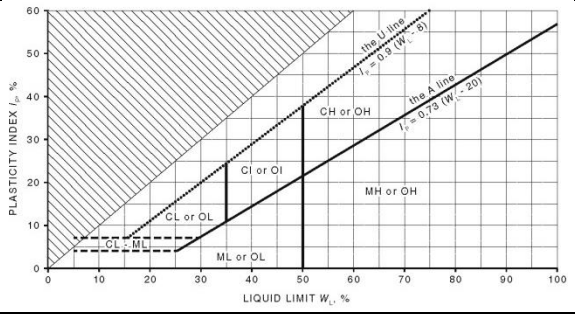
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS 1726:2017, Section 6.1 – Soil description and classification.

PARTICLE SIZE CHARACTERISTICS

Fraction	Components	Sub Division	Size mm
Oversize	BOULDERS		>200
	COBBLES		63 to 200
Coarse grained soil	GRAVEL	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	SAND	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine grained soil	SILT		0.002 to 0.075
	CLAY		<0.002

PLASTICITY PROPERTIES



GROUP SYMBOLS

Major Divisions		Symbol	Description
COARSE GRAINED SOILS More than 65% of soil excluding oversize fraction is greater than 0.075mm	GRAVEL More than 50% of coarse fraction is >2.36mm	GW	Well graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GP	Poorly graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GM	Silty gravel, gravel-sand-silt mixtures, zero to medium dry strength.
		GC	Clayey gravel, gravel-sand-clay mixtures, medium to high dry strength.
	SAND More than 50% of coarse fraction is <2.36 mm	SW	Well graded sand and gravelly sand, little or no fines, no dry strength.
		SP	Poorly graded sand and gravelly sand, little or no fines, no dry strength.
		SM	Silty sand, sand-silt mixtures, zero to medium dry strength.
		SC	Clayey sand, sandy-clay mixtures, medium to high dry strength.
FINE GRAINED SOILS More than 35% of soil excluding oversized fraction is less than 0.075mm	Liquid Limit less < 50%	ML	Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands, zero to medium dry strength.
		CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, medium to high dry strength.
		OL	Organic silts and organic silty clays of low plasticity, low to medium dry strength.
	Liquid Limit > than 50%	MH	Inorganic silts of high plasticity, high to very high dry strength.
		CH	Inorganic clays of high plasticity, high to very high dry strength.
		OH	Organic clays of medium to high plasticity, medium to high dry strength.
Highly Organic soil		PT	Peat muck and other highly organic soils.

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Non- cohesive and free-running.
M	Moist	Soils feel cool, darkened in colour. Soil tends to stick together.
W	Wet	Soils feel cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture content of cohesive soils shall be described in relation to plastic limit (PL) or liquid limit (LL) for soils with higher moisture content as follows: Moist, dry of plastic limit (w < PL); Moist, near plastic limit (w ≈ PL); Moist, wet of plastic limit (w < PL); Wet, near liquid limit (w ≈ LL), Wet, wet of liquid limit (w > LL),

CONSISTENCY

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N" #
VS	Very Soft	≤ 12	≤ 2
S	Soft	>12 to ≤ 25	>2 to ≤ 4
F	Firm	>25 to ≤ 50	>4 to 8
St	Stiff	>50 to ≤ 100	>8 to 15
VSt	Very Stiff	>100 to ≤ 200	>15 to 30
H	Hard	>200	>30
Fr	Friable	-	

DENSITY

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	≤ 15	0 to 4
L	Loose	>15 to ≤ 35	4 to 10
MD	Medium Dense	>35 to ≤ 65	10 to 30
D	Dense	>65 to ≤ 85	30 to 50
VD	Very Dense	>85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material. # SPT correlations are not stated in AS1726:2017, and may be subject to corrections for overburden pressure, moisture content of the soil, and equipment type.

MINOR COMPONENTS

Term	Assessment Guide	Proportion by Mass
Add 'Trace'	Presence just detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: ≤ 5% Fine grained soil: ≤ 15%
Add 'With'	Presence easily detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: 5 - 12% Fine grained soil: 15 - 30%
Prefix soil name	Presence easily detectable by feel or eye in conjunction with the general properties of primary component	Coarse grained soils: >12% Fine grained soil: >30%

TERMS FOR ROCK MATERIAL STRENGTH AND WEATHERING

CLASSIFICATION AND INFERRED STRATIGRAPHY
Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

ROCK MATERIAL STRENGTH CLASSIFICATION

Symbol	Term	Point Load Index, $Is_{(50)}$ (MPa) #	Field Guide
VL	Very Low	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of 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.
M	Medium	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

 # Rock Strength Test Results

▼ Point Load Strength Index, $Is_{(50)}$, Axial test (MPa)

● Point Load Strength Index, $Is_{(50)}$, Diametral test (MPa)

Relationship between rock strength test result ($Is_{(50)}$) and unconfined compressive strength (UCS) will vary with rock type and strength, and should be determined on a site-specific basis. However UCS is typically 20 x $Is_{(50)}$.

ROCK MATERIAL WEATHERING CLASSIFICATION

Symbol		Term	Field Guide
RS		Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
XW		Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW	Distinctly Weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
	MW		
SW		Slightly Weathered	Rock slightly discoloured but shows little or no change of strength relative to fresh rock.
FR		Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

CLASSIFICATION AND INFERRED STRATIGRAPHY
Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

DETAILED ROCK DEFECT SPACING

Defect Spacing	
Term	**Description**
Massive	No layering apparent
Indistinct	Layering just visible; little effect on properties
Distinct	Layering (bedding, foliation, cleavage) distinct; rock breaks more easily parallel to layering

Bedding Thickness (Stratification)	
Term	**Spacing (mm)**
Thinly laminated	<6
Laminated	6 – 20
Very thinly bedded	20 – 60
Thinly bedded	60 – 200
Medium bedded	200 – 600
Thickly bedded	600 – 2,000
Very thickly bedded	> 2,000

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT TYPES

Defect Type	Abbr.	Description
Joint	JT	Surface of a fracture or parting, formed without displacement, across which the rock has little or no tensile strength. May be closed or filled by air, water or soil or rock substance, which acts as cement.
Bedding Parting	BP	Surface of fracture or parting, across which the rock has little or no tensile strength, parallel or sub-parallel to layering/ bedding. Bedding refers to the layering or stratification of a rock, indicating orientation during deposition, resulting in planar anisotropy in the rock material.
Contact	CO	The surface between two types or ages of rock.
Sheared Surface	SSU	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.
Sheared Seam/ Zone (Fault)	SS/SZ	Seam or zone with roughly parallel almost planar boundaries of rock substance cut by closely spaced (often <50 mm) parallel and usually smooth or slickensided joints or cleavage planes.
Crushed Seam/ Zone (Fault)	CS/CZ	Seam or zone composed of disoriented usually angular fragments of the host rock substance, with roughly parallel near-planar boundaries. The brecciated fragments may be of clay, silt, sand or gravel sizes or mixtures of these.
Extremely Weathered Seam/ Zone	XWS/XWZ	Seam of soil substance, often with gradational boundaries, formed by weathering of the rock material in places.
Infilled Seam	IS	Seam of soil substance, usually clay or clayey, with very distinct roughly parallel boundaries, formed by soil migrating into joint or open cavity.
Vein	VN	Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.

NOTE: Defects size of <100mm SS, CS and XWS. Defects size of >100mm SZ, CZ and XWZ.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

Shape	Abbr.	Description	Roughness	Abbr.	Description
Planar	PR	Consistent orientation	Polished	POL	Shiny smooth surface
Curved	CU	Gradual change in orientation	Slickensided	SL	Grooved or striated surface, usually polished
Undulating	UN	Wavy surface	Smooth	SM	Smooth to touch. Few or no surface irregularities
Stepped	ST	One or more well defined steps	Rough	RO	Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper
Irregular	IR	Many sharp changes in orientation	Very Rough	VR	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper

Orientation: **Vertical Boreholes –** The dip (inclination from horizontal) of the defect.
Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

Coating	Abbr.	Description
Clean	CN	No visible coating or infilling
Stain	SN	No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)
Veneer	VNR	A visible coating of soil or mineral substance, usually too thin to measure (< 1 mm); may be patchy

DEFECT APERTURE

Aperture	Abbr.	Description
Closed	CL	Closed.
Open	OP	Without any infill material.
Infilled	-	Soil or rock i.e. clay, silt, talc, pyrite, quartz, etc.

Appendix B – Laboratory Certificates

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

NATA Accredited for Compliance with ISO/IEC 17025 - Testing No. 2750

Atterberg Limits and Linear Shrinkage Report

Project: E25541.G03: 16 MACPHERSON STREET, WARRIEWOOD, NSW — Project No.: 31380

Client: EI AUSTRALIA — Report No.: 22/3295

Address: Suite 6.01, 55 Miller Street, Pyrmont NSW 2009 — Report Date: 13/09/2022

Test Method: AS1289.3.1.2,3.2.1,3.4.1,2.1.1 — Page: 1 OF 2

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

STS / Sample No.	6853D-L / 1	6853D-L / 2	6853D-L / 3	6853D-L / 4		
Sample Location	Borehole 2	Borehole 4	Borehole 6	Borehole 8M		
Material Description	Silty Clay, grey brown	Silty Clay, yellow grey	Silty Sandy Clay	Sandy Silty Clay		
Depth (m)	1.5 - 1.95	3.0 - 3.45	4.7 - 4.95	6.0 - 6.45		
Sample Date	19/08/2022	19/08/2022	19/08/2022	19/08/2022		
Sample History	Natural Preparation	Oven Dried	Oven Dried	Oven Dried		
Method of Preparation	Natural Preparation	Dry Sieved	Dry Sieved	Dry Sieved		
Liquid Limit (%)	**77**	**32**	**60**	**34**		
Plastic Limit (%)	**37**	**18**	**22**	**17**		
Plasticity Index	**40**	**14**	**38**	**17**		
Linear Shrinkage (%)	**N/A**	**9**	**17**	**9**		
Mould Size (mm)	N/A	125.5	127.1	149.8		
Crumbing	N/A	N	N	N		
Curling	N/A	N	N	N		

Remarks:

Approved Signatory.....

Technician: AW/DH — Lucky Ly - Senior Geotechnician

STS GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

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14/1 Cowpasture Place, Wetherill Park NSW 2164
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Moisture Content of Soil and Aggregate Samples

Project: E25541.G03: 16 MACPHERSON STREET, WARRIEWOOD, NSW — Project No.: 31380

Client: EI AUSTRALIA — Report No.: 22/3295

Address: Suite 6.01, 55 Miller Street, Pyrmont NSW 2009 — Report Date: 13/09/2022

Test Method: AS1289.2.1.1 — Page: 2 OF 2

Sampling Procedure: Samples Supplied By Client (Not covered under NATA Scope of Accreditation)

STS / Sample No.	6853D-L / 1	6853D-L / 2	6853D-L / 3	6853D-L / 4		
Sample Location	Borehole 2	Borehole 4	Borehole 6	Borehole 8M		
Material Description	Silty Clay, grey brown	Silty Clay, yellow grey	Silty Sandy Clay	Sandy Silty Clay		
Depth (mm)	1.5 - 1.95	3.0 - 3.45	4.7 - 4.95	6.0 - 6.45		
Sample Date	19/08/2022	19/08/2022	19/08/2022	19/08/2022		
Moisture Content (%)	**47.6**	**17.7**	**21.2**	**18.2**		

Remarks:

Approved Signatory.....

Technician: AW/DH — Lucky Ly - Senior Geotechnician

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Jeff Lu
Client	EI AUSTRALIA
Address	SUITE 6.01 55 MILLER STREET PYRMONT NSW 2009
Telephone	61 2 95160722
Facsimile	(Not specified)
Email	jeff.lu@eiaustralia.com.au
Project	**E25541.G03 16 Macpherson St, Warriewood**
Order Number	**E25541.G03**
Samples	5

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE235872 R0**
Date Received	24/8/2022
Date Reported	30/8/2022

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing. NATA accredited laboratory 2562(4354).

SIGNATORIES

Dong LIANG
Metals/Inorganics Team Leader

Shane MCDERMOTT
Inorganic/Metals Chemist

Soluble Anions (1:5) in Soil/Solids by Ion Chromatography [AN245] Tested: 26/8/2022

PARAMETER	UOM	LOR	BH1M_1.5-1.95 SOIL - 19/8/2022 SE235872.001	BH3_3.0-3.45 SOIL - 19/8/2022 SE235872.002	BH5_0.5-0.95 SOIL - 19/8/2022 SE235872.003	BH7_4.5-4.95 SOIL - 19/8/2022 SE235872.004	BH9_6.0-6.45 SOIL - 19/8/2022 SE235872.005
Chloride	mg/kg	0.25	**14**	**39**	**7.5**	**4.4**	**9.9**
Sulfate	mg/kg	5	**11**	**84**	**39**	**39**	**43**

pH in soil (1:5) [AN101] Tested: 26/8/2022

PARAMETER	UOM	LOR	BH1M_1.5-1.95 SOIL - 19/8/2022 SE235872.001	BH3_3.0-3.45 SOIL - 19/8/2022 SE235872.002	BH5_0.5-0.95 SOIL - 19/8/2022 SE235872.003	BH7_4.5-4.95 SOIL - 19/8/2022 SE235872.004	BH9_6.0-6.45 SOIL - 19/8/2022 SE235872.005
pH	pH Units	0.1	**4.6**	**4.9**	**5.8**	**4.6**	**5.1**

Conductivity and TDS by Calculation - Soil [AN106] Tested: 26/8/2022

PARAMETER	UOM	LOR	BH1M_1.5-1.95 SOIL - 19/8/2022 SE235872.001	BH3_3.0-3.45 SOIL - 19/8/2022 SE235872.002	BH5_0.5-0.95 SOIL - 19/8/2022 SE235872.003	BH7_4.5-4.95 SOIL - 19/8/2022 SE235872.004	BH9_6.0-6.45 SOIL - 19/8/2022 SE235872.005
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	**28**	**81**	**31**	**29**	**35**

Moisture Content [AN002] Tested: 26/8/2022

PARAMETER	UOM	LOR	BH1M_1.5-1.95 SOIL - 19/8/2022 SE235872.001	BH3_3.0-3.45 SOIL - 19/8/2022 SE235872.002	BH5_0.5-0.95 SOIL - 19/8/2022 SE235872.003	BH7_4.5-4.95 SOIL - 19/8/2022 SE235872.004	BH9_6.0-6.45 SOIL - 19/8/2022 SE235872.005
% Moisture	%w/w	1	**28.2**	**49.7**	**14.3**	**12.9**	**16.8**

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl2) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract of as received sample with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		
***	Indicates that both * and ** apply.				

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

Appendix C – Important Information

Important Information

SCOPE OF SERVICES

The geotechnical report ("the report") has been prepared in accordance with the scope of services as set out in the contract, or as otherwise agreed, between the Client And EI Australia ("EI"). The scope of work may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

EI has relied on data provided by the Client and other individuals and organizations, to prepare the report. Such data may include surveys, analyses, designs, maps and plans. EI has not verified the accuracy or completeness of the data except as stated in the report. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations ("conclusions") are based in whole or part on the data, EI will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to EI.

GEOTECHNICAL ENGINEERING

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared for a specific client, for a specific project and to meet specific needs, and may not be adequate for other clients or other purposes (e.g. a report prepared for a consulting civil engineer may not be adequate for a construction contractor). The report should not be used for other than its intended purpose without seeking additional geotechnical advice. Also, unless further geotechnical advice is obtained, the report cannot be used where the nature and/or details of the proposed development are changed.

LIMITATIONS OF SITE INVESTIGATION

The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model, and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation, the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies. The engineering logs are the subjective interpretation of subsurface conditions at a particular location and time, made by trained personnel. The actual interface between materials may be more gradual or abrupt than a report indicates.

SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions can be modified by changing natural forces or man-made influences. The report is based on conditions that existed at the time of subsurface exploration. Construction operations adjacent to the site, and natural events such as floods, or ground water fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. EI should be kept appraised of any such events, and should be consulted to determine if any additional tests are necessary.

VERIFICATION OF SITE CONDITIONS

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that EI be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of change of soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

REPRODUCTION OF REPORTS

 Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimize the likelihood of misinterpretation from logs.

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the Client and no other party. EI assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of EI or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

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