GEOTECHNICAL INVESTIGATION REPORT

No. 7 Cullen Street
Forestville, NSW

Prepared for

Shirley Chen
C/- Zouk Architects

Reference No. ESWN-PR-2022-1529

28th November 2022

Geotechnical Engineering Services

- Geotechnical investigation
- Lot classification
- Geotechnical design
- Footing inspections
- Excavation methodology and monitoring plans
- Slope stability analysis
- Landslide risk assessment
- Tests on soil permeability and absoprtion rate
- Finite element analysis(FEA)

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Revision	Details	Date	Amended By
00	Original	10/10/2022	J.L.
01	Assessment of site condition in Appendix E	28/11/2022	

Author: Jiameng Li.....

Signed: .....JLi.....

Date: 28/11/2022 .....

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REFERENCES

1. Australian Standard – AS 1726-2017 Geotechnical Site Investigation.
2. Australian Standard AS 1289.6.3.2 – Determination of the penetration resistance of a soil – 9 kg dynamic cone penetrometer test.
3. Australian Standard – AS 2870-2011 Residential Slabs and Footings.
4. Australian Standard – AS 2159-2009 Piling - Design and Installation.
5. Australian Standard – AS 3798-2007 Guidelines on Earthworks for Commercial and Residential Developments.
6. Australian Standard – AS 1170.4-2007 Structural Design Actions – Part 4: Earthquake actions in Australia.
7. Austroads – "Pavement Design – A Guide to the Structural Design of Road Pavements", 2004.
8. "NSW WorkCover: Code of Practice – Excavation" July 2015.
9. Pells, P.J.N, Mostyn, G. & Walker B.F., "Foundations on Sandstone and Shale in the Sydney Region", Australian Geomechanics Journal, 1998.
10. Australian Geomechanics Society, Landslide Risk Management Sub-Committee Guidelines: *Landslip Risk Management Concepts and Guidelines,* March 2007.
11. CSIRO, BTF 18 - "Foundation Maintenance and Footing Performance: A Homeowner's Guide".
12. E10 Landslip Risk, Warringah Development Control Plan 2011.
13. Landslip Risk Map – Sheet LSR_004, Warringah Local Environmental Plan 2011.

1. INTRODUCTION

ESWNMAN Pty Ltd (ESWNMAN) was commissioned by Shirley Chen c/- Zouk Architects to undertake a geotechnical investigation for a proposed development at No. 7 Cullen Street, Forestville, NSW 2087. The fieldwork was completed on 5th October 2022 by ESWNMAN staff under the supervision of an experienced Geotechnical Engineer.

The purpose of investigation was to assess the feasibility of site in geotechnical prospective for a proposed alteration & addition to an existing dwelling.

This report presents results of geotechnical investigation & in-situ tests, interpretation and assessment, and provides comments on geotechnical related issues and recommendations.

1.1 Available Information

The following information was provided to ESWNMAN prior to the fieldwork:

- Architectural drawings titled "Alterations & Additions to Existing Dwelling, 7 Cullen Street, Forestville" prepared by Zouk Architects, referenced Project no. 22-106, including drawing nos. A200 & A210, Issue C and dated 10th August 2022.
- A site survey plan titled "Topographical Survey Plan of No. 7 Cullen Street, Forestville, Being Lot 6 Section 44 in DP758421" prepared by ATS Land & Engineering Surveyors Pty Ltd, drawing No. 11613-00 and dated 22nd March 2022.

1.2 Proposed Development

Based on the information provided in Section 1.1, the proposed development will comprise the partial demolition of existing structures, adding the 1st floor level onto existing dwelling and construction of a two storey rear extension.

1.3 Scope of Work

The geotechnical investigation was carried out by an experienced Geotechnical Engineer from ESWNMAN, including the following:

- Collection and review of Before-You-Dig-Australia (BYDA) plans and our in-house dataset near the subject site;
- A site walkover to assess the surface conditions, identify relevant site features and nominate borehole and testing locations;
- Augering of boreholes to check thickness of fill and natural soils;

- Undertaking Dynamic Cone Penetrometer (DCP) Tests to assess the strength of soils with depth and rock profile;
- Reinstatement of site with soil cuttings from boreholes;
- Interpretation of investigation data obtained; and
- Preparation of a geotechnical report.

The approximate locations of boreholes and DCP tests completed during site investigation are shown on Figure 1 – "Site Location Plan" as included in Appendix A of this report.

2. SITE DESCRIPTION

The site is located within Northern Beaches Council area, approximately 12.6km to the north of Sydney CBD, 440m to the south of Carroll Creek and 290m to the northeast of Port Jackson.

The site is identified as Lot 4, Section 44 in Deposited Plan (DP)758421, with an approximate area of 1084m^2. At time of site investigation, the site was occupied by a single storey rendered house.

Based on our observations during a site walkover and site survey plan provided, the site is characterised by a gentle sloping ground towards the Port Jackson in the southwest.

Selected site photographs recorded during site investigation are provided in Appendix B.

3. LOCAL GEOLOGY

Reference to the Sydney 1:100,000 Geological Series Sheet 9130 (Edition 1), dated 1983, by the Geological Survey of New South Wales, Department of Mineral Resources, indicates the site is located within an area underlain by Hawkesbury Sandstone (Rh). The Hawkesbury Sandstone is described as "Medium to coarse-grained quartz sandstone, very minor shale and laminite lenses".

Results of site investigation as provided in Section 5.2 confirmed the published geology.

4. METHODOLOGY OF INVESTIGATION

4.1 Pre-fieldwork

Prior to the commencement of the fieldwork, a desktop study on local geology, Warringah Landslip Risk Map and our in-house dataset near the subject site was undertaken.

BYDA services search was also conducted and reviewed prior to the commencement of fieldwork and in-situ tests.

4.2 Borehole Drilling

A total of four(4) boreholes, to check thickness of fill and property of natural soils, were completed at variable refusal depth between 0.7m and 1.0m below existing ground level (BGL), using a hand operated equipment assisted with in-situ tests.

The approximate location of boreholes is shown on Figure 1 attached in Appendix A. Engineering logs of boreholes processed using Bentley gINT software along with an explanatory note are presented in Appendix C.

4.3 Dynamic Cone Penetrometer (DCP) Test

The Dynamic Cone Penetrometer (DCP) Test involves hammering cone tipped rods using a standard weight and drop height. The number of blows required to penetrate each 100 mm is recorded (Reference 2). The DCP test is used to assess in-situ strength of undisturbed soil and/or compacted materials. The penetration rate of the 9-kg DCP can be used to estimate in-situ CBR (California Bearing Ratio) and to identify strata thickness and other material characteristics.

A total of four(4) DCP tests positioned next to boreholes identified as DCPs 1 to 4 accordingly, were also completed during site investigation. The DCP tests reached refusal depth and bounce of DCP hammer occurred approximately at 0.9m, 0.9m, 0.7m and 1.1m BGL at location of DCPs 1 to 4 respectively.

The location of DCP tests is shown on Figure 1 attached in Appendix A. The record of DCP test results is presented in Appendix D.

All fieldwork was supervised on a full time basis by an experienced Geotechnical Engineer who was responsible for nominating locations of boreholes and DCP tests, preparing field engineering logs of subsurface strata encountered in accordance with AS 1726 for Geotechnical Site Investigation(Reference 1), conducting in-situ tests and taking site photographs.

The approximate reduced levels of boreholes & DCP tests, which were estimated based on the survey plan as referenced in Section 1.1, are presented in the attached engineering logs and record sheet of DCP tests.

5. RESULTS OF INVESTIGATION

5.1 Surface Conditions

At time of investigation, apart from existing single storey dwelling, paved driveway and tiled surface, the remainder of outdoor area was covered with grass and lawn. Some sandstone outcrops were present on surface at rear of the site.

5.2 Subsurface Conditions

Based on borehole information and interpreted results of DCP test, subsurface conditions encountered consisted of the following:

- **Fill** (Unit 1): Clayey SAND, fine-medium grained, grey, some topsoil near surface, some gravel, moist, poorly compacted, typically 0.5m-0.6m in thickness at testing locations; overlying
- **Residual Soils** (Unit 2): SAND/Clayey SAND, medium grained, brown, moist, medium dense, approximately extending to inferred top of rock at 0.9m, 0.9m, 0.7m and 1.1m BGL at location of DCPs 1 to 4 respectively; overlying
- **Weathered Sandstone** (Unit 3): Class V Sandstone, medium to coarse grained, brown, moderately to slightly weathered, medium strength, based on interpreted results of DCP test and visual examination of sandstone outcrops exposed at rear of the site(See Photo 4 in Appendix B). The classification of rock was carried out in accordance with Pells et al (Reference 9).

The subsurface conditions described above are also summarised in Table 1 below.

Table 1 – Subsurface Conditions at Testing Locations

Geotechnical Unit and Description		**Inferred Depth to Top of Unit** (m, BGL)			
		BH1/ DCP1	BH2/ DCP2	BH3/ DCP3	BH4/ DCP4
Fill (Unit 1)	SAND, poorly compacted	0	0	0	0
Residual Soils (Unit 2)	Clayey SAND, medium dense	0.6	0.5	0.5	0.6
Weathered Sandstone (Unit 3)	Class V- IV SANDSTONE, medium strength	0.9	0.9	0.7	1.1

5.3 Groundwater

No groundwater was encountered during drilling of any boreholes up to 1.0m BGL. No indication of water seepage/inflow or wet soil materials were observed on DCP tools when DCP accessories were extracted onto ground surface upon completion of DCP tests.

6. GEOTECHNICAL ASSESSMENT

The main geotechnical aspects associated with proposed development are assessed to include the following:

- Site classifications;
- Excavation conditions and stability;
- Earth retaining structures;
- Foundations;
- Foundation/subgrade preparation;
- Earthworks and material use; and
- Preliminary assessment of site conditions.

The assessment of geotechnical aspects above and recommendations for the proposed development are presented in the following sections.

6.1 Site Classifications

(a) Site reactive classification

Based on ground profile of the site and the criteria specified in AS 2870 (Reference 3), the site is assessed as Class A – "Most sand and rock sites" with little or no ground movement from moisture changes, provided that our recommendations in Section 6.4 – "Foundations" are adopted during design and construction.

The above classification and footing recommendations are provided on the basis that the performance expectations set out in Appendix B of AS2870 are accepted.

Design, construction and maintenance of plumbing, ground drainage, protection of building perimeter, the garden, etc. should be carried out in accordance with CSIRO BTF18 (Reference 11) to avoid any water related problems or significant changes of moisture in building foundations, which may contribute to surface movement.

(b) Site earthquake classification

The results of the site investigation indicate the presence of fill and residual soils underlain by Class V Sandstone or stronger rock. In accordance with Australian Standard AS 1170.4, the site may be classified as a "Rock site" (Class B_e) for foundation design of building and retaining walls embedded in the underlying sandstone. The Hazard Factor (Z) for Forestville in accordance with AS 1170.4 (Reference 6) is considered to be 0.08.

(c) Landslide risk

Review of landslip risk in accordance with E10 Landslip Risk, Warringah Development Control Plan 2011(Reference 12) was undertaken.

In accordance with "Landslip Risk Map" – Sheet LSR_004, Warringah Local Environmental Plan 2011 (Reference 13), the site is located within an area defined as "**Area B** – Flanking slopes 5° to 25°".

6.2 Excavation Conditions

The design information summarised in Section 1.2 for the proposed development indicate excavation of proposed ground floor level, footing areas for building and retaining walls, and trench excavation for installation of underground pipes and landscaping, would be required during construction.

The observations and results of boreholes indicate the presence of Fill(Unit 1), Residual Soils(Unit 2) and Weathered Sandstone(Unit 3) within the site.

Any fill and deleterious materials, including old footings/buried structures, concrete slabs, plant/tree roots, redundant services, timber/brick material, and sandstone boulders, are expected to be stripped and removed from development area to spoils.

Excavation of the soils and low strength Class V Sandstone (may encounter locally) would be feasible using conventional earthmoving equipment.

For shallow excavation (i.e. <1.0m in depth) The excavations should be carried out in accordance with the 'NSW WorkCover: Code of Practice – Excavation' (Reference 8).

Temporary excavations away from site boundaries through the underlying soils to a maximum depth of 1.0m, may be excavated near vertical provided that:

- They do not encroach ZOI(Zone of Influence, defined as 45° angle of draw from nearest edge of footing underside) of any site structures or adjoining properties;
- They are barricaded when not in use;
- They are not left open for more than 24 hours;
- No surcharge loading is applied within 1.5m from edge of excavation;
- No groundwater flows are encountered; and
- They are not used for access by a worker.

Where access is required for workers, the temporary excavation batters should be re-graded to no steeper than 2 Horizontal (H) to 1 Vertical (V) for the soils above the natural groundwater level, or supported by a suitable temporary shoring measure.

Any permanent excavation (or filling) greater than 0.6m in height should be retained by a permanent retaining wall to be designed by a qualified Engineer based on the recommendation provided in Section 6.3 below.

6.3 Earth Retaining Structures

The earth retaining structure should be designed to withstand the applied lateral pressures of the subsurface layers, the existing surcharges in their zone of influence, including existing structures, construction machines, traffic and construction related activities. The design of retaining structures should also take into consideration hydrostatic pressures and lateral earthquake loads as appropriate. **Filter type geofabric should be considered to be installed between wall backfill area and surrounding soils** to prevent the fines from entering the wall drainage system.

The recommended preliminary parameters for design of retaining structures are presented in Tables 2 and 3 below. The coefficients provided are based on drained conditions.

Table 2 - Preliminary Geotechnical Design Parameters for Retaining Walls

Geotechnical Unit	Unit Weight (kN/m^3)	Effective Cohesion c′ (kPa)	Angle of Effective Internal Friction ϕ'(°)	Modulus of Elasticity E_{sh} (MPa)	Poisson Ratio ν
Fill (Unit 1)	17	0	30	10	0.35
Residual Soils (Unit 2)	18	0	33	30	0.35
Class V Sandstone[1] (Unit 3)	24	100	35	100	0.20

[1] - Classification of the rock in accordance with Pells et al (Reference 9).

Table 3 - Preliminary Coefficients of Lateral Earth Pressure

Geotechnical Unit	Coefficient of Active Lateral Earth Pressure (Ka)	Coefficient of Active Lateral Earth Pressure at Rest (Ko)	Coefficient of Passive Lateral Earth Pressure (Kp)
Fill (Unit 1)	0.33	0.50	3.0
Residual Soils (Unit 2)	0.29	0.46	3.4
Class V Sandstone[1] (Unit 3)	0.27	0.43	3.7

[1] - Classification of the rock in accordance with Pells et al (Reference 9).

6.4 Foundations

Results of investigation and assessments indicate the ground conditions at this site are suitable for the proposed development and associated works.

Based on proposed development and subsurface conditions, in particular the rock profile (i.e. 0.7m-1.1m BGL), we assessed the following footing systems are applicable for proposed development at this site (including new structures or underpinning design):

- **Option 1: Piers/piled foundations;** or
- **Option 2: Cast in-situ reinforced concrete shallow foundations**, such as pad and strip footings under columns and walls.

For any footing systems above, **we recommend all footings for building and retaining walls should be founded in Unit 3 – "Class V Sandstone" or stronger rock**, with minimum 300 footing embedment.

The preliminary geotechnical parameters recommended for design of shallow and piled foundations are provided in Table 4 below.

Table 4 - Preliminary Geotechnical Foundation Design Parameters

Geotechnical Unit	Allowable Bearing Capacity (kPa[1])	Allowable Shaft Adhesion (kPa)	Modulus of Elasticity (Es,v, MPa)
Fill (Unit 1)	N/A[2]	N/A[2]	15
Residual Soils (Unit 2)	150 (Shallow footings)[2]	15	30
Class V Sandstone(Unit 3)	800 (Shallow footings/piles)	60	150

[1] With a minimum embedment depth of 300mm into bearing stratum.
[2] N/A, Not Applicable, not recommended for building and retaining wall structures

Design of shallow and piled foundations should be carried out in accordance with Australian Standards AS2870(Reference 3) and AS2159 (Reference 4).

To minimise the potential effects of differential settlement under the buildings loads, it is recommended all foundations of the proposed building should be founded on consistent materials of similar properties or rock of similar class.

Any water, debris, loose and wet materials should be removed from excavations prior to placement of reinforcement and pouring of concrete.

A Geotechnical Engineer should be engaged to inspect footing excavations to ensure foundation bases have suitable materials with adequate bearing capacity, and to check the

adequacy of footing embedment/socket depth if unexpected ground conditions are encountered.

6.5 Foundation/subgrade Preparation

For service pipes or slabs to fully or partially rely on soils underneath (existing fill or new fill), to achieve an allowable bearing capacity of 150kPa, the following is recommended:

- Excavate and re-compact Unit 1 – "Fill";
- Remove roots/timber and organic matters and oversized materials(if any);
- Level off the existing natural ground surface and provide proof rolling;
- Place fill materials (preferably granular materials) at loose layer of not exceeding 150mm in thickness for cohesive soils and 200mm for cohesionless materials;
- Densify the fill mechanically, using a suitable roller or compaction equipment and provide adequate compaction;
- Repeat the above till proposed FLL is reached.

The compaction for different engineering purposes should be carried out in accordance with recommendations provided in Section 6.6 below.

6.6 Earthworks and Material Use

The excavated materials from excavation are assessed to be generally suitable for landscaping provided they are free of any contaminants.

The suitability of site excavated or imported materials should be subject to satisfying the following criteria:

- The materials should be Virgin Excavated Natural Material (VNEM) and clean (i.e. free of contaminants, deleterious or organic material), free of inclusions of >75mm in size, high plasticity material be removed and suitably conditioned to meet the design assumptions where fill material is proposed to be used.
- The materials should satisfy the Australian Standard AS 3798 Guidelines on Earthworks for Commercial and Residential Developments (Reference 5).

The final surface levels of all excavation and filling areas should be compacted in order to achieve an adequate strength for subgrade.

As a guidance for fill construction, the following compaction targets can be adopted:

- Moisture content of ±2% of OMC (Optimal Moisture Content);

- Minimum density ratio of 100% of MDD (Maximum Dry Density) for filling within building/structural foundation areas;
- Minimum density ratio of 98% of MDD for filling surrounding the pipes within trenches or behind retaining walls (unless otherwise specified on design drawings);
- The loose thickness of layer should not exceed 200mm for cohesionless soils; and
- For the footpath and pavement areas, minimum density ratio of 95% of MDD for general fill and 98% for the subgrade to 0.5m depth.

Design and construction of earthworks should be carried out in accordance with Australian Standard AS 3798 (Reference 5).

6.7 Preliminary Assessment of Site Conditions

Review of Landslide Risk Map – Sheet LSR_004, Warringah Local Environmental Plan 2011(Reference 13) and our on-site assessment as provided in Section 6.1 (c) indicate the site is located within **"Area B"** in accordance with Landslip Risk Map.

Based on preliminary assessment of site conditions as provided in Appendix E of this report in accordance with Clause 6.4 of WLEP 2011 and Clause E10 of WDCP 2011, **we recommended that a geotechnical assessment is not required for this site.**

Nevertheless, a geotechnical investigation and report (this report) was completed at this site was for structural design purposes. We recommend footings of new building and retaining walls structures should be founded in underlying **Unit 3 – "Class V Sandstone"** with minimum 300mm footing embedment into underlying rock as provided in Section 6.4, so that any potential risks for site instability or landslip can be effectively eliminated.

7. CONCLUSIONS AND RECOMMENDATIONS

- Results of geotechnical investigation and assessment indicate ground conditions at this site are suitable for proposed alterations and additions.
- Preliminary assessment of site conditions conducted in accordance with Clause 6.4 of WLEP 2011 and Clause E10 of WDCP 2011 suggested that a geotechnical assessment is not required for this site.
- We assessed a footing system consisting of **piers/piles** or **cast in-situ reinforced concrete shallow footings** are applicable for proposed development at this site. **We recommend the suitable founding materials should be Unit 3 – "Class V Sandstone" or stronger rock, with minimum 300mm footing embedment** for

both footing options. The footing options and recommended geotechnical design parameters are provided in Section 6.4.

- For service pipes or slabs to fully or partially rely on soils underneath (either existing fill or new fill), "Foundation/subgrade Preparation" in Section 6.5 should be implemented during construction.
- The construction, including excavation methods, safe excavation batter, footing systems, foundation/subgrade preparation, cut/fill & earthworks, retaining walls and drainage works, should be implemented in accordance with the recommendations provided in Section 6.
- A Geotechnical Engineer should be engaged to inspect footing excavations to ensure the foundation base have been taken to suitable materials of appropriate bearing capacity and adequate embedment depth/socket length if unexpected ground conditions are encountered.

8. LIMITATIONS

This report should be read in conjunction with the "Limitations of Geotechnical Investigation Statement" attached as Appendix F, which provides important information regarding geotechnical investigation, assessment and reporting. If the actual subsurface conditions exposed during construction vary significantly from those discussed in this report, this report should be reviewed, and the undersigned should be contacted for further advices.

For and on behalf of
ESWNMAN Pty Ltd

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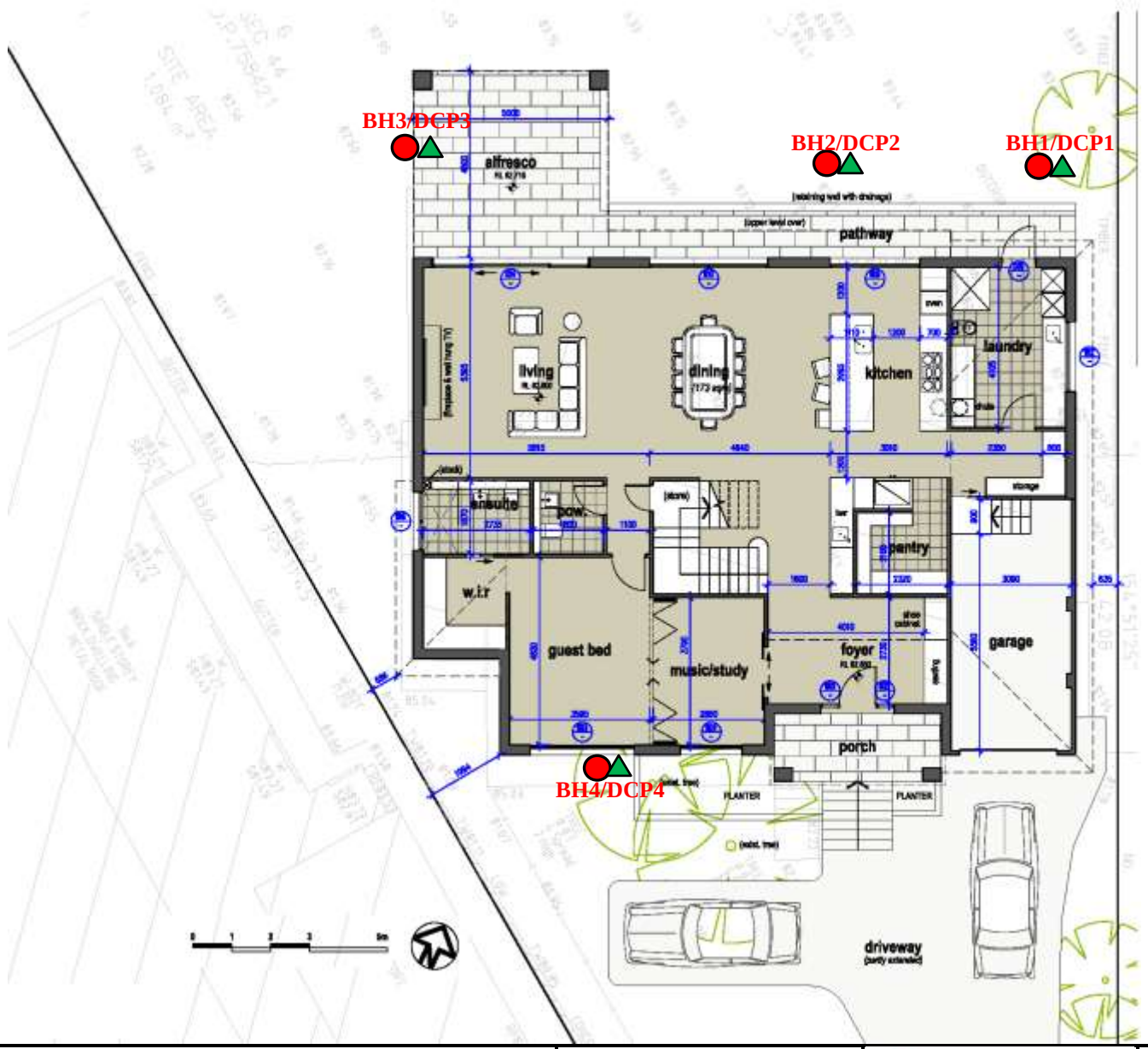
ESWNMAN 25 YEARS EXPERIENCE

APPENDIX A

SITE LOCATION PLAN

Image source: An architectural drawing prepared by Zouk Architects.



LEGEND

- Approximate Location of Borehole (BH)
- Approximate Location of Dynamic Cone Penetrometer (DCP) Test

PROJECT: No. 7 Cullen Street, Forestville, NSW 2087	**DRAWN BY:** J.L.	ESWNMAN 25 YEARS EXPERIENCE	**CLIENT:** Shirley Chen	
PROJECT NO: ESWN-PR-2022-1529	**DATE:** 10th October 2022		**TITLE:** Site Location Plan	FIGURE 1

APPENDIX B

SITE PHOTOGRAPHS

	
Photograph 1 Dynamic Cone Penetrometer(DCP) Test at location of DCP1 within rear garden	**Photograph 2** DCP test at location of DCP3 within rear garden
	
Photograph 3 DCP test at location of DCP4 at front yard	**Photograph 4** Sandstone outcrops exposed at rear of site

Appendix B Site Photographs

APPENDIX C

ENGINGGERING BOREHOLE LOGS AND EXPLANATORY NOTES

BOREHOLE NUMBER BH1

ESWNMAN ESWNMAN Pty Ltd
25 YEARS EXPERIENCE

CLIENT Shirley Chen **PROJECT NAME** Geotechnical Investigation

PROJECT NUMBER ESWN-PR-2022-1529 **PROJECT LOCATION** 7 Cullen Street, Forestville, NSW

DATE STARTED 5/10/22 **COMPLETED** 5/10/22 **R.L. SURFACE** 83.5 **DATUM** m AHD

DRILLING CONTRACTOR ESWNMAN Pty Ltd **SLOPE** 90° **BEARING** ---

EQUIPMENT Hand Auger & DCP Test **HOLE LOCATION** Refer to Figure 1 Site Location Plan

HOLE SIZE 70mm **LOGGED BY** W.L. **CHECKED BY** J.L.

NOTES Rear garden

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
HA	Not Encountered	83.0	0.5		SC	Clayey SAND, fine-medium grained, grey, some topsoil near surface, trace gravel, moist, poorly compacted.		FILL
					SC	SAND, medium grained, brown, moist, medium dense.		RESIDUAL SOILS DCP test indicates top of rock below 0.9m depth
		82.5	1.0			Borehole BH1 terminated at 0.8m		
		82.0	1.5					

BOREHOLE NUMBER BH2

ESWNMAN ESWNMAN Pty Ltd
25 YEARS EXPERIENCE

CLIENT Shirley Chen **PROJECT NAME** Geotechnical Investigation

PROJECT NUMBER ESWN-PR-2022-1529 **PROJECT LOCATION** 7 Cullen Street, Forestville, NSW

DATE STARTED 5/10/22 **COMPLETED** 5/10/22 **R.L. SURFACE** 83.1 **DATUM** m AHD

DRILLING CONTRACTOR ESWNMAN Pty Ltd **SLOPE** 90° **BEARING** ---

EQUIPMENT Hand Auger & DCP Test **HOLE LOCATION** Refer to Figure 1 Site Location Plan

HOLE SIZE 70mm **LOGGED BY** W.L. **CHECKED BY** J.L.

NOTES Rear garden

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
HA	Not Encountered	83.0			SC	Clayey SAND, fine grained, grey, some topsoil near surface, moist, poorly compacted.		FILL
			0.5		SC	SAND, medium grained, brown, moist, medium dense.		RESIDUAL SOILS
		82.5						DCP test indicates top of rock below 0.9m depth
						Borehole BH2 terminated at 0.8m		
			1.0					
		82.0						
			1.5					

BOREHOLE NUMBER BH3

ESWNMAN ESWNMAN Pty Ltd
25 YEARS EXPERIENCE

CLIENT Shirley Chen
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER ESWN-PR-2022-1529
PROJECT LOCATION 7 Cullen Street, Forestville, NSW

DATE STARTED 5/10/22 **COMPLETED** 5/10/22 **R.L. SURFACE** 82.6 **DATUM** m AHD
DRILLING CONTRACTOR ESWNMAN Pty Ltd **SLOPE** 90° **BEARING** ---
EQUIPMENT Hand Auger & DCP Test **HOLE LOCATION** Refer to Figure 1 Site Location Plan
HOLE SIZE 70mm **LOGGED BY** W.L. **CHECKED BY** J.L.
NOTES Rear garden

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
HA	Not Encountered	82.5			SC	Clayey SAND, fine-medium grained, grey, some topsoil near surface, some gravel, moist, poorly compacted.		FILL
			0.5		SC	SAND, medium grained, brown, moist, medium dense.		RESIDUAL SOILS
		82.0						DCP test indicates top of rock below 0.7m depth
						Borehole BH3 terminated at 0.7m		
			1.0					
		81.5						
			1.5					

BOREHOLE NUMBER BH4

ESWNMAN ESWNMAN Pty Ltd
25 YEARS EXPERIENCE

CLIENT Shirley Chen
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER ESWN-PR-2022-1529
PROJECT LOCATION 7 Cullen Street, Forestville, NSW

DATE STARTED 5/10/22 **COMPLETED** 5/10/22 **R.L. SURFACE** 81.1 **DATUM** m AHD
DRILLING CONTRACTOR ESWNMAN Pty Ltd **SLOPE** 90° **BEARING** ---
EQUIPMENT Hand Auger & DCP Test **HOLE LOCATION** Refer to Figure 1 Site Location Plan
HOLE SIZE 70mm **LOGGED BY** W.L. **CHECKED BY** J.L.
NOTES Front yard

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
HA	Not Encountered	81.0	0.5		SC	Clayey SAND, fine-medium grained, grey, trace gravel, moist, poorly compacted.		FILL
		80.5	1.0		SC	SAND, medium grained, brown, moist, medium dense.		RESIDUAL SOILS DCP test indicates top of rock below 1.1m depth
		80.0	1.5			Borehole BH4 terminated at 1m		

Explanatory Notes – Description for Soil

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

METHOD

Method	Description
AS	Auger Screwing
BH	Backhoe
CT	Cable Tool Rig
EE	Existing Excavation/Cutting
EX	Excavator
HA	Hand Auger
HQ	Diamond Core-63mm
JET	Jetting
NMLC	Diamond Core –52mm
NQ	Diamond Core –47mm
PT	Push Tube
RAB	Rotary Air Blast
RB	Rotary Blade
RT	Rotary Tricone Bit
TC	Auger TC Bit
V	Auger V Bit
WB	Washbore
DT	Diatube

WATER


Water level at date shown


Partial water loss


Water inflow


Complete water loss

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

NFGWE: The borehole/test pit was dry soon after excavation. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING

Sample	Description
B	Bulk Disturbed Sample
D	Disturbed Sample
Jar	Jar Sample
SPT	Standard Penetration Test
U50	Undisturbed Sample –50mm
U75	Undisturbed Sample –75mm

UNIFIED SOIL CLASSIFICATION

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

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

MOISTURE CONDITION

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

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

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

For cohesive soils the following codes may also be used:

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

PLASTICITY

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

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

COHESIVE SOILS - CONSISTENCY

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

A Hand Penetrometer may be used in the field or the laboratory to provide an approximate assessment of the unconfined compressive strength (UCS) of cohesive soils. The undrained shear strength of cohesive soils is approximately half the UCS. The values are recorded in kPa as follows:

Strength	Symbol	Undrained Shear Strength, C_u (kPa)
Very Soft	VS	< 12
Soft	S	12 to 25
Firm	F	25 to 50
Stiff	St	50 to 100
Very Stiff	VSt	100 to 200
Hard	H	> 200

COHESIONLESS SOILS - RELATIVE DENSITY

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

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

COHESIONLESS SOILS PARTICLE SIZE DESCRIPTIVE TERMS

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

Description for Rock

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

METHOD

Refer soil description sheet

WATER

Refer soil description sheet

ROCK QUALITY

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

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

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

ROCK MATERIAL WEATHERING

Rock weathering is described using the abbreviations and definitions used in AS1726. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between (but not including) XW and SW. For projects where it is not practical to delineate between HW and MW or it is deemed that there is no advantage in making such a distinction, DW may be used with the definition given in AS1726.

Symbol	Term	Definition
RS	Residual Soil	Soil definition on extremely weathered rock; the mass structure and substance 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, ie. It either disintegrates or can be remoulded in water
HW	Highly Weathered	The rock substance is affected by weathering to the extent that limonite staining or bleaching affects the whole rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength is usually decreased compared to the fresh rock. The colour and strength of the fresh rock is no longer recognisable.
DW	*Distinctly Weathered (see AS1726 Definition below)*	
MW	Moderately Weathered	The whole of the rock substance is discoloured, usually by iron staining or bleaching, to the extent that the colour of the fresh rock is no longer recognisable
SW	Slightly Weathered	Rock is slightly discoloured but shows little or no change of strength from fresh rock
FR	Fresh	Rock shows no sign of decomposition or staining

"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 the deposition of weathering products in pores." (AS1726)

ROCK STRENGTH

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

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

● Diametral Point Load Index test

■ Axial Point Load Index test

DEFECT SPACING/BEDDING THICKNESS

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

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

DEFECT DESCRIPTION

Type:	Definition:
B	Bedding
BP	Bedding Parting
F	Fault
C	Cleavage
J	Joint
SZ	Shear Zone
CZ	Crushed Zone
DB	Drill Break

Planarity:	Roughness:
P – Planar	R – Rough
Ir – Irregular	S – Smooth
St – Stepped	Sl – Slickensides
U – Undulating	Po – Polished

Coating or Infill:	Description
Clean	No visible coating or infilling
Stain	No visible coating or infilling but surfaces are discoloured by mineral staining
Veneer	A visible coating or infilling of soil or mineral substance but usually unable to be measured (<1mm). If discontinuous over the plane, patchy veneer
Coating	A visible coating or infilling of soil or mineral substance, >1mm thick. Describe composition and thickness

The inclinations of defects are measured from perpendicular to the core axis.

Graphic Symbols for Soil and Rock

Graphic symbols used on borehole and test pit reports for soil and rock are as follows. Combinations of these symbols may be used to indicate mixed materials such as clayey sand.

Soil Symbols

Main Components


CLAY


SILT


SAND


GRAVEL


BOULDERS / COBBLES


PEAT (Organic)

Minor Components


Clayey


Silty


Sandy


Gravelly

Other Symbols


TOPSOIL


FILL


ASPHALT


CONCRETE


NO CORE

Rock Symbols

Sedimentary Rocks


SANDSTONE


SILTSTONE


CLAYSTONE, MUDSTONE


SHALE


LAMINITE


CONGLOMERATE


BRECCIA


TILL


COAL


LIMESTONE

Igneous Rocks


PLUTONIC IGNEOUS (eg: Granite)


VOLCANIC IGNEOUS (eg: Basalt)


PYROCLASTIC IGNEOUS (eg: Ignimbrite)

Metamorphic Rocks


SLATE, PHYLLITE, SCHIST


GNEISS


QUARTZITE

Engineering classification of shales and sandstones in the Sydney Region - A summary guide

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

CLASSIFICATION FOR SANDSTONE

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

CLASSIFICATION FOR SHALE

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

1. ROCK STRENGTH

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

2. DEFECT SPACING

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

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

[1]After ISO/CD14689 and ISRM.

3. ALLOWABLE SEAMS

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

Source: Based on Pells, P.J.N, Mostyn, G. and Walker, B.F. (1998) – Foundations on sandstone and shale in the Sydney region. Australian Geomechanics Journal, No 33 Part 3

APPENDIX D

RESULTS OF DYNAMIC CONE PENETROMETER(DCP) TEST

RESULTS OF DYNAMIC CONE /PERTH SAND PENETROMETER TEST

ESWNMAN
25 YEARS EXPERIENCE

Client:	Shirley Chen	Ref No:	ESWN-PR-2022-1529
Project:	Geotechnical Investigation	Date tested:	5/10/2022
Location:	7 Cullen Street, Forestville, NSW 2087	Tested By:	W.L./J.L.

Depth (mm)	DCP No.				Depth (mm)	DCP No.			
	DCP1	DCP2	DCP3	DCP4		5	6	7	8
0-100	0	0	0	0	0-100				
100-200	1			1	100-200				
200-300		1			200-300				
300-400				2	300-400				
400-500	1	1	1	1	400-500				
500-600	1	2	3	1	500-600				
600-700	2	4	4	3	600-700				
700-800	2	6	Bounce	3	700-800				
800-900	4/60mm	6/50mm		5	800-900				
900-1000	Bounce	Bounce		7	900-1000				
1000-1100				10/50mm	1000-1100				
1100-1200				Bounce	1100-1200				
1200-1300					1200-1300				
1300-1400					1300-1400				
1400-1500					1400-1500				
1500-1600					1500-1600				
1600-1700					1600-1700				
1700-1800					1700-1800				
1800-1900					1800-1900				
1900-2000					1900-2000				
2000-2100					2000-2100				
2100-2200					2100-2200				
2200-2300					2200-2300				
2300-2400					2300-2400				
2400-2500					2400-2500				
2500-2600					2500-2600				
2600-2700					2600-2700				
2700-2800					2700-2800				
2800-2900					2800-2900				
2900-3000					2900-3000				
3000-3100					3000-3100				
3100-3200					3100-3200				
3200-3300					3200-3300				
3300-3400					3300-3400				
3400-3500					3400-3500				
3500-3600					3500-3600				
3600-3700					3600-3700				
3700-3800					3700-3800				
3800-3900					3800-3900				
3900-4000					3900-4000				
RL (m)	83.5	83.1	82.6	81.1	RL (m)				

Notes:

1. Australian Standard AS 1289.6.3.2 – Determination of the penetration resistance of a soil – 9 kg dynamic cone penetrometer test.
2. Australian Standard AS 1289.6.3.3 – Determination of the penetration resistance of a soil – Perth Sand Penetrometer (PSP) test.

APPENDIX E

CHECKLIST FOR COUNCIL'S ASSESSMENT OF SITE CONDITIONS

APPENDIX E - ASSESSMENT OF SITE CONDITIONS

1.0	***LANDSLIP RISK CLASS*** *(circle Landslip Risk Class in which site is located)*
	A A Geotechnical report not normally required.
O	Ⓑ *B Preliminary assessment of site conditions required to determine whether a geotechnical report is required.*
	C C Geotechnical report required.
	D Preliminary assessment of site conditions required to determine whether a geotechnical report required.
	E Geotechnical report required.

2.0 SITE LOCATION

Street no.& Name, Position in street (above or below), Site dimensions (block shape & size);

- ***Site address:*** *No. 7 Cullen Street, Forestville, NSW, Lot 4, Section 44 in DP758421*
- ***Position in street:*** *Above street*
- ***Site dimensions:*** *Semi triangular-shaped land, 1084m^2*

3.0 PROPOSED DEVELOPMENT

General description, including maximum excavation depths, maximum fill depths, and proximity to existing structures;

- ***Maximum cut depth:*** *200mm-500mm*
- ***Maximum fill height:*** *200mm-400mm*
- ***Proximity to existing structures:*** *Attached to rear of existing dwelling*

Other comments: *minor footing excavation, such as piers/piles.*

4.0 EXISTING SITE DESCRIPTION

eg. Topography, slope angles (in degrees), exposures of rock and soil, existing site development, evidence of possible slope instability.

- ***Topography:*** *General flat and slightly sloping (with slope angle of 3°) at front and middle of site (existing dwelling & new extension), gentle & minor moderate sloping ground at rear of site (slope angle varying from 5° to 15°, >15m offset from proposed extension)*
- ***Exposure of rock and soil:*** *Shallow rock across the site(<1m deep), some sandstone outcrops and boulders exposed at rear of site (see Photo 4 in Appendix B)*
- ***Existing site development:*** *No crack on ground surface or walls of existing building; no distressing of existing site structures*
- ***Evidence of possible slope instability:*** *No evidence on existing instability/landslip, no rockfall. Sandstone bedrock and boulders at rear embedded into soils, no potential for landslip or rock fall, as indicated on Photo 4 in Appendix B.*

5.0 RECOMMENDATIONS

Based on the above items, and the attached flowchart that indicates the principal factor(s) considered in the assessment, it is recommended that:

Geotechnical assessment is not required.

Other comments: *Geotechnical report was prepared for Structural Engineer and Builder.*

6.0 DATE OF ASSESSMENT*: 25/11/2022*

7.0 ASSESSMENT BY: *Jiameng Li, Principal Geotechnical Engineer, BE (Civil), MEngSc (Geotechnical), MIEAust, CPEng, NER, RPEQ*

APPENDIX F

LIMITATIONS OF GEOTECHNICAL INVESTIGATION

General

In making an assessment of a site from a limited number of boreholes or test pits there is the possibility that variations may occur between testing locations. Site exploration identifies specific subsurface conditions only at those points from which samples have been taken. The risk that variations will not be detected can be reduced by increasing the frequency of testing locations. The investigation program undertaken is a professional estimate of the scope of investigation required to provide a general profile of the subsurface conditions. The data derived from the site investigation program 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 borehole/test pit logs are the subjective interpretation of subsurface conditions at a particular location, made by trained personnel. The interpretation may be limited by the method of investigation, and cannot always be definitive.

Subsurface conditions

Subsurface conditions may be modified by changing natural forces or man-made influences. A geotechnical report is based on conditions which existed at the time of subsurface exploration.

Construction operations at or adjacent to the site, and natural events such as rainfall events, floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept appraised of any such events, and should be consulted to determine if additional tests are necessary.

Assessment and interpretation

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

Information and documentations

Final logs are developed by geotechnical engineers based upon their interpretation of field description and laboratory results of field samples. Customarily, only the final logs are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings. To minimise the likelihood of bore/profile log misinterpretation, contractors should be given access to the complete geotechnical engineering report prepared or authorised for their use. Providing the best available information to contractors helps prevent costly construction problems.

Construction phase service (CPS)

During construction, excavation is frequently undertaken which exposes the actual subsurface conditions. For this reason geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed and to conduct additional tests which may be required and to deal quickly with geotechnical problems if they arise.

Report

The report has been prepared for the benefit of the client and no other parties. ESWNMAN PTY LTD 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 ESWNMAN PTY LTD 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 enquiries and obtain independent advice in relation to such matters.

Other limitations

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