TGE Taylor Geotechnical Engineering

Geotechnical Civil Engineers & Project Managers

REPORT ON GEOTECHNICAL INVESTIGATION

PROPOSED RESIDENTIAL DEVELOPMENT

41 & 43 BEACH ROAD COLLAROY

CLIENT: JENNIFER & RUSSELL STALEY

PROJECT: TGE21914

DATE: 15 JUNE 2019

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LRT
Report TGE21914
15 June 2019

REPORT ON GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
41 & 43 BEACH ROAD COLLAROY

1. INTRODUCTION

This report details the results of a geotechnical investigation undertaken at 41 & 43 Beach Road Collaroy. Virginia Kerridge Architect requested the investigation on behalf of the property owners, Jennifer & Russell Staley, which was carried out by Taylor Geotechnical Engineering Pty Limited as per the fee Proposal tgeP1904 dated 14th May 2019.

It is understood that development will comprise demolition of the two existing residences and construction of a new three level residence including basement car parking and in-ground swimming pool. The aim of the investigation was to provide information on subsurface conditions to assist with design and planning.

The investigation comprised photographic survey, test bores, insitu testing of the subsurface strata and engineering inspection and assessment. Details of the fieldwork are given in the report, together with comments relating to design and construction practice.

2. SITE DESCRIPTION

The site is located on the eastern side of Beach Road and has the shape and dimensions as shown on Drawing 1 - Site Plan in Appendix 1 with a total area of approximately 1536.5 m^2. The site is bounded by neighbouring properties to the north, south west and south and is located atop the headland at the southern end of Collaroy Beach. Natural ground falls to the west and south with average slopes of approximately 1 degree across No. 43 and the northern area of No. 41. The land falls away across the southern section of No. 41 with slopes increasing to approximately 20 degrees to the south and up to 10 degrees to the east along the western section of the southern boundary before levelling out towards the eastern end of the southern boundary. The site is retained along the southern side boundary by a sandstone block retaining wall shown in Photo 6 in Appendix 3, approximately 3 m in height at the eastern end reducing to 1 m at the western end. Various views of the site are shown in Photos 1 to 7 in Appendix 3 with the photo locations shown on Drawing 1.

Reference to the Sydney 1:100,000 Geological Sheet indicates that the site is underlain by the Newport Formation from the Narrabeen Group, of the Triassic Period. The Newport Formation typically comprises interbedded laminite, shale and quartz to lithic-quartz sandstone. The rocks of this formation typically weather to form moderately reactive sandy and silty clay soils but highly reactive clay soils are possible.

3. FIELD WORK METHODS

The fieldwork comprised the drilling of six test bores. The test bores were drilled with a Dingo mounted 100 mm diameter continuous flight auger. A dynamic penetrometer test (DPT) was conducted at each bore location, testing from the surface level to a maximum depth of 2.4 m or prior refusal. The DPT's were conducted in order to give an indication of the strength of the near surface strata and depth to bedrock (if within 2.4 m) and were carried out in accordance with test method AS 1289.6.3.2. An experienced geotechnical engineer logged the bores on site with strata identification made from the auger cuttings.

4. FIELD WORK RESULTS

Details of the conditions encountered in the test bores are given in the test bore report sheets in Appendix 2 and are summarised below. The bores were drilled to depths ranging from 2.2 to 4.0 metres in the approximate locations shown on Drawing 1 in Appendix 1.

The test bores encountered relatively similar subsurface geology with Bore 1 encountering sandy topsoil to a depth of 0.15 m then sandy filling to 1.0 m and stiff and very stiff silty clay layers to 1.9 m where very low strength siltstone was encountered. The bore was terminated at a depth of 2.3 m due to auger refusal on the siltstone.

Bore 2 encountered sandy topsoil to a depth of 0.3 m then sandy filling to 0.6 m underlain by initially firm becoming stiff and very stiff to hard silty clay layers to 2.4 m where very low strength siltstone was encountered. The bore was terminated at a depth of 3.1 m due to auger refusal on the siltstone.

Bore 3 encountered sandy topsoil to 0.6 m underlain by stiff then hard silty clay layers to 2.0 m where very low strength siltstone was encountered to a depth 2.7 m where very low to low strength sandstone was encountered. The bore was terminated at a depth of 3.1 m due to auger refusal on the sandstone.

Bore 4 encountered sandy topsoil to a depth of 0.25 m then sandy filling to 0.6 m underlain by initially stiff becoming very stiff then hard silty clay layers to 2.0 m where very low strength siltstone was encountered, underlain by very low strength sandstone at a depth of 3.0 m. The bore was terminated at a depth of 4.0 m due to auger refusal on the sandstone.

Bore 5 encountered sandy topsoil to a depth of 0.2 m then sandy filling to 0.4 m underlain by initially firm becoming stiff then very stiff and hard silty clay layers to 1.8 m where very low strength siltstone was encountered. The bore was terminated at a depth of 2.2 m due to auger refusal on the siltstone.

Bore 6 encountered sandy topsoil to a depth of 0.3 m then clayey sand filling to 0.9 m underlain by hard silty clay layers to 1.7 m where very low strength siltstone was encountered, underlain by very low strength sandstone at a depth of 2.7 m. The bore was terminated at a depth of 2.9 m due to auger refusal on the sandstone.

Dynamic penetrometer tests (DPT's) encountered refusal at depths of 1.8 m to 2.2 m, indicating the likely presence of the weathered bedrock profile at these depths and locations. The silty clays underlying the site are generally in a stiff grading to hard condition.

Groundwater seepage was not observed in any of the bores at the time of investigation but seepage would be expected during excavation, particularly after rain given the local topography.

Although the southern section of the site is affected by the Class 5 Acid Sulfate Soils zone as shown on Warringah Local Environmental Plan 2011 map, the results of the fieldwork indicate that no acid sulfate generating soils are likely to be present.

5. PROPOSED DEVELOPMENT

It is understood that that the proposed development will comprise demolition of the existing two residences and construction of a new three level residence spanning both blocks with a basement car parking and storage level, two levels above and an in-ground swimming pool at the basement level. Reference to Virginia Kerridge Architect plans, DA issue, indicate that the proposed basement floor level will be RL 8.35, the ground floor will be at RL 12.0 and the first floor level will be at RL 15.3.

6. COMMENTS

6.1 Inferred Geological Profile

Based on the results of the field work the inferred geological profile underlying the site consists of surficial loose sandy topsoils and filling underlain by natural silty clays overlying siltstone grading to sandstone bedrock at depths of generally 1.7-2.4 m over much of the proposed building platform.

6.2 Stability Risk Assessment

Reference to the Warringah Council (now Northern Beaches Council) Landslip map indicates that much of the site is within Area A (generally near flat areas) with the southern section of No. 41 within Area E (slopes greater than 15 degrees). The results of the geotechnical investigation indicated that there is no evidence of recent instability (over the design life of the current developments) and that currently there are no landslide hazards that would pose an unacceptable risk to property or life. It is expected that the proposed development will be constructed in a manner that will not increase the risk of instability to this or any adjoining sites. This will involve the control of stormwater and provision of adequate shoring measures (if required) for proposed excavations.

Assessment of the site has been made in accordance with the methods and requirements as outlined by the Australian Geomechanics Society Landslide Taskforce, Landslide Practice Note Working Group paper titled 'Practice Note Guidelines for Landslide Risk Management 2007'.

6.3 Excavation

Excavation of up to approximately 4.5 m will be required for construction of the basement parking and storage level. Conventional earthmoving equipment such as an excavator fitted with a digging bucket, is normally used to excavate residual soils and very low strength bedrock. The use of rippers and hydraulic rock breakers will be required to excavate low or better strength bedrock. It is expected that much of the material that will require excavation below 2.0 m depth will consist of siltstone and sandstone bedrock ranging in strength from extremely to very low grading to medium strength with possibly high strength layers.

Vibration levels are controlled by rock strength and the size of the rock hammer used to excavate the material, therefore if medium or higher strength sandstone is encountered and hydraulic rock hammers are used, precautions will need to be put in place to limit site vibration levels. Given the limited access for larger excavation equipment it is likely that small hand held equipment will be used. Consideration could also be given to hydraulic rock splitting techniques to limit vibration associated with excavation of medium and high strength sandstone.

A maximum peak particle velocity of 10 mm/sec is recommended by AS 2187 Explosives Code for houses and low rise residential buildings and this is the peak particle velocity limit recommended for this site (unless otherwise specified by Council).

If medium or higher strength bedrock is encountered, and hydraulic hammer equipment is used then it is suggested that a vibration monitor be set up onsite to check that vibration levels (peak particle velocity levels) are kept below the recommended peak particle velocity. Although a peak particle velocity of 10 mm/sec is recommended by the relevant Australian Standard, experience has shown that cosmetic damage to masonry structures may occur with peak particle velocities of less than 10 mm/sec. If vibration levels exceed 5 mm/sec cosmetic damage to neighbouring masonry structures may result. If the neighbouring structures are of significant age or show signs of foundation movement, then vibration levels should be kept below 3 mm/sec.

Should larger excavation equipment be required then based on previous experience monitoring excavation of medium or higher strength sandstone in the Sydney region, vibration levels are generally kept below 5 mm/sec if the excavator fitted with hydraulic hammer equipment operates at a distance greater than 3 m away from any neighbouring masonry structures for a 300 kg hammer, 6 m for a 600 kg hammer and 20 m for a 900 kg hammer. If the hydraulic hammer equipment is required to operate within these distances then the hammer should be used in short durations with the hammer pointed away from the structure in question (if possible) and the size of the hammer should be minimised.

If localised excavation to a depth of greater than 1.5 m is required then the sides of the excavation must be either retained or trimmed to a gradient that will ensure stability in both the short term during construction and the long term. The following table lists suggested batter slopes for materials likely to be encountered during excavation.

Table 1 - Batter Slopes

Material	Safe Batter Slope (H:V)	
	Short Term/ Temporary	Long Term/ Permanent
Compacted filling	1.5:1	2.5:1
Residual Clayey soils	1:1	2:1
Clayey Siltstone / Sandstone (extremely & very low strength)	1:1	1.5:1
Siltstone / Sandstone (low strength)	0.5:1	0.75:1 *
Siltstone / Sandstone (medium or better strength)	Vertical *	Vertical *

* Dependent upon jointing and the absence of unfavourably oriented joints

It is recommended that a geotechnical engineer or engineering geologist inspect the faces of the excavation for every 1.5 m depth increment and at completion in order to assess the specific shoring requirements which, if required, may include localised rock bolting and shotcreting or retaining walls.

6.4 Retaining Walls

Where space limitations preclude the battering of either cut or filled slopes, it will be necessary to provide support to the cut or filled embankments using an appropriate "engineer designed" retaining wall system. There is sufficient setback from site boundaries to allow for battering of the excavation, eliminating the need for temporary shoring during construction. The exception is the northern basement wall where battering of the upper 2 m of soils may be feasible but temporary shoring such as reinforced shotcrete may be required for the lower 2.5 m. The basement walls will need to be designed as retaining walls.

Pressures acting on retaining walls can be calculated based on the parameters listed in Table 2 for the materials likely to be retained.

Table 2 - Retaining Structures Design Parameters

Material	Unit Weight (kN/m^3)	Friction Angle Long Term (Drained)	Cohesion (Drained) (kPa)	Earth Pressure Coefficients		Passive Earth Pressure Coefficient *
				Active (Ka)	At Rest (Ko)	
Residual clayey soils and well compacted clayey filling	20	$\phi' = 25°$	c'=5	0.35	0.5	2.0
Silty Sands (Loose)	18	$\phi' = 30°$	c'=0	0.35	0.5	3.0
Extremely low strength rock	22	$\phi' = 30°$	c'=10	0.25	0.4	200 kPa
Very low and low strength rock (jointed)	22	$\phi' = 35°$	c'=20	0.20	0.3	400 kPa
Low strength rock	22	$\phi' = 38°$	c'=50	0.1		2000 kPa
Medium strength rock	24	$\phi' = 40°$	c'=250	0.0**		4000 kPa
High Strength Rock	24	$\phi' = 40°$	c'=500	0.0**		6000 kPa

* Ultimate design values

** 0.1 if highly fractured

Retaining walls should be designed for free draining granular backfill and appropriate surface and subsoil drains to either divert or intercept groundwater flow which otherwise could provide surcharging on the walls and additional pressures. Reinforced concrete block walls or Dincel walls (reinforced concrete wall system) would be appropriate. It is understood that the existing large sandstone block retaining wall along the southern boundary of No 41 will be retained.

6.5 Foundations

Given that weathered bedrock is likely to be exposed at founding level over the building area, then it is recommended that foundations for the development found directly on the weathered bedrock. The use of pad or strip footings, founding in the weathered bedrock would be appropriate, with the foundations dimensioned based on founding in at least very low strength siltstone or sandstone with an allowable bearing capacity of 600 kPa, increasing to 1500 kPa for footings founded in low strength siltstone / sandstone and 3500 kPa for footings founded in medium strength siltstone / sandstone.

A geotechnical engineer should inspect and verify the founding strata for all footings at the time of construction. No water should be allowed to ingress the footing excavations prior to concreting as water ingress will soften clay soils or clayey siltstone / sandstone and reduce the allowable bearing pressure.

Additional information on residential foundations is supplied in CSIRO BTF 18 which is enclosed in Appendix 4.

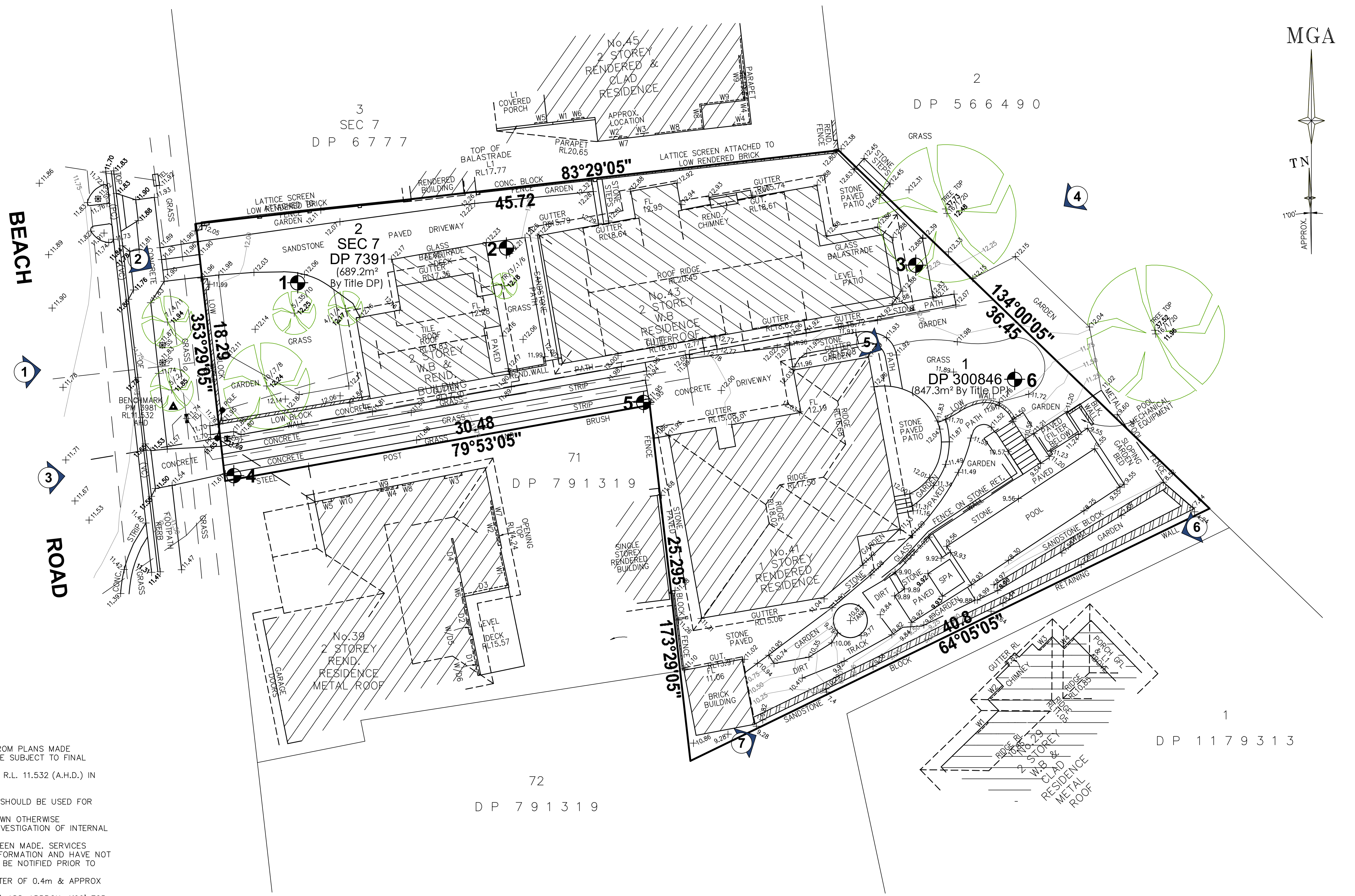
6.6 Geotechnical Verification

In order to verify design bearing capacities and founding strata a certification schedule will be required. A geotechnical engineer or engineering geologist should inspect and verify the founding strata for any footings at the time of construction to ensure that they comply with the certification schedule. If the founding strata are not inspected at the time of construction, then geotechnical certification can't be provided.

TAYLOR GEOTECHNICAL ENGINEERING PTY LIMITED,

Lachlan Taylor
MIE Aust. CPEng. NER.
Principal Geotechnical Engineer

Appendix 1



LEGEND

BENCH MARK	▲
TELSTRA PIT	TEL
ELECTRICITY PIT	EPIT
POWER POLE	● PP
STREET SIGN	⊠ SS
VEHICLE CROSSING	(VC)
PRAM CROSSING	(PC)
GAS (DBYD)	
TELSTRA (DBYD)	
SEWER (DBYD)	
ELECTRICITY (OVERHEAD)	
ELECTRICITY (U'GROUND) (DBYD)	

NOTES

1. ALL AREAS AND DIMENSIONS HAVE BEEN COMPILED FROM PLANS MADE AVAILABLE BY NSW LAND REGISTRY SERVICES AND ARE SUBJECT TO FINAL SURVEY
2. ORIGIN OF LEVELS ON A.H.D. IS TAKEN FROM PM 3981 R.L. 11.532 (A.H.D.) IN BEACH ROAD
3. CONTOUR INTERVAL 0.25 m
4. CONTOURS ARE INDICATIVE ONLY. ONLY SPOT LEVELS SHOULD BE USED FOR CALCULATIONS OF QUANTITIES WITH CAUTION
5. KERB LEVELS ARE TO THE TOP OF KERB UNLESS SHOWN OTHERWISE
6. FLOOR LEVELS SHOWN ARE THRESHOLD LEVELS. NO INVESTIGATION OF INTERNAL FLOOR LEVELS HAS BEEN UNDERTAKEN
10. NO INVESTIGATION OF UNDERGROUND SERVICES HAS BEEN MADE. SERVICES HAVE BEEN PLOTTED FROM RELEVANT AUTHORITIES INFORMATION AND HAVE NOT BEEN SURVEYED. ALL RELEVANT AUTHORITIES SHOULD BE NOTIFIED PRIOR TO ANY EXCAVATION ON OR NEAR THE SITE
11. 8/.4/7 DENOTES TREE SPREAD OF 8m, TRUNK DIAMETER OF 0.4m & APPROX HEIGHT OF 7m
12. BEARINGS SHOWN ARE MGA (MAP GRID OF AUSTRALIA) ADD APPROX. 1°00' FOR TRUE NORTH

Approximate location of test bore.

1 Photo Location

Note: Survey carried out by others.

TGE Taylor Geotechnical Engineering
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Drawing 1 - Site Plan
Proposed Residential Development
41 & 43 Beach Road Collaroy

Project: TGE21914
Date: 15 June 2019
Scale: As Shown

Appendix 2

TEST BORE REPORT

CLIENT: Jennifer & Russell Staley — DATE: 23-May-2019 — Bore No: **1**

PROJECT: Proposed Residential Development — PROJECT No.: TGE21914 — 1 of 1

LOCATION: 41 & 43 Beach Road Collaroy — SURFACE LEVEL: RL = 12.1*

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Blows/150mm N Value	Core Recovery%
0.00	TOPSOIL - Dark brown fine grained silty sand.				
0.15	FILLING - Light brown, fine to medium grained sand with some sandstone gravel.				
1.00	SILTY CLAY - Stiff, yellow brown & grey brown silty clay.				
1.50	SILTY CLAY - Very stiff becoming hard, orange brown and grey silty clay.				
1.90	SILTSTONE - Very low strength, light grey, yellow brown & red brown, siltstone.				
2.30	TEST BORE DISCONTINUED AT 2.3 METRES. Auger refusal on siltstone.				

RIG: Dingo Mounted

TYPE OF BORING: 100mm CFA

GROUND WATER OBSERVATIONS: No Free Groundwater Observed.

REMARKS: *RL interpolated from survey plan.

DRILLER: Contractor

LOGGED: Taylor

CHECKED: *[signature]*

SAMPLING & IN SITU TESTING LEGEND

D = Disturbed auger sample

B = Bulk sample

Ux = x mm dia. Tube Sample

Taylor Geotechnical Engineering

TEST BORE REPORT

CLIENT: Jennifer & Russell Staley — DATE: 23-May-2019 — Bore No: **2**

PROJECT: Proposed Residential Development — PROJECT No.: TGE21914 — 1 of 1

LOCATION: 41 & 43 Beach Road Collaroy — SURFACE LEVEL: RL = 12.2*

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Blows/150mm N Value	Core Recovery%
0.00	TOPSOIL - Dark brown fine grained silty sand.				
0.30	FILLING - Yellow brown sand and sandstone gravel.				
0.60	SILTY CLAY - Firm, dark brown silty clay.				
1.00	SILTY CLAY - Stiff, yellow grey brown silty clay.				
1.60	SILTY CLAY - Very stiff to hard, yellow brown and grey silty clay.				
2.40	SILTSTONE - Very low strength light grey & orange brown siltstone.				
3.10	TEST BORE DISCONTINUED AT 3.1 METRES. Auger refusal on siltstone.				

RIG: Dingo Mounted

TYPE OF BORING: 100mm CFA

GROUND WATER OBSERVATIONS: No Free Groundwater Observed.

REMARKS: *RL interpolated from survey plan.

DRILLER: Contractor

LOGGED: Taylor

CHECKED: ATJ

SAMPLING & IN SITU TESTING LEGEND

D = Disturbed auger sample

B = Bulk sample

Ux = x mm dia. Tube Sample

Taylor Geotechnical Engineering

TEST BORE REPORT

CLIENT: Jennifer & Russell Staley — DATE: 23-May-2019 — Bore No: **3**

PROJECT: Proposed Residential Development — PROJECT No.: TGE21914 — 1 of 1

LOCATION: 41 & 43 Beach Road Collaroy — SURFACE LEVEL: RL = 12.9*

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Blows/150mm N Value	Core Recovery%
0.00	TOPSOIL - Dark brown fine grained silty sand.				
0.60	SILTY CLAY - Stiff, yellow brown & orange brown silt clay.				
1.50	SILTY CLAY - Hard, light grey to white and red brown silty clay.				
2.00	SILTSTONE - Very low strength, light grey and red brown, siltstone.				
2.70	SANDSTONE - Very low to low strength, light grey to white and red brown, fine grained sandstone.				
3.10	TEST BORE DISCONTINUED AT 3.1 METRES. Auger refusal on sandstone.				

RIG: Dingo Mounted

TYPE OF BORING: 100mm CFA

GROUND WATER OBSERVATIONS: No Free Groundwater Observed.

REMARKS: *RL interpolated from survey plan.

DRILLER: Contractor

LOGGED: Taylor

CHECKED: [signature]

SAMPLING & IN SITU TESTING LEGEND

D = Disturbed auger sample

B = Bulk sample

Ux = x mm dia. Tube Sample

Taylor Geotechnical Engineering

TEST BORE REPORT

CLIENT: Jennifer & Russell Staley | DATE: 23-May-2019 | Bore No: **4**

PROJECT: Proposed Residential Development | PROJECT No.: TGE21914 | 1 of 1

LOCATION: 41 & 43 Beach Road Collaroy | SURFACE LEVEL: RL = 11.5*

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Blows/150mm N Value	Core Recovery%
0.00	TOPSOIL - Dark brown fine grained silty sand.				
0.25	FILLING - Yellow brown and grey brown gravelly silty sand.				
0.60	SILTY CLAY - Stiff, yellow orange brown silty clay.				
1.20	SILTY CLAY - Very stiff, orange brown silty clay. Hard below 1.4m				
2.00	SILTSTONE - Extremely low to very low strength, light grey red brown and yellow brown siltstone.				
3.00	SANDSTONE - Very low strength, light grey and red brown fine grained sandstone.				
4.00	TEST BORE DISCONTINUED AT 4.0 METRES. Auger refusal on sandstone.				

RIG: Dingo Mounted

TYPE OF BORING: 100mm CFA

GROUND WATER OBSERVATIONS: No Free Groundwater Observed.

REMARKS: *RL interpolated from survey plan.

DRILLER: Contractor

LOGGED: Taylor

CHECKED: [signature]

SAMPLING & IN SITU TESTING LEGEND

D = Disturbed auger sample

B = Bulk sample

Ux = x mm dia. Tube Sample

Taylor Geotechnical Engineering

TEST BORE REPORT

CLIENT: Jennifer & Russell Staley

DATE: 23-May-2019

Bore No: **5**

PROJECT: Proposed Residential Development

PROJECT No.: TGE21914

LOCATION: 41 & 43 Beach Road Collaroy

SURFACE LEVEL: RL = 11.9*

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Blows/150mm N Value	Core Recovery%
0.00	TOPSOIL - Dark brown fine grained silty sand.				
0.20	FILLING - Yellow brown and grey brown gravelly silty sand.				
0.40	SILTY CLAY - Firm then stiff, dark brown silty clay.				
1.40	SILTY CLAY - Hard, yellow brown silty clay.				
1.80	SILTSTONE - Very low strength, yellow brown, light grey & red brown siltstone.				
2.20	TEST BORE DISCONTINUED AT 2.2 METRES. Auger refusal on siltstone.				

RIG: Dingo Mounted

DRILLER: Contractor

TYPE OF BORING: 100mm CFA

LOGGED: Taylor

GROUND WATER OBSERVATIONS: No Free Groundwater Observed.

CHECKED:

REMARKS: *RL interpolated from survey plan.

SAMPLING & IN SITU TESTING LEGEND

D = Disturbed auger sample

B = Bulk sample

Ux = x mm dia. Tube Sample

Taylor Geotechnical Engineering

TEST BORE REPORT

CLIENT: Jennifer & Russell Staley
DATE: 23-May-2019
Bore No: **6**

PROJECT: Proposed Residential Development
PROJECT No.: TGE21914
1 of 1

LOCATION: 41 & 43 Beach Road Collaroy
SURFACE LEVEL: RL = 11.75*

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Blows/150mm N Value	Core Recovery%
0.00	TOPSOIL - Dark brown fine grained silty sand.				
0.30	FILLING - Clayey sand and sandstone gravel.				
0.90	SILTY CLAY - Hard, yellow orange brown silty clay.				
1.70	SILTSTONE - Very low strength, light grey & red brown siltstone.				
2.70	SANDSTONE - Very low strength, light grey to white and red brown, fine grained sandstone.				
2.90	TEST BORE DISCONTINUED AT 2.9 METRES. Auger refusal on sandstone.				

RIG: Dingo Mounted
DRILLER: Contractor

TYPE OF BORING: 100mm CFA
LOGGED: Taylor

GROUND WATER OBSERVATIONS: No Free Groundwater Observed.
CHECKED:

REMARKS: *RL interpolated from survey plan.

SAMPLING & IN SITU TESTING LEGEND

D = Disturbed auger sample
B = Bulk sample
Ux = x mm dia. Tube Sample

Taylor Geotechnical Engineering

RESULTS OF DYNAMIC PENETROMETER TESTS

CLIENT: Jennifer & Russell Staley

DATE: 23 May 2019

PROJECT: Proposed Residential Development

PROJECT No: TGE21914

LOCATION: 41 & 43 Beach Road Collaroy

SHEET: 1 of 1

	PENETRATION RESISTANCE BLOWS / 150mm									
TEST LOCATION / DEPTH (m)	**1**	**2**	**3**	**4**	**5**	**6**				
0.00 - 0.15	4	3	2	4	3	3				
0.15 - 0.30	4	3	12	8	8	9				
0.30 - 0.45	4	1	4	8	3	5				
0.45 - 0.60	4	1	4	5	4	10				
0.60 - 0.75	5	2	3	4	5	13				
0.75 - 0.90	3	5	5	5	5	10				
0.90 – 1.05	4	6	6	5	10	12				
1.05 – 1.20	5	9	8	16	16	18				
1.20 – 1.35	6	5	7	20	20	20				
1.35 – 1.50	9	7	10	20	20	20				
1.50 – 1.65	8	11	15	20	20	25				
1.65 – 1.80	8	15	Refusal	Refusal	Refusal	Refusal				
1.80 – 1.95	12	17								
1.95 – 2.10	13	10/50mm								
2.10 – 2.25	10/50mm									
2.25 – 2.40										
2.40 – 2.55										
2.55 – 2.70										
2.70 – 2.85										
2.85 – 3.00										

TEST METHOD:AS 1289.6.3.2, CONE PENETROMETER YES

AS 1289.6.3.3, FLAT END PENETROMETER

TESTED BY: Taylor

REMARKS:

Taylor Geotechnical Engineering

Appendix 3

Photo 1 – Site viewed from Beach Road looking east.

Photo 2 – View of site from north west corner, looking south east showing the front of No. 43.

Photo 3 – View of drive accessing No. 41 with No. 43 to left (north).

Photo 4 – View of site from beyond eastern boundary, looking west.

Photo 5 – View of rear section of No. 41, looking south east.

Photo 6 – View along southern boundary of No. 41, looking west.

Photo 7 – View along southern boundary of No 41, looking east.

Appendix 4

Foundation Maintenance and Footing Performance: A Homeowner's Guide

BTF 18 replaces Information Sheet 10/91

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

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

Soil Types

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

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

Causes of Movement

Settlement due to construction

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

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

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

Erosion

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

Saturation

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

Seasonal swelling and shrinkage of soil

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

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

Shear failure

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

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

GENERAL DEFINITIONS OF SITE CLASSES

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

Tree root growth

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

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

Unevenness of Movement

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

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

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

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

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

Effects of Uneven Soil Movement on Structures

Erosion and saturation

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

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

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

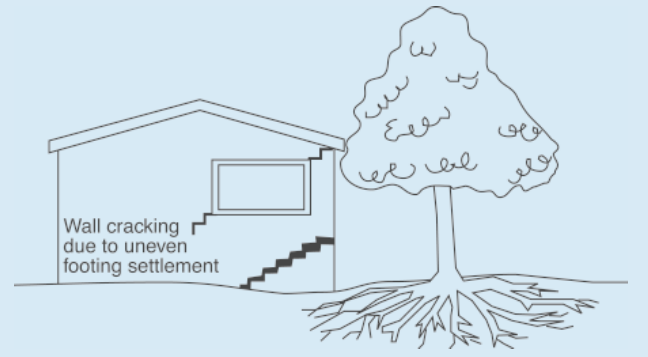
Seasonal swelling/shrinkage in clay

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

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

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

Trees can cause shrinkage and damage



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

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

Movement caused by tree roots

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

Complications caused by the structure itself

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

Effects on full masonry structures

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

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

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

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

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

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

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

Effects on framed structures

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

Effects on brick veneer structures

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

Water Service and Drainage

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

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

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

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

Prevention/Cure

Plumbing

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

Ground drainage

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

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

Protection of the building perimeter

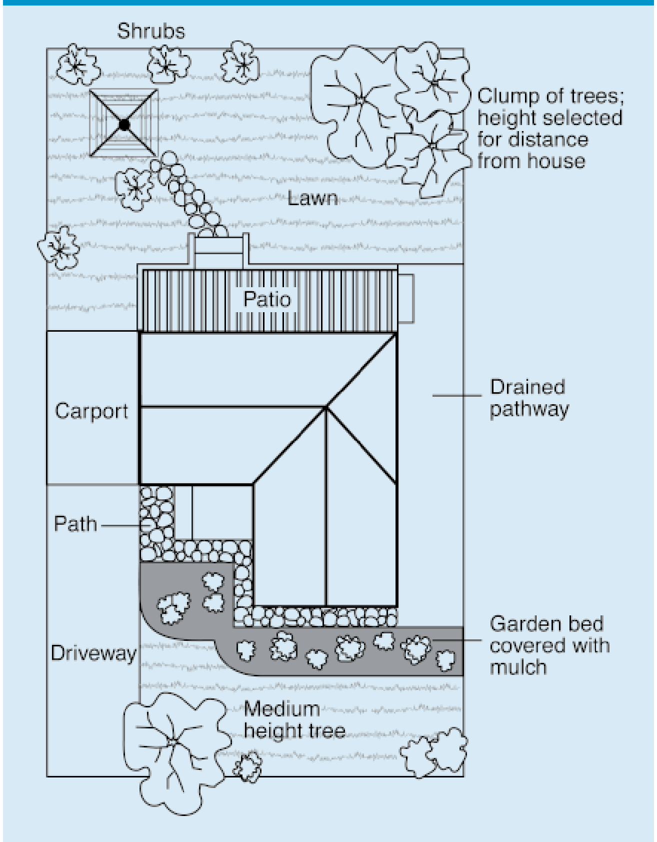
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

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

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

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

Gardens for a reactive site



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

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

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

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

Condensation

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

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

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

The garden

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

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

Existing trees

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

Information on trees, plants and shrubs

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

Excavation

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

Remediation

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

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

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

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