

Geotechnical Investigation

DATE: 01.04.19

INVESTIGATION DATE: 29.03.19

JOB No: **11487**

SITE ADDRESS: No. 4 & 6 Dubbo Street
Albion

CLIENT: Achieve Design Group

SITE CLASSIFICATION: "P" Due to abnormal moisture conditions as a result of:

- Trees on this and adjacent sites
- Existing buildings on site

This site has been classified in accordance with AS2870-2011, Section 2.

ABH Soil Testing & Surveying



Andrew Ryan
BE (Civil)

1.0 INTRODUCTION

ABH Soil Testing & Surveying has been engaged to assess the subsurface conditions at the site address mentioned above, with a view to report on the Site Classification and Footing Recommendations for a proposed unit development consisting of ten single/double storey articulated brick veneer dwellings to be constructed on this site.

2.0 FIELDWORK

The fieldwork consisted of the drilling of **TEN (10)** boreholes by means of a **Hand Auger** to the depths indicated in the borehole logs. The relatively disturbed cores obtained were logged and then classified in accordance with AS2870-2011. Full details of the observed soil profile have been recorded in the borehole logs.

Additional site features such as slope, trees, and existing buildings have been presented on the site plan. In addition, the site plan shows the locations of the boreholes.

3.0 GEOLOGY

The Geological Survey Maps show the site to be underlain by **QUATERNARY aged BASALT**. The geology in this region generally consists of highly reactive clays with a high potential to shrink and swell with changes in moisture conditions.

4.0 SITE CLASSIFICATION

The site is classified **"P"** in accordance with AS2870 – 2011 (Section 2) which represents a **PROBLEM** site. The site is a problem site because it is subjected to abnormal moisture conditions as a result of:

- Trees on this and adjacent sites
- Existing buildings on site

(See site plan for details).

The designing engineer should recognise that in the absence of these abnormal moisture conditions, a site classification of **"H2"** would apply to this site.

This site classification is based on the proposed construction outlined in the introduction, the plans supplied by the client, and the site conditions at the time of the investigation. Should any of these elements alter prior to construction, this report must be reviewed and further investigation may be required.

NOTE: This site is subjected to abnormal moisture conditions as defined in AS 2870-2011, Clause 1.3.3, due to trees as outlined above (refer to site plan for approximate location). **The designing engineer may be required to make provisions for an effective root barrier and/or deepening/stiffening of the footings to compensate the potential ground movements caused by the trees.** For more detail on the potential impact these trees may have, it is recommended an Arborist is engaged to undertake an assessment.

5.0 FOOTING RECOMMENDATIONS

OVERVIEW:

It is recommended that the footing system be designed by engineering principles (AS. 2870 Cl 1.4). The designing engineer should refer to AS2870-2011 to ensure design compliance to this document, especially Sections 1.3 "Performance of Footing Systems" and "Design Considerations".

Provided the designing engineer takes the appropriate measures to deal with the abnormal moisture conditions present on this site, a footing design in accordance with AS 2870 corresponding to a site classification of "H2" can be considered as an alternative to the engineered design approach recommended herein.

BORED PIERS:

Bored piers may be required for the purpose of designing for; abnormal moisture conditions, building near an easement, or building on fill. If bored piers are used as part of the design, bored piers of 450 mm diameter should be founded a minimum of **600 mm** into the **SILTY CLAY**. At this depth, an allowable end bearing pressure of **250 kPa** may be assumed. **Drilling to this depth or greater may be difficult due to the presence of basalt rock. A suitable founding depth and material should be confirmed during construction.**

Piers may also be founded onto basalt rock however it is possible that the rock is floaters/boulders and will be difficult to excavate for the purpose of piers. It is recommended an auger equipped with a rock coring bucket (or similar) is used to achieve the required depth. Alternatively, slotted piers may be the preferable option.

It should be noted that this recommended founding depth is a minimum depth for achieving a sufficient bearing capacity only. The designing engineer may adopt much greater depths due to the potential factors mentioned above.

The scope of this investigation is limited to drilling to the depths shown in the borehole logs – if deepened footings are required, further testing may be necessary to determine the type of soil and/or rock beyond the depths reached in this investigation.

NOTE ON FOOTING RECOMMENDATIONS:

- If strip footings are required, they will need to be designed by engineering principles (AS. 2870 Cl 1.4) due to the highly reactive soils on this site.
- **The boreholes on this site revealed that basalt rock was encountered at shallow depths. Consequently, it is likely that considerable difficulty may be encountered when undertaking excavations at this site – rock breaking equipment may be required.**

IMPORTANT NOTE TO BUILDER AND STRUCTURAL ENGINEER REGARDING ROCK:

If bored piers are required due to the angle of repose to a pipe in an easement, it is likely they will be required to be deep and beyond the depth where rock has been/may be encountered on this site. The rock found in this geology is often Basalt floaters/boulders, which are usually not suitable for piers to be founded on as more clay may exist underneath them.

The angle of repose can be considered negligible if piers are founded on Basalt bedrock and/or massive Basalt floaters. However, if rock is encountered it is difficult to verify whether it is suitable by looking down pier holes and/or inspecting small trenches. If deep piers are required, it is **STRONGLY** recommended that a rock-drilling machine is utilised to achieve the required depth. In the experience of this office, the up-front cost of rock-drilling will prevail over the issues and delays associated with conventional machinery. Please contact this office for further advice.

5.1 WAFFLE RAFT

A waffle raft footing system should be designed by engineering principles (AS. 2870 Cl 1.4) and by an engineer familiar with designing for abnormal moisture conditions. The waffle raft should meet the requirements below. **NOTE: The designing engineer may choose to modify the following requirements in order to design for the abnormal moisture conditions on this site.**

5.1.1 Where Fill DOES NOT Exceed 300 mm

Where the overall depth of fill (both existing site fill and placed additional fill) does not exceed 300 mm, this fill may make up all of the foundation if it is **controlled fill**¹, or part of the foundation if it is **rolled fill**², in accordance with AS2870-2011, Cl. 6.4.2.

Slab panels, internal beams, and load support thickenings may be founded on natural soil, controlled fill, or rolled fill.

Edge beams and heavily loaded internal beams must be founded on natural soil or controlled fill, with a minimum bearing capacity of 50 kPa as noted in the borehole logs.

Note: Edge beams or heavily loaded internal beams may not be founded in rolled fill.

5.1.2 Where Fill EXCEEDS 300 mm

Where the overall depth of fill exceeds 300 mm and/or is not compacted as per the requirements of AS2870-2011 Cl. 6.4.2, the waffle slab is to be supported on bored concrete piers.

For single storey construction, the location of piers, and reinforcement is to be in accordance with AS2870-2011 Cl. 3.4.5.

For double-storey construction, the location and spacing of piers, and reinforcement is to be determined during design by a qualified engineer.

If the existing fill on site is "Controlled Fill" in accordance with AS2870-2011 Cl. 6.4.2 (a), a "slab-on-fill" design may be adopted where the waffle footings are founded entirely on the existing fill material. However, this office must be supplied with a suitable compaction report to utilise this design approach.

5.1.3 Construction Techniques

The following construction techniques shall in general be followed in constructing the waffle raft:

1. Scrape a minimum depth of 100 mm and remove vegetation and roots off the building area.
2. Cut site to form a level bench.
3. Place the layer of quarry product over the building area which shall extend at least 1.0m outside the building line.
4. Set up string lines, edge boards and formwork.
5. Plumber shall lay waste pipes below ground surface at minimum grade. Risers are to be staked firmly.
6. Prepare waffle raft within formwork in accordance with the footing plan and details. Use minimum of 0.2 mm approved plastic membrane under waffle pods & ribs. Waffle pods shall be cut and taped around plumbing pipes.

Proper site drainage is very important in reactive sites such as this site. It is therefore recommended that the ground surface immediately next to the perimeter footings be graded away at approximately 1:50 within at least 1500 mm. A concrete path around the perimeter of the slab is further recommended.

¹ **Controlled Fill** – Fill that is in accordance with the technical and control requirements specified in AS 3798. Sand fill up to 800 mm deep that is well compacted by a vibrating plate or vibrating roller in layers not more than 300 mm thick is deemed to be controlled fill. Non-sand fill up to 400 mm deep that is well compacted by a mechanical roller in layers not more than 150 mm thick is deemed to be controlled fill. Clay fill shall be moist during compaction. Refer to AS2870-2011 Clauses 2.5.3, 2.5.3(a), and 6.4.2(a)

² **Rolled Fill** - Consists of material compacted in layers by repeated rolling with an excavator or similar equipment. The depth of rolled fill shall not exceed 600 mm compacted in layers of not more than 300 mm thick for sand material or 300 mm compacted in layers of not more than 150 mm thick for other materials as per AS2870-2011 Clause 6.4.2(b).

5.2 STIFFENED RAFT

A stiffened raft footing system should be designed by engineering principles (AS. 2870 Cl 1.4) and by an engineer familiar with designing for abnormal moisture conditions.

At a minimum, edge and load bearing beams and internal beams should be founded in firm natural bearing materials, penetrating through any fill material, and founded at least **100 mm** into the recommended founding material, and a minimum of **300 mm** below ground level.

Slab panels and non-heavily loaded internal beams can be founded in the natural soil profile, in compacted surface filling and/or as required in the design by engineering principles. Compacted filling used to raise levels beneath panels must be placed and compacted as per specifications for Controlled or Rolled fill in accordance with section 6.4.2 AS2870-2011. Total fill depths beneath slab panels and internal stiffening beams (including any existing filling on site) must not exceed that specified in clause 6.4.2 AS 2870-2011.

Note: *The following recommended founding depths are to be used as minimum depths. If bored piers are adopted, the founding depths will need to be increased as per the Bored Piers recommendations above.*

Borehole No	Minimum Founding Depth for Slab Edge Beams & Heavily Loaded Internal Beams (mm)	Founding Material	Allowable Bearing Capacity (kPa) *
1	300	SILTY CLAY	100
2	300	SILTY CLAY	100
3	300	SILTY CLAY	100
4	300	SILTY CLAY	100
5	300	SILTY CLAY	100
6	300	SILTY CLAY	100
7	400	SILTY CLAY	100
8	400	SILTY CLAY	100
9	300	SILTY CLAY	100
10	300	SILTY CLAY	100

* Higher bearing capacities may be available at greater depths – refer to borehole logs.

6.0 CONSTRUCTION TECHNIQUES / ISSUES

6.1 GENERAL

- The presence of groundwater with surface soils may lead to construction difficulties during wet winter and spring months.
- Surface filling or natural sands may cause collapse of side of excavations.
- Scrape a minimum depth of **100 mm** unless otherwise specified and remove vegetation and roots from the building area.
- Plumber shall lay waste pipes below ground surface at minimum grade. Risers are to be staked firmly.
- Care shall be taken with surface drainage of the allotment from the start of construction and the site must be well drained so that water cannot pond beside or adjacent to footings. The drainage system shall be completed by the finish of construction of the house in accordance with AS2870-2011 Clause 5.6.3.

6.2 SITE SPECIFIC

- **Floaters/boulders, weathered basalt and/or basalt bedrock may be encountered within proposed excavation depths. Excavations for site works, footings and trenches may be difficult with lightweight machinery due to the shallow depth to the rock.**

- If bored piers are required, it is strongly recommended that an excavator capable of breaking/coring through basalt rock is utilised to achieve the required founding depth. Excavation of bored piers with a standard auger will be extremely difficult on this site. Further to this, for any other type of excavation, heavy machinery with powerful rock breaking capability is recommended.
- Carbonate layers may soften with moisture ingress. Deep footings should penetrate through any carbonates and be founded on stiff underlying clay or basalt rock.
- This and adjacent sites contain trees which may affect the foundations of the proposed dwellings. The roots of trees which are to remain should be isolated from the new footings by means of deepened footings or a root barrier or similar. If trees are removed, deepening of the footings and/or root barriers may also be required at the designing engineer's discretion. Trees which are removed will still have an effect on the soil up to one year after their removal.
- Remove trees over the building area as well as existing footings and building rubble from any structures over the building area. Any large holes resulting from the removal of trees or footings must be filled and compacted. If the material does not respond to compaction, it should be excavated to achieve a firm working base. Then fill the holes with non-porous fill compacted in 150 mm layers (maximum). Footings may need to be locally deepened in areas where footings and/or trees have been removed and/or old service trenches exist.
- This site contains between 100 - 400 mm of fill - depending on cut and fill works, and the adopted footing system, footings may need to be deepened in areas where the fill exceeds 300 mm and/or does not meet the requirements outlined in AS2870-2011 Cl. 6.4.2.

7.0 ARTICULATION OF BUILDINGS

Amongst others, foundation movement may be a cause of visible cracks in buildings. It is therefore important to ensure flexibility of the structure by providing full height openings (doors and corridors) or construction joints at suitable spacings.

Brickwork should be in accordance with industry guidelines and articulation of masonry walls should be provided as per details contained in the "Cement & Concrete Association-TN61. However, construction joints should also be incorporated for buildings on other sites, particularly at locations where changes in foundation materials occur.

8.0 FOUNDATION MAINTENANCE

The footing recommendations outlined in section 5.0 assume that aspects of site drainage, paving and landscaping are taken into consideration and implemented in accordance with CSIRO Building Technology File, BTF 18 "Foundation Maintenance and Footing Performance: A Homeowner's Guide". The agent of the homeowner (builders, designers or any person(s) acting on behalf of the homeowner) should ensure that the rightful owner of the property (as registered on the Certificate of Title) receives a copy of this document.

AS2870-2011 embraces the philosophy that optimum performance of rational and economical footing designs can only be achieved with the co-operation of informed owners who pay attention to maintaining a stable condition of the foundation soils as recommended in the above referenced CSIRO Notes.

9.0 CONDITIONS OF USE OF THIS REPORT

9.1 COPYRIGHT

This Geotechnical Investigation report has been prepared expressly for the client for the sole purpose of constructing the building described in the plans and specifications. This report is copyright to ABH Soil Testing & Surveying. No part of this report including the whole or part of same shall be used for any other purpose or by any third party without the prior written consent of ABH Soil Testing & Surveying.

The *client* is defined as the person or persons named in this report or the person or persons for whom the named building company is acting as agent.

9.2 REPORT LIMITATIONS

- The recommendations made in this report may need to be reviewed should any site works disturb any soil 200 mm below the proposed founding depth.
- The descriptions of the soils encountered in the boreholes closely follow those outlined in AS1726-1993; Geotechnical Site Investigations. Colour descriptions can vary with soil moisture content and individual interpretation. It should be noted that colour and shade descriptions outlined in this report are made when the soil is in a moist condition, colour alone should not be used to identify soils.
- If there is any doubt in relation to the depth of fill, founding material and bearing capacity of such, the owner, builder or Engineer must contact ABH Soil Testing & Surveying for a site inspection prior to any footing being poured. The owner/builder will be responsible for any fees associated with this additional work.
- This report assumes that the soil profile observed in the boreholes is representative of the entire site. If the soil profile and site conditions appear to differ substantially from those reported, ABH Soil Testing & Surveying should be contacted immediately and this report may need to be reviewed and revised if necessary.
- It is expected that all relevant information regarding the site, for example previous filling, old water courses etc, has been investigated by the client and this information has been supplied to ABH, even if it is after the report has been written. Consequently, ABH Soil Testing & Surveying reserves the right to amend the initial report on receipt of supplementary and relevant information. In the event of an amended report for such reasons, ABH Soil Testing & Surveying will not accept responsibility for any financial loss consequential or otherwise.
- The user of this report must take into account that soil and fill depths are given to a tolerance of +/- 200 mm.
- Whilst every effort is made to identify fill material across the site, the difficulties in determining fill material when utilising a small diameter auger, which is standard geotechnical practice, must be understood and accepted. Consequently ABH Soil Testing & Surveying emphasises again that we will not be responsible for any financial losses, consequently or otherwise, that may occur as a result of not accurately determining the depth of fill across the site.


9.3 LOSS OR DAMAGES


Subject to the limitations of this report as expressed in Section 9.2, ABH Soil Testing & Surveying will not accept liability for loss or damage from any activity undertaken based on the recommendations. Should a more detailed geotechnical assessment be required, ABH Soil Testing & Surveying can provide such a report. Please contact ABH Soil Testing & Surveying to discuss this further.


9.4 VARIATIONS FROM THIS REPORT

It is neither economically feasible nor practical to determine every subsurface feature on the site. Studies have shown that a large number of boreholes leads to only a slight increase in probability of detecting hidden site features (such as a filled well or cellar) in the foundation soils. As such, any variations, or discrepancies in soil type, colour, or horizon depth must be reported to the Engineer immediately so that their potential influence on the footings may be assessed.

10.0 BOREHOLE LOGS

 <p>PO Box 308 Keilor VIC 3036 P: 03 9336 3545 E: info@abhsoil.com.au</p>				Site Address:		Date:	29.03.19
				4 & 6 Dubbo Street Albion		Job No:	11487
Borehole No. 1				Borehole No. 2			
Depth (mm)	Horiz.	Description	Q _a (kPa)	Depth (mm)	Horiz.	Description	Q _a (kPa)
0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.		0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.	
100				100			
200				200			
300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity. Becoming moist and very stiff with depth.	100	300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity. Becoming moist and very stiff with depth.	100
400				400			
500				500			
600				600			
700				700			
800				800			
900				900			
1000				1000			
1100				1100			
1200				1200			
1300		Refusal on Hard Base – Most Likely a Floater	250	1300		Refusal on Hard Base – Most Likely a Floater	
1400				1400			
1500				1500			
1600				1600			
1700				1700			
1800				1800			
1900				1900			
2000				2000			
1900		End of Borehole – No Refusal		1900			
2000				2000			
Borehole No. 3				Borehole No. 4			
Depth (mm)	Horiz.	Description	Q _a (kPa)	Depth (mm)	Horiz.	Description	Q _a (kPa)
0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.		0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.	
100				100			
200		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity.	100	200		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity.	100
300				300			
400				400			
500		Refusal on Hard Base – Most Likely a Floater		500		Refusal on Hard Base – Most Likely a Floater	
600				600			
700				700			
800				800			
900				900			
1000				1000			
1100				1100			
1200				1200			
1300				1300			
1400				1400			
1500				1500			
1600				1600			
1700				1700			
1800				1800			
1900				1900			
2000		2000					

				PO Box 308 Keilor VIC 3036 P: 03 9336 3545 E: info@abhsoil.com.au				Site Address: 4 & 6 Dubbo Street Albion		Date: 29.03.19											
Borehole No. 5				Borehole No. 6				Job No: 11487													
Depth (mm)	Horiz.	Description	Q _a (kPa)	Depth (mm)	Horiz.	Description	Q _a (kPa)	Depth (mm)	Horiz.	Description	Q _a (kPa)										
0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.		0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.		0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.											
100				100				100													
200				200				200													
300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey, hard, high plasticity.	100	300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity.	100	300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity.	100										
400				400				400													
500		Refusal on Hard Base – Most Likely a Floater		500		Becoming moist and very stiff with depth.		500		Becoming moist and very stiff with depth.											
600								600						600							
700								700						700							
800								800						800			250				
900								900						900							
1000								1000						1000							
1100								1100						1100							
1200								1200						1200							
1300								1300				Refusal on Hard Carbonates - Possible Floater or Weathered Rock		1300		Refusal on Hard Carbonates - Possible Floater or Weathered Rock					
1400								1400										1400			
1500								1500										1500			
1600				1600				1600													
1700				1700				1700													
1800				1800				1800													
1900				1900				1900													
2000				2000				2000													
Borehole No. 7				Borehole No. 8																	
Depth (mm)	Horiz.	Description	Q _a (kPa)	Depth (mm)	Horiz.	Description	Q _a (kPa)	Depth (mm)	Horiz.	Description	Q _a (kPa)										
0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.		0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.		0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.											
100				100				100													
200				200				200													
300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity.	100	300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity.	100	300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity.	100										
400				400				400													
500								500						500							
600								600						600							
700								700				Refusal on Hard Base – Most Likely a Floater		700		Refusal on Hard Base – Most Likely a Floater					
800								800										800			
900								900										900			
1000					250			1000										1000			
1100								1100										1100			
1200								1200										1200			
1300								1300										1300			
1400				1400				1400													
1500				1500				1500													
1600				1600				1600													
1700				1700				1700													
1800				1800				1800													
1900		End of Borehole – No Refusal		1900				1900													
2000				2000				2000													

 <p style="text-align: right;"> PO Box 308 Keilor VIC 3036 P: 03 9336 3545 E: info@abhsoil.com.au </p>				Site Address:		Date:	29.03.19
				4 & 6 Dubbo Street Albion		Job No:	11487
Borehole No. 9				Borehole No. 10			
Depth (mm)	Horiz.	Description	Q _a (kPa)	Depth (mm)	Horiz.	Description	Q _a (kPa)
0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.		0		FILL – SANDY CLAY, slightly moist, mottled dark brown-grey, variably compacted.	
100				100			
200				200			
300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity. Becoming moist and very stiff with depth.	100	300		SILTY CLAY (CH) – slightly moist, high strength, mottled brown-grey becoming light grey with depth, hard, high plasticity. Becoming moist and very stiff with depth.	100
400				400			
500				500			
600				600			
700				700			
800				800			
900				900			
1000				1000			
1100				1100			
1200				1200			
1300		250		1300		250	
1400				1400			
1500				1500			
1600				1600			
1700				1700			
1800				1800			
1900				1900			
2000				2000			
1900		End of Borehole – No Refusal		1900		End of Borehole – No Refusal	
2000				2000			

11.0 SITE PLAN

NOTES:

- Site Plan is not to scale
- Locations of trees are approximate - refer to a feature survey plan for an accurate location
- Tree heights and canopies are approximate - a full tree survey is required for an accurate assessment
- For accurate tree type/species, an Arborist should be engaged.
- Borehole locations are approximate

