

REPORT No: 1210524-1

CLIENT: Norcal Station Developments Pty Ltd
C/- Planning & Property Partners
13/1 Collins Street
MELBOURNE VIC 3000

AUTHORISED BY: Ms Hanna Worthington

PROJECT LOCATION: 56-74 Station Street
NUNAWADING VIC

COMMISSION: Carry out appropriate in-situ soil tests and observations at four locations as shown on the attached plan to a depth of up to 4.5 metres.

Recommend allowable bearing pressures for pad and strip footings, end bearing pressures and skin friction for bored piers and design parameters for retaining wall structures.

Comment on the stability of short-term excavations.

1. INTRODUCTION:

1.1 Aim

This report discusses the field investigation carried out on 23 April 2021 for the proposed development of several buildings of various sizes including mixed use buildings with single level basement carpark.

2. INVESTIGATION:

2.1 Site Geology

Geological maps of the area suggest that the site is in an area of Silurian Sediments. The natural soil encountered during the site investigation confirmed this.

2.2 Site Topography

The ground surface over the site is generally undulating. Ground cover consists of natural grasses and asphalt. A photograph taken during the site investigation which shows the existing site condition is provided below.



Photograph 1: Existing site surface condition

2.3 Fieldwork

The fieldwork consisted of drilling four boreholes to 4.5 metres depth with a mechanical auger. The approximate locations of the boreholes are shown on the attached site plan. Subsurface materials penetrated were visually classified to AS1726: Geotechnical Site Investigation.

3. FINDINGS:

3.1 Field Data

The boreholes revealed the substrata consisted of existing FILL varying in depth between 800mm (in BH1) and 1800mm (in BH4). Except for the weathered underlying the FILL layer in BH1, the FILL is underlain typically by naturally occurring clayey SILT followed by silty CLAY that abuts on weathered ROCK. The existing FILL material comprises of crushed ROCK, silty SAND, soft ROCK and silty sandy CLAY. The materials encountered were dry to moist, moist and moist to wet with consistencies described as medium dense for the SAND, SILT and crushed ROCK dominated layers and firm to stiff for the CLAY dominated unit.

Weathered rock was encountered in the boreholes at the following depths:

- BH1: 0.8m
- BH2: 2.8m
- BH3: 2.4m
- BH4: 4.0m

The initial part of the ROCK has described as extremely weathered grading into distinctly weathered ROCK.

Free groundwater table was not intersected in the boreholes. However, moist to wet soil conditions were recorded within the FILL and SILT dominated layers indicating presence of perched water conditions. Substrata conditions encountered are such that surface infiltration and occurrence of perched water at the interface between different material layers should not be disregarded. Basement and foundation excavations should take note of this.

3.2 Site Classification

After considering the area geology, the soil profile encountered in the bores, the proposed superstructure and the climatic zone of the area, this site has been classified as CLASS P with respect to foundation construction (Australian Standard 2870-2011 Residential Slabs and Footings) due to the depth of uncontrolled FILL on this site. However, this classification is technically not correct for the proposed type of structure, therefore is given as a guide only.

It is anticipated that the normal seasonal surface movement at this site, without the effect of abnormal moisture conditions, will not exceed 40mm.

4. RECOMMENDATIONS:

4.1 Building Foundations

4.1.1 Pad and Strip Footings

Pad and strip footings are an appropriate footing arrangement for any shallow foundations adjoining the proposed structure. Based on the site investigation, pad and strip footings founded at least 100mm into the naturally occurring silty CLAY or extremely weathered ROCK as described in the engineering logs can be assumed to have an allowable bearing pressure of 200kPa.

As a guide to the founding depths with regard to the above along with information obtained from the bores, the founding depths at this site will be up to 1900mm in relationship to the existing surface.

For founding in and on existing fill, if any, then the fill must be stripped and the surface of the natural soil must be compacted with the soil in a moist condition. Stripped or imported fill meeting the minimum suitability requirements of section 4 of AS3798 must be placed at maximum 150mm uncompacted layers and each layer shall be compacted to minimum 98% dry density ratio at moisture contents between -2.5% and +2.5% of the optimum moisture content. Following the above ground preparation, an allowable bearing pressure of 100kPa can be assumed at 200mm below the compacted surface.

At basement level, which is approximately 3 metres below the existing surface level, pad or strip footings will also be a suitable foundation arrangement. Based on the site investigation, pad and strip footings founded at least 100mm into the distinctly weathered ROCK as described in the engineering logs can be assumed to have allowable bearing pressures of 400kPa for pad footings and 360kPa for strip footings.

The allowable bearing pressures provided in the report are the maximum values.

In accordance with Appendix D of AS2870 – 2011 the soil profile and site conditions should be inspected at footing excavation stage by CIVILTEST PTY LTD to confirm the soil profile and site classification.

After excavation for the footings has been completed if there is any doubt as to the bearing capacity of the founding soil, then Civiltest Pty Ltd should be contacted.

4.1.2 Piled Foundations

If shallow bored piers are used at this site, they should be founded not less than 300mm into the naturally occurring silty CLAY or extremely weathered ROCK as described in the engineering logs and be based on an allowable bearing pressure of 230kPa. The embedment depth provided above is only for compressive loading.

For bored piers founded below the basement level into the distinctly weathered ROCK, allowable end bearing pressures of 460kPa and 540kPa at depths of 4 metres and 5 metres respectively below the existing ground surface will apply.

A maximum allowable skin friction of 30kPa can be assumed to exist between piers and any of the naturally occurring silty CLAY soils. No skin friction should be allowed in the FILL soils or soils within 1500mm of surface level.

Maximum allowable skin friction values of 45kPa and 60kPa can be assumed over the pier shafts embedded within the extremely weathered and distinctly weathered ROCK respectively.

In accordance with Appendix D of AS2870 – 2011 the soil profile and site conditions should be inspected at footing excavation stage by CIVILTEST PTY LTD to confirm the soil profile and site Classification.

4.1.3 Carpark Basement Slab

The floor slab and any stiffening beams may be placed on or in the weathered ROCK as described in the engineering logs. This is providing that any soft areas have been well compacted with the soil in a moist condition with a small vibratory roller or vibratory plate compactor. This material will provide a subgrade for the slab and based on the field observations can be assumed to have a modulus of subgrade reaction of 35kPa/mm.

Where levelling fill is used the floor slab and any stiffening beams required may be placed on or in levelling fill provided that not more than 400mm of site derived clayey or 800mm of site derived sandy or imported granular fill, including existing fill material excluding perishable and organic matter if any is used. The fill must be placed in 150mm thick layers and densely compacted in a moist condition with a small vibratory roller or vibratory plate compactor. After allowing for the likely wetting up under the slab and the condition of the fill after compaction, this surface can be assumed to have a modulus of subgrade reaction of 40kPa/mm for SAND FILL and 30kPa/mm for CLAY FILL. If significant amounts of fill are placed under the pavement slab, then the above parameters may need to be reviewed.

In accordance with Appendix D of AS2870 – 2011 the soil profile and site conditions should be inspected at footing excavation stage by CIVILTEST PTY LTD to confirm the soil profile and site Classification.

4.2 Retention System

4.2.1 Design Parameters

The following parameters can be used for WALLAP analysis in the design of a retention system. These values assume that the soil being retained/supported has a horizontal surface.

Soil Strata description	Unit Weight (kN/m ³) γ	Poisson's Ratio ν	Parameters for Short Term Analysis						Parameters for Long Term Analysis					
			K _o	K _a	K _p	C _u (kPa)	ϕ_u (deg)	E _u (MPa)	K _o	K _a	K _p	c' (kPa)	ϕ' (deg)	E' (MPa)
Silty SAND FILL	17.5	0.37	0.53	0.36	2.77	1	28	30	0.47	0.31	3.25	0	32	25
Silty CLAY FILL	19.0	0.45	0.74	0.59	1.70	25	15	25	0.63	0.45	2.20	3	22	20
Crushed ROCK FILL	20.0	0.35	0.41	0.26	3.85	1	36	45	0.46	0.22	4.60	0	40	35
Sandy/Silty CLAY	20.0	0.40	0.66	0.49	2.04	70	20	35	0.57	0.40	2.55	15	26	30
Extremely to Distinctly weathered ROCK – Very low strength to low strength	21.5	0.25	-	-	-	-	36	500 - 12000	-	-	-	-	45	300 - 10000

Note that K_a and K_o are the active and at-rest earth pressure coefficients, and c' is the effective cohesion.

Allowable bearing pressures given under 4.1.1 and 4.1.2 are relevant for foundation loading.

There are adjacent structures founded within the zone of influence for the excavations, so therefore at-rest earth pressure should be used to limit the possibility of any damage to the adjoining property.

The above parameters assume that the level of the water table is below the bottom of the excavation by the use of adequate drainage and that any adjacent surcharge loads are superimposed.

If anchors are required, these may be either grouted or of a mechanical nature. The anchors must extend into the weathered ROCK and can be designed on a grout or mechanical bond strength of 260kPa. A greater bond strength may be available but it is recommended that the 260kPa can only be exceeded if a pull out test is carried out.

4.2.2 Site Excavation

During the excavation of the site following prolonged rain periods, seepage water may be present in the excavation. The installation of temporary cut-off drains and / or pumping from sumps at the base of the excavation may be required. The zone of influence that the work has on the surface of the excavation during construction is at an angle of 45° from the vertical face of the excavation or at a distance of 1.0H horizontal from the surface of the excavation where H is the depth of the excavation.

It is recommended that where any footings are to be constructed next to the existing underground services (sewers, etc), then these footings should be founded and designed taking into account the above parameters.

Basement excavations on this site will require the use of specialised techniques to excavate the site and ensure the excavation is stable for the construction of the basement retaining walls.

Vertical excavations through the naturally occurring silty CLAY and weathered ROCK will remain stable for a period of a few days. The upper FILL, SILT and SAND layers should be temporarily retained or battered to not steeper than 35° with the horizontal. It is recommended that bulk excavation of the basement is undertaken with batters made at a maximum angle of 45° (from the horizontal) all around the perimeter of the basement excavation.

Once the bulk excavation of the basement is completed, then the vertical batter excavations in sections around the site can be undertaken followed by the immediate construction of the precast concrete retaining walls. This technique will ensure that the time the vertical batters are unretained is kept to a maximum of a few days.

Alternatively, non-contiguous piles can be used.

In accordance with Appendix D of AS2870 – 2011 the soil profile and site conditions should be inspected at footing excavation stage by CIVILTEST PTY LTD to confirm the soil profile and site Classification.

4.2.3 Non Contiguous Piles:

Subject to the temporary retention or battering of the upper FILL, SILT and SAND layers, non-contiguous piles can be spaced at a maximum spacing of four diameters taken from centre to centre of adjacent piles. At this spacing the arching forces in the soils which consist of the internal angle of friction and cohesion will remain stable for short periods of time to allow the placing of steel reinforcement and shotcrete to complete the retaining wall in segments. It is anticipated that the site will be excavated in 1.0 metre segments and the retaining wall constructed in top-down construction in 1.0 metre segments.

Spacing in excess of four pile diameters (taken from centre to centre of adjacent piles) is not recommended due to the spacing being in excess of which effective arching forces in the soils can be relied on to create a safe working environment. A safe working environment is one where there is minimal risk to ground loss and the risk of external ground settlement from excessive lateral movement of the cantilevered non-contiguous piles is kept within acceptable limits.

In accordance with Appendix D of AS2870 – 2011 the soil profile and site conditions should be inspected at footing excavation stage by CIVILTEST PTY LTD to confirm the soil profile and site Classification.

5. EARTHQUAKE SITE SUBSOIL CLASS

The earthquake site subsoil class as per Australian Standard (AS1170.4 2007) is taken as **Class = C_e – Shallow Soil**. A hazard factor of 0.09 can be adopted for this site.

6. CONDITIONS OF THE REPORT:

The recommendations made in this report may need to be reviewed should any site works disturb any soil 300mm below the founding depth of the structure.

Since the soil horizons and layers can vary in depth and thickness over the site, the depths and bearing pressure given above (i.e., in the report) are given as a guide only. If the footings are founded at the minimum depth as stated and are in the soil as described in the engineering logs for this site, then the requirements of this report have been met.

Where any filling is to be placed (other than under the basement slab, refer to 4.1.3 above) the footing founding depths and design parameters recommended in this report will need to be increased accordingly in relationship to the depth of that fill.

The descriptions of the soils found in the boreholes closely follow those outlined in AS1726-2017 (Geotechnical Site Investigations). Colour descriptions can vary with soil moisture content and exposure. It should be noted therefore, colour and shade descriptions mentioned in this report are made when the soil is in a moist condition.

This report has been compiled and recommendations made based on information supplied in the brief to Civiltest Pty Ltd and from the field investigation and observations made including the extent of, if any, site filling. Every care has been taken within the terms of the brief to ensure that the field investigation is representative of the site. Therefore, if it is found that for any reason information received by Civiltest Pty Ltd is incorrect or conditions on site vary considerably during construction to those described in this report then the comments and recommendations made in this report may need to be amended.

The recommendations given in this report have been based largely on the soil conditions encountered at the time of the field investigation. Under inclement weather or prolonged wet weather conditions, the soil conditions noted and reported in this report could vary. It is advisable to undertake construction during and following good weather conditions - i.e., dry weather conditions - not during or following inclement weather or prolonged wet weather conditions.

Finally, no responsibility will be taken for this report if it is altered in any way or is not reproduced in full.

This report consists of nine pages including one site plan. Appendix A (Engineering Logs) is attached.

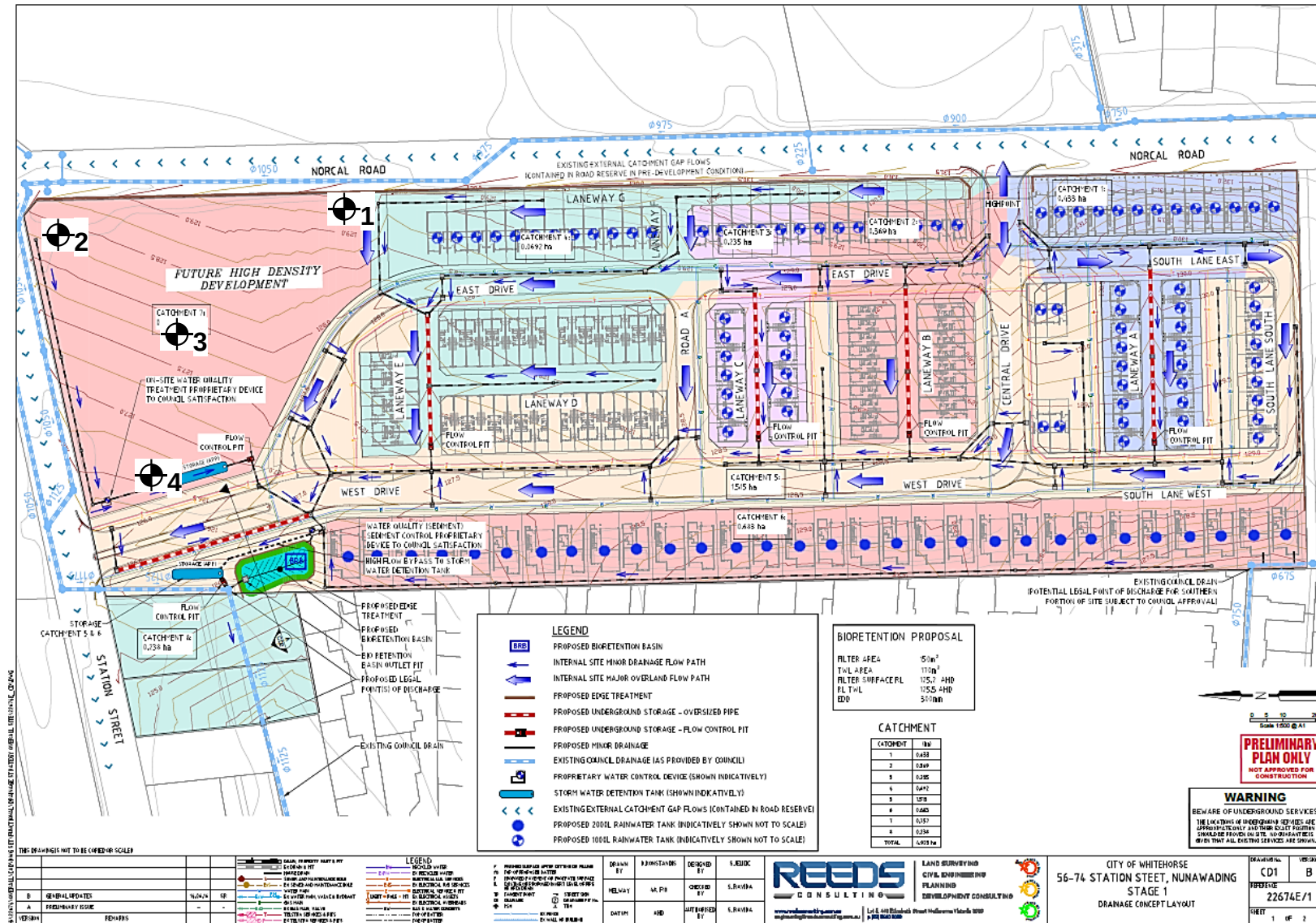


PATRICK OAI
SENIOR GEOTECHNICAL ENGINEER
CIVILTEST PTY LTD

REF: JR/PO/bg

3 May 2021

LOCATION OF TEST SITES: 56-74 STATION STREET NUNAWADING



Denotes Boreholes

APPENDIX A

ENGINEERING LOGS

ENGINEERING LOG

REPORT NO. 1210524-1
FIELD TECHNICIAN: jr

BOREHOLE NO. 1
DATE: 23-APR-2021



DEPTH (m)	STRATA DESCRIPTION	NOTES	GRAPHIC LOG	TESTING					
				DEPTH (m)	RESULTS				
					DCP Blows/100mm	FIELD CBR (%)	SPT	MC (%)	PP (kg/cm²)
0	ASPHALT								
0.050	<u>FILL</u> , CRUSHED ROCK Grey; Dry to moist; Medium dense								
0.300	<u>FILL</u> , SAND, silty, with gravel Red; Moist; Medium dense to dense crushed brick pieces throughout								
0.800	Extremely Weathered ROCK, MUDSTONE Pale brown white; Moist; Very low strength								
1									
2									
2.200	Distinctly Weathered ROCK, MUDSTONE Brown; Dry to moist; Very low strength								
3									
	occasional low strength layers at 3.5m								
4	Continued on next page								

ENGINEERING LOG

REPORT NO. 1210524-1
FIELD TECHNICIAN: jr

BOREHOLE NO. 1
DATE: 23-APR-2021

[illegible]

ENGINEERING LOG

REPORT NO. 1210524-1
FIELD TECHNICIAN: jr

BOREHOLE NO. 2
DATE: 23-APR-2021



DEPTH (m)	STRATA DESCRIPTION	NOTES	GRAPHIC LOG	TESTING					
				DEPTH (m)	RESULTS				
					DCP Blows/100mm	FIELD CBR (%)	SPT	MC (%)	PP (kg/cm²)
0	FILL , SOFT ROCK, trace gravel Brown red grey; Moist; Medium dense More moist with depth								
1									
1.500	ML SILT, clayey Brown mottled pale brown orange; Moist; Medium dense								
1.800	CH CLAY, silty Brown mottled pale brown orange; Moist; Stiff								
2									

ENGINEERING LOG

REPORT NO. 1210524-1
FIELD TECHNICIAN: jr

BOREHOLE NO. 2
DATE: 23-APR-2021

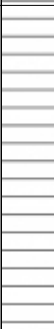
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ENGINEERING LOG

REPORT NO. 1210524-1
FIELD TECHNICIAN: jr

BOREHOLE NO. 3
DATE: 23-APR-2021



DEPTH (m)	STRATA DESCRIPTION	NOTES	GRAPHIC LOG	TESTING					
				DEPTH (m)	RESULTS				
					DCP Blows/100mm	FIELD CBR (%)	SPT	MC (%)	PP (kg/cm²)
0	FILL , CLAY, silty, with gravel Brown red grey; Moist; Stiff More moist with depth								
1									
1.100	MH SILT, clayey Brown mottled pale brown orange; Moist to wet; Medium dense								
1.800	CH CLAY, silty Brown mottled pale brown orange; Moist; Stiff								
2.400	Extremely Weathered ROCK, MUDSTONE Brown; Dry to moist; Very low strength								
3.200	Distinctly Weathered ROCK, MUDSTONE Pale brown white; Dry to moist; Very low strength occasional low strength layers								
4	Continued on next page								

ENGINEERING LOG

REPORT NO. 1210524-1
FIELD TECHNICIAN: jr

BOREHOLE NO. 3
DATE: 23-APR-2021

[illegible]

ENGINEERING LOG

REPORT NO. 1210524-1
FIELD TECHNICIAN: jr

BOREHOLE NO. 4
DATE: 23-APR-2021



DEPTH (m)	STRATA DESCRIPTION	NOTES	GRAPHIC LOG	TESTING					
				DEPTH (m)	RESULTS				
					DCP Blows/100mm	FIELD CBR (%)	SPT	MC (%)	PP (kg/cm²)
0	<u>FILL</u> , CLAY, silty, with gravel Brown red grey; Moist; Firm to stiff More moist with depth. occasional brick pieces								
1									

ENGINEERING LOG

REPORT NO. 1210524-1
FIELD TECHNICIAN: jr

BOREHOLE NO. 4
DATE: 23-APR-2021

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