GEOTECHNICAL SITE INVESTIGATION FOR RESIDENTIAL SLABS AND FOOTINGS

REPORT NUMBER: 2120566-1B

CLIENT: Norcal Station Development Pty Ltd
C/- Nash Management
Suite 5, Level 5, 617 Chapel Street
SOUTH YARRA VIC 3141

SITE ADDRESS: 58-74 Station Street - Zone 1
NUNAWADING

PROPOSED STRUCTURE: Three storey townhouses, access roads and a recreational park

SITE GEOLOGY: Silurian Sediment - CLAYS

SITE CLASSIFICATION: CLASS P (Reclassified as CLASS M)

SUMMARY OF FOUNDING DEPTHS:

FOUNDATION DETAILS	Type	Bearing Capacity	Actual Founding depth*
Slab (Stiffened)	Class M	80 kPa	200mm
Slab (Waffle)	Class M	50 kPa	On natural ground and/or Controlled Fill
Strip footings	Class M	150 kPa	525mm
Stumps	Class M	150 kPa	500mm

**Actual founding depths from the existing surface level at the time of the geotechnical site investigation.*

Note:
This summary should be read in conjunction with the full report.

Document Quality Control Reference:
CIV-DOC-004-001-SD6
Issue #1 – 5 April 2011

1. COMMISSION:

Investigation for site classification in accordance with Section 2 Clause 2.2.2 (a) of Australian Standard 2870-2011 - Residential Slabs and Footings with reference to Clause 2.2.2 (b) and 2.3.2 (c) iii, recommend a founding depth and / or foundation treatment if appropriate, as per Clause 1.3.1 – Performance of Footing Systems (AS2870–2011).

2. SITE GEOLOGY:

The field investigation suggests that the site is in a geological area of Silurian Sediment - CLAYS. Geological maps of the area confirmed this.

3. SITE TOPOGRAPHY:

The site is relatively level and has been cleared.

4. INVESTIGATION:

Nine boreholes were drilled by mechanical auger at the approximate locations shown on the attached plan.

Soil strengths of the cohesive soils were tested (if considered appropriate) by using a shear vane apparatus and observed densities of non-cohesive soils were noted.

The logs of each borehole are attached showing the soil descriptions and depths along with any cohesive strengths measured and observed densities on non-cohesive soils.

This investigation was biased towards the development of townhouses, as no information was provided to Civiltest Pty Ltd on the location of access roads and recreational parks at the time of this investigation.

5. FINDINGS:

The boreholes revealed that the existing soil profile consisted of yellow orange brown silty GRAVEL CONTROLLED FILL overlying white yellow orange silty CLAY CONTROLLED FILL and soft ROCK CONTROLLED FILL. This is followed by the naturally occurring yellow brown silty CLAY.

6. 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 is technically classified as CLASS P with respect to foundation construction (Australian Standard 2870-2011 Residential Slabs and Footings). However, this site can be reclassified as CLASS M [as per AS2870-2011 Clause 2.5.3(c)] on the basis that the fill shown in the bore holes has been placed under controlled conditions in accordance with AS3798 “Guide Lines on Earthworks for Commercial and Residential Developments” “Level 1 Inspection and Testing”. The site preparation prior to filling, the fill material used, the method of placement and compaction was such that the fill meets the requirements of AS2870-2011, Clause 2.5.3. However, this classification is technically not correct for the proposed type of structure, therefore is given as a guide only.

> *Note: The number of compaction tests carried out over the subdivision where this allotment is situated are too numerous to be included in this report. All the individual compaction tests are kept at the Mitcham office of CIVILTEST PTY LTD, Reference No. RT5013*. These can be made available for an appropriate fee.

It is anticipated that the seasonal surface movement at this site will not exceed 40mm.

Due to the nature and composition of the soil profile found in the site, construction during or after wet weather may be difficult. Therefore, it is recommended that an open cut drain be constructed around the proposed site to a depth of not less than 300mm below the site foundation material, or CLAY, whichever occurs first to intercept any ground water. There is no need to maintain this drain after construction to ground level has been reached. At this stage the drain should be backfilled, failure to do so may have detrimental effects.

It must be emphasised that the heave mentioned and recommendations referred to in this report are based solely on the observed soil profile at the time of the investigation for this report without taking into account the effects of any abnormal moisture conditions that may develop after construction as defined in Clause 1.3.3 (A) (B) (C) (D) (E).

7. RECOMMENDED FOUNDATION FOR SLABS:

7.1 Stiffened Raft Slab:

7.1.1 Edge Beams:

It is recommended that a CLASS M (Refer AS2870 – 2011) slab on ground should be used at this site with edge beams founded not less than 200mm below the finished surface level surrounding the structure.

However, the founding depth must be at least 100mm into any of the naturally occurring soils after the removal of any organic and deleterious matter as described in the logs of boring which from the site investigation can be assumed to have an allowable bearing capacity of 80kPa at this depth.

As a guide to the actual site founding depths with regard to the above along with information obtained from the bores, the actual founding depth at this site will be 200mm in relationship to the existing surface where this surface is to be the finished surface level.

7.1.2 Slab and or Stiffening Beams:

Any organic and deleterious matter should be removed from under the proposed slab area to a depth of not less than 50mm and replaced where necessary with levelling fill (See 7.1.3 below) under the slab and internal beams. This excavated surface can be assumed to have an allowable bearing pressure of at least 50kPa.

7.1.3 Levelling Fill:

Up to 400mm of CLAY FILL or 800mm of SAND FILL, imported or site derived, excluding existing controlled FILL but including uncontrolled FILL, if any, may be placed under the slab and internal beams providing that this filling is placed in 150mm thick layers and compacted in a moist condition using a light weight vibratory roller or vibratory plate tamper or similar to form a dense layer. Based on the likely condition of this levelling fill, an allowable bearing pressure of at least 50kPa can be assumed to exist beneath the slab and any internal beams founded in or on this filling.

If more than 400mm of CLAY FILL or 800mm of SAND FILL, imported or site derived, excluding existing controlled FILL but including uncontrolled FILL, is required, then the slab must be designed as a suspended slab and supported by a grid of beams founded through any fill material in accordance with the above edge beam recommendations (or see 10.4 below).

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.

7.2 Waffle Raft Slab:

Waffle raft slabs for this site can be designed for a CLASS M following AS2870 and detailed as per Clauses 6.4 (in particular Clause 6.4.3) of Section 6 of AS2870. For the purposes of design, the surface of the natural soils at this site as described in the engineering logs will have an allowable bearing pressure of at least 50kPa. Alternatively, fill placed in accordance with clause 10.4.2 of this report can be used as a foundation with a bearing pressure of at least 50kPa.

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.

8. RECOMMENDED FOUNDATION STRIP FOOTINGS AND / OR STUMPS:

8.1 Isolated Footings:

The use of CLASS M (AS2870-2011) proportioned strip footings and stumps founded at minimum depths of 525mm and 500mm respectively, below the finished surface level surrounding the structure is recommended. However, the founding depth must be at least 100mm into any of the naturally occurring CLAY soils for strip footings and / or stumps as described in the logs of boring, which from the site investigation can be assumed to have an allowable bearing capacity of 150kPa at this depth.

As a guide to the actual site founding depths with regard to the above along with information obtained from the bores, the actual founding depths at this site will be 525mm for strip footings and 500mm for stumps in relationship to the existing surface where this surface is to be the finished surface level.

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.

8.2 Allowable Bearing Pressures:

The following allowable bearing pressures can be used in the design of spread footings at other depths.

Depth (m)	Allowable Bearing Pressure (kPa)	
	Pad Footings	Strip Footings
0.75	175	160
1.50	200	180
2.50	280	240

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.

9. RECOMMENDATIONS FOR ADDITIONAL WORK:

It is understood that in addition to the townhouses, a recreational park and internal access roads are also proposed for the site identified as Zone 1. For these infrastructure developments, further site specific investigations are required, and we will require a site layout plan showing the proposed development in detail.

10. CONDITIONS OF THE RECOMMENDATIONS:

10.1 Foundations Adjacent to Easements:

It is recommended that where any footings are to be constructed next to existing underground services (sewers, etc.) and / or excavations, then these footings or edge beams should be founded at a depth below the invert of the service at an angle of repose of 45° for CLAYS and 30° for SANDS, unless special consideration has been given to the founding material.

10.2 Review of the recommendations:

The recommendations made in this report may need to be reviewed by Civiltest Pty Ltd should any of the following occur:

10.2.1 Where any site works disturb any soil 300mm below the founding depth of any footing system as defined in AS2870 Clause 1.8.25.
10.2.2 Where any individual foundation depth exceeds the investigation depth.
10.2.3 Where any earthworks lower the building area by 0.5 metres or more.

10.3 Founding soils and depths:

Since the soil horizons and layers can vary in depth and thickness over the site, the depths and bearing pressures given in this 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 logs of boring for this site, then the requirements of this report have been met.

10.4 Use of FILL materials:

Where any filling is to be placed (other than under the floor slab, refer to 7.1.3 above), the footing founding depths recommended in this report will need to be increased accordingly by the depth of that fill unless one of the following occurs:-

10.4.1 The base of the footing is founded in the founding soil recommended in 7.1.1.

10.4.2 The fill has been placed under controlled conditions and compacted to a minimum of 95% of AS1289, 5.1.1 (Standard Compaction) throughout. In this case, the footings may be placed in this fill depending on the findings of further site investigations and the revision of the recommendations made in this report.

10.5 Soil descriptions:

The descriptions of the soils found in the boreholes closely follow those outlined in AS1726 -1993 (Geotechnical Site Investigations). Colour descriptions can vary with soil moisture content. It should be noted therefore, colour and shade descriptions mentioned in this report are made when the soil is in a moist condition.

10.6 Amendment of the report:

This report has been compiled and recommendations made based on information supplied in the brief to Civiltest Pty Ltd and from the field investigations 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 by Civiltest Pty Ltd.

10.7 Foundation design:

The recommendations in this report are not based on a design by engineering principles as defined in Section 4, AS2870 – 2011.

10.8 Long term maintenance and performance:

To ensure acceptable long term performance of the footing systems recommended in this report, care should be taken that the fundamental building, landscaping and long term maintenance procedures are adhered to as set out in the CSIRO Division of Building, Construction and Engineering: Building Technology File 18-2011, "Foundation Maintenance and Footing Performance: A homeowners guide" which is available on the CSIRO website http://www.publish.csiro.au/home.htm. This information sheet forms an integral part of this report.

10.9 Abnormal moisture conditions:

The recommendations made in this report are based on current findings and investigations. Civiltest Pty Ltd cannot be held responsible for any financial loss and / or hardship in relation to the construction of the structure and future performance of the footing system if relevant historical information has not been supplied in writing by the client to Civiltest Pty Ltd. (For example, the recent removal of trees or buildings or any other activity that is likely to have created abnormal moisture conditions as defined in AS2870 prior to Civiltest being commissioned for the investigation reported herein.)

10.10 Building cost estimation:

The limitations of this report should be closely observed when carrying out detailed costings of the proposed structure.

10.11 The information and any recommendations given in this report are limited to the client named herein.

10.12 Whilst CIVILTEST PTY LTD has accepted the commission for the work reported herein, the ownership of the report and any liabilities associated with it, remain with CIVILTEST PTY LTD until all relevant accounts have been paid.

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

This report consists of eighteen pages including one site plan.

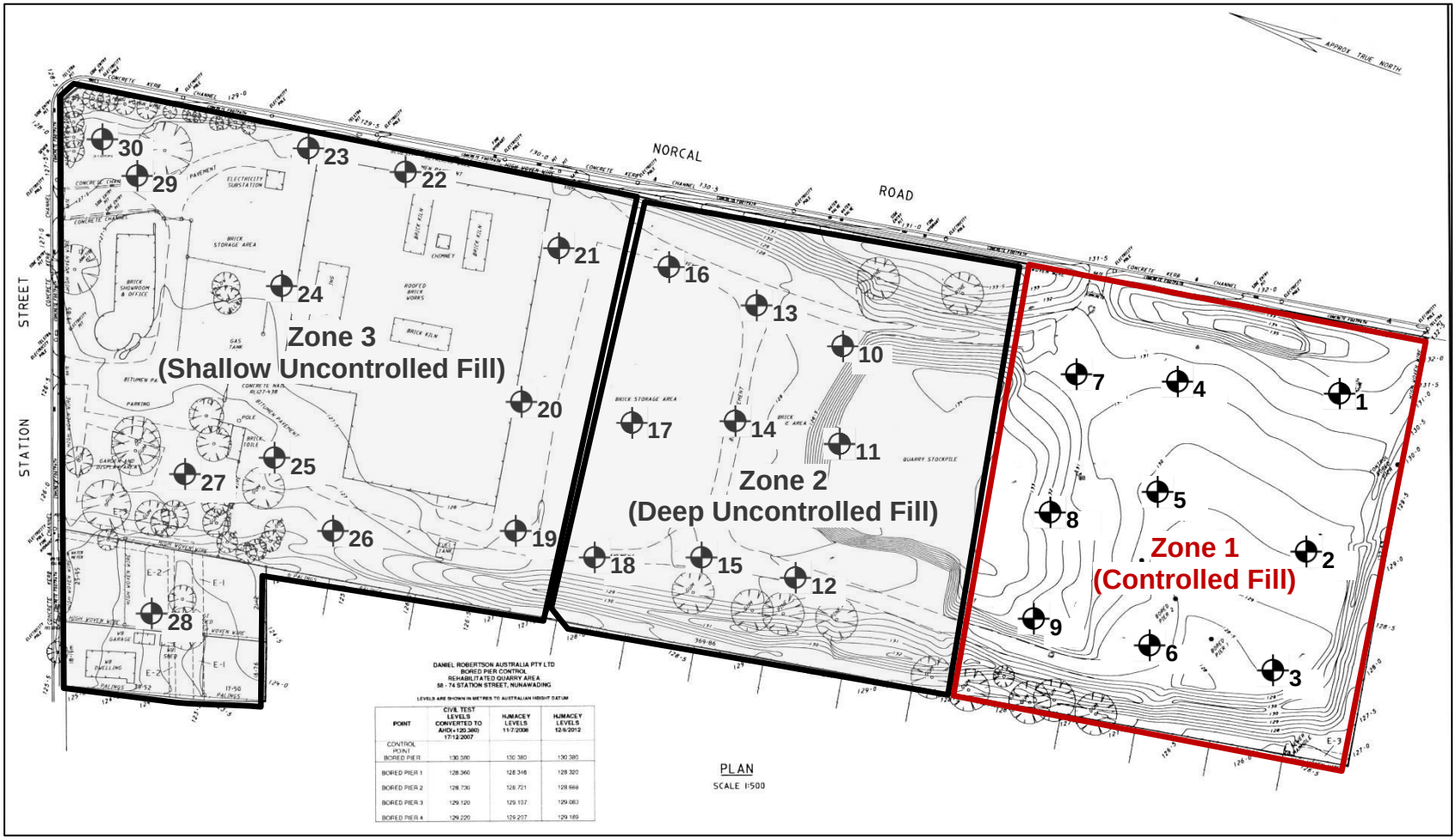
PATRICK OAI
SENIOR GEOTECHNICAL ENGINEER
CIVILTEST PTY LTD

REF: SH/*PO*/mg/*km/sb*

6 April 2017

AMENDMENT: *This report was first issued on 17 December 2012. Sections of this report were amended on 5 and 6 April 2017 and consequently, this revised report now takes precedence over any previously dated report.*

LOCATION OF TEST SITES: 58-74 STATION STREET NUNAWADING



Denotes Test Holes

THIS SKETCH IS NOT INTENDED TO BE AN ACCURATE DEPICTION OF THE NUMBER, SIZE OR LOCATION OF TREES AND/OR SHRUBS

NOT TO SCALE

For bore holes 10 – 30, see Civiltest Pty Ltd Reports 2120566-2A & 2120566-3B.

Test Hole No 1 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
0.900			Yellow orange brown Silty GRAVEL CONTROLLED FILL Medium dense Dry to moist **CONTROLLED FILL**
1.800			White yellow orange Silty CLAY CONTROLLED FILL Stiff Moist **CONTROLLED FILL**
3.000			Yellow brown Silty CLAY Very stiff Moist Becoming yellow, orange and pale grey at 2.500
			END OF BORE (31-10-12)

Test Hole No 2 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
2.200	: : x : : x : : x : : x : : x		Yellow orange brown Silty GRAVEL CONTROLLED FILL Medium dense Dry to moist **CONTROLLED FILL**
3.000	o o o o o o o o o o o o o o o o o o o o		Yellow brown Extremely weathered ROCK Very low strength Dry
			END OF BORE (31-10-12)

Test Hole No 3 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
3.000	: : x : : x : : x : : x : : x : : x : :		Yellow orange brown Silty GRAVEL CONTROLLED FILL Medium dense Dry to moist **CONTROLLED FILL**
4.500	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Brown Extremely weathered ROCK Low strength Dry
			END OF BORE (31-10-12)

Test Hole No 4 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
2.300	: : x : : x : : x : : x : : x : :		Yellow brown Silty GRAVEL CONTROLLED FILL Medium dense Dry **CONTROLLED FILL**
4.500	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Brown Extremely weathered ROCK Low strength Dry
			END OF BORE (31-10-12)

Test Hole No 5 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
5.000	: : x : : x : : x : : x : : x : : x : : x : : x : :		Yellow brown Silty GRAVEL CONTROLLED FILL Medium dense Dry **CONTROLLED FILL**
6.000	o o o o o o o o o o o o o o o		Brown Extremely weathered ROCK Low strength Dry
			END OF BORE (31-10-12)

Test Hole No 6 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
3.200	: : x : : x : : x : : x : : x : :		Yellow brown Silty GRAVEL CONTROLLED FILL Dense Moist to dry **CONTROLLED FILL**
6.000	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Yellow pale brown Extremely weathered ROCK Very low strength Dry
			END OF BORE (31-10-12)

Test Hole No 7 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
2.000	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Pale brown Soft ROCK CONTROLLED FILL Fine gravels present Dense Dry to moist Becoming moist and clayey at 0.800 **CONTROLLED FILL**
3.000	x x x x x x		Grey mottled red and orange Silty CLAY Very stiff Moist
			END OF BORE (15-11-12)

Test Hole No 8 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG	
7.800	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Pale brown Soft ROCK CONTROLLED FILL Fine gravels present Dense Dry to moist Becoming moist and clayey at 0.800 Becoming red brown, moist to dry and not clayey at 1.800 Becoming pale brown at 3.000	**CONTROLLED FILL**
8.600	x —— – x – —— x —— —		Grey and orange Silty CLAY CONTROLLED FILL Stiff Moist	**CONTROLLED FILL**
10.300	o o o o o o o o o o o o o o o o o o		Pale brown Soft ROCK CONTROLLED FILL Stiff Moist **AUGER REFUSAL ON ROCK**	**CONTROLLED FILL**
			END OF BORE (15-11-12)	

Test Hole No 9 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Pale brown Soft ROCK CONTROLLED FILL Fine gravels present Dense Dry to moist **CONTROLLED FILL**
9.300			**AUGER REFUSAL ON ROCK**
			END OF BORE (15-11-12)

REPORT No.	:	2120566-2A
CLIENT	:	Norcal Station Development Pty Ltd C/- Nash Management Suite 5, Level 5, 617 Chapel Street SOUTH YARRA VIC 3141
PROJECT	:	58-74 Station Street NUNAWADING - Zone 2
PROPOSAL	:	It is proposed to construct three storey townhouses, internal access roads and a recreational park at this site.

1. COMMISSION:

Investigation for site classification (Australian Standard 2870-2011 Residential Slabs and Footings), recommend a founding depth and or foundation treatment where appropriate.

2. SITE GEOLOGY:

Geological maps of the area suggest that the site is in an area of Silurian Sediment - CLAYS. The site investigation confirmed this.

3. SITE TOPOGRAPHY:

The site is relatively level. The site has been cleared.

4. INVESTIGATION:

Nine boreholes were drilled by auger at the approximate locations shown on the attached plan.

Soil strengths of the cohesive soils were tested (if considered appropriate) by using a shear vane apparatus and observed densities of non-cohesive soils were noted.

The logs of each bore are attached showing the soil descriptions and depths along with any cohesive strengths measured and observed densities on non-cohesive soils.

This investigation was biased towards the development of townhouses, as no information was provided to Civiltest Pty Ltd regarding the location of access roads and recreational parks at the time of this investigation.

5. FINDINGS:

The boreholes revealed that the existing soil profile consisted of red brown gravelly SILT FILL overlying the naturally occuring yellow white extremely weathered ROCK followed by yellow dinstinctly weathered ROCK.

6. 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 due to the depth of fill, with respect to foundation construction (Australian Standard 2870-2011 Residential Slabs and Footings). It is anticipated that the seasonal surface movement at this site will not exceed 40mm.

It must be emphasised that the heave mentioned and recommendations referred to in this report are based solely on the observed soil profile at the time of the investigation for this report without taking into account the effects of any abnormal moisture conditions that may develop after construction as defined in Clause 1.3.3 (A) (B) (C) (D) (E).

7. RECOMMENDED FOUNDATION FOR SLABS AND OR STRIP FOOTINGS:

7.1 Edge Beams and Driven or Bored Piers:

It is recommended that an engineered designed slab, founded on driven or bored piers should be used at this site. The slab should be designed as a suspended slab.

The piers should be founded not less than 100mm into the naturally occuring weathered ROCK as described in the logs of boring which from the site investigation can be assumed to have an allowable bearing capacity of 450kPa at this depth.

As a guide to the founding depths with regard to the above, along with information obtained from the bores, the founding depth at this site will be approximately up to 14,100mm in relationship to the existing surface where this surface is to be the finished surface level surrounding the structure.

In the design of bored piers or driven piles, consideration should be given to the possibility of adverse lateral loading on the piers/piles induced by foundation movements as a result of permanent moisture changes in the foundation material after construction or by variable moisture changes in the foundation material due to seasonal influences. The above is of particular importance at the edge of fill batters and adjacent to service trenches. Changes in moisture contents of the foundation material due to seasonal variation are more prevalent at the edges of the proposed building and in particular, where piers/piles are used to protect the building from the influence of existing trees.

7.2 Skin Friction:

It can be assumed that 25kPa skin friction will exist between the piers and all CLAY soils. However no skin friction will exist within the crack zone which at this site is 1500mm from the finished surface level and/or FILL soils.

An allowable skin friction of 50kPa can be assumed over the pier shaft embedded within the weathered ROCK.

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.

7.3 Stiffened Raft Slab:

Alternatively to using piers or piles, a stiffened raft slab designed by a qualified engineer (as defined in AS2870-2011) that is designed to cater for a loss of support under the slab could be used at this site. In this case, a comprehensive geotechnical investigation will be required at the site in order to provide the design parameters for such a slab. The comprehensive geotechnical investigation must have as a minimum, a soil moisture profile for the depth of the fill but with a minimum depth of 4.0 metres, Penetration Resistance Testing (either SPT, DCP or SCP) for the depth of the fill and/or Inplace Density testing from undisturbed samples or test pits to determine the relative density of the fill material for the depth of the fill. The geotechnical investigation must be able to assess the likely degree of settlement and site seasonal surface movement under the proposed building for the life of the building as defined in AS2870-2011.

7.4 Strip Footings and Stumps:

Although classified as CLASS P due to the depth of fill found, the use of CLASS (AS 2870-2011) proportioned strip footings and stumps founded at minimum depths of mm and mm respectively, below the finished surface level surrounding the structure is recommended. However, the founding depth must be at least 100mm into the naturally occurring weathered ROCK as described in the logs of boring, which from the site investigation can be assumed to have an allowable bearing capacity of 450kPa at this depth.

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 mm for strip footings and mm for stumps in relationship to the existing surface where this surface is to be the finished surface level.

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.

Alternatively, strip footings could be designed (by a qualified engineer as defined by AS28702011) to be supported on piers or piles as recommended in 7.3 above.

7.5 Foundations Adjacent to Easements:

It is recommended that where any footings are to be constructed next to existing underground services (sewers, etc.), then these footings or edge beams should be founded at a depth below the invert of the service at an angle of repose of 45° for CLAYS and 30° for SANDS, unless special consideration has been given to the founding material.

8. RECOMMENDATIONS FOR ADDITIONAL WORK:

It is understood that in addition to the townhouses, a recreational park and access roads are also proposed for the site identified as Zone 2. For these infrastructure developments, further site specific investigations are required, and we will require a site layout plan showing the proposed development in detail.

9. CONDITIONS OF THE RECOMMENDATIONS:

9.1 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.

9.2 Since the soil horizons and layers can vary in depth and thickness over the site, the depths and bearing capacities given above 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 logs of boring for this site, then the requirements of this report have been met.

9.3 The descriptions of the soils found in the boreholes closely follow those outlined in AS1726 -1993 (Geotechnical Site Investigations). Colour descriptions can vary with soil moisture content. It should be noted therefore, colour and shade descriptions mentioned in this report are made when the soil is in a moist condition.

9.4 This report has been compiled and recommendations made based on information supplied in the brief to Civiltest Pty Ltd and from the field investigations 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.

9.5 To ensure acceptable long term performance of the footing systems recommended in this report, care should be taken that the fundamental building, landscaping and long term maintenance procedures are adhered to as set out in the CSIRO Division of Building, Construction and Engineering: Building Technology File 18 [http://www.publish.csiro.au/pid/3612.htm], "Foundation Maintenance and Footing Performance: A homeowners guide". This information sheet forms an integral part of this report.

9.6 The information and any recommendations given in this report are limited to the client named herein.

9.7 Whilst CIVILTEST PTY LTD has accepted the commission for the work reported herein, the ownership of the report and any liabilities associated with it, remain with CIVILTEST PTY LTD until all relevant accounts have been paid.

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

This report consists of fourteen pages including one site plan.

PATRICK OAI
SENIOR GEOTECHNICAL ENGINEER
CIVILTEST PTY LTD

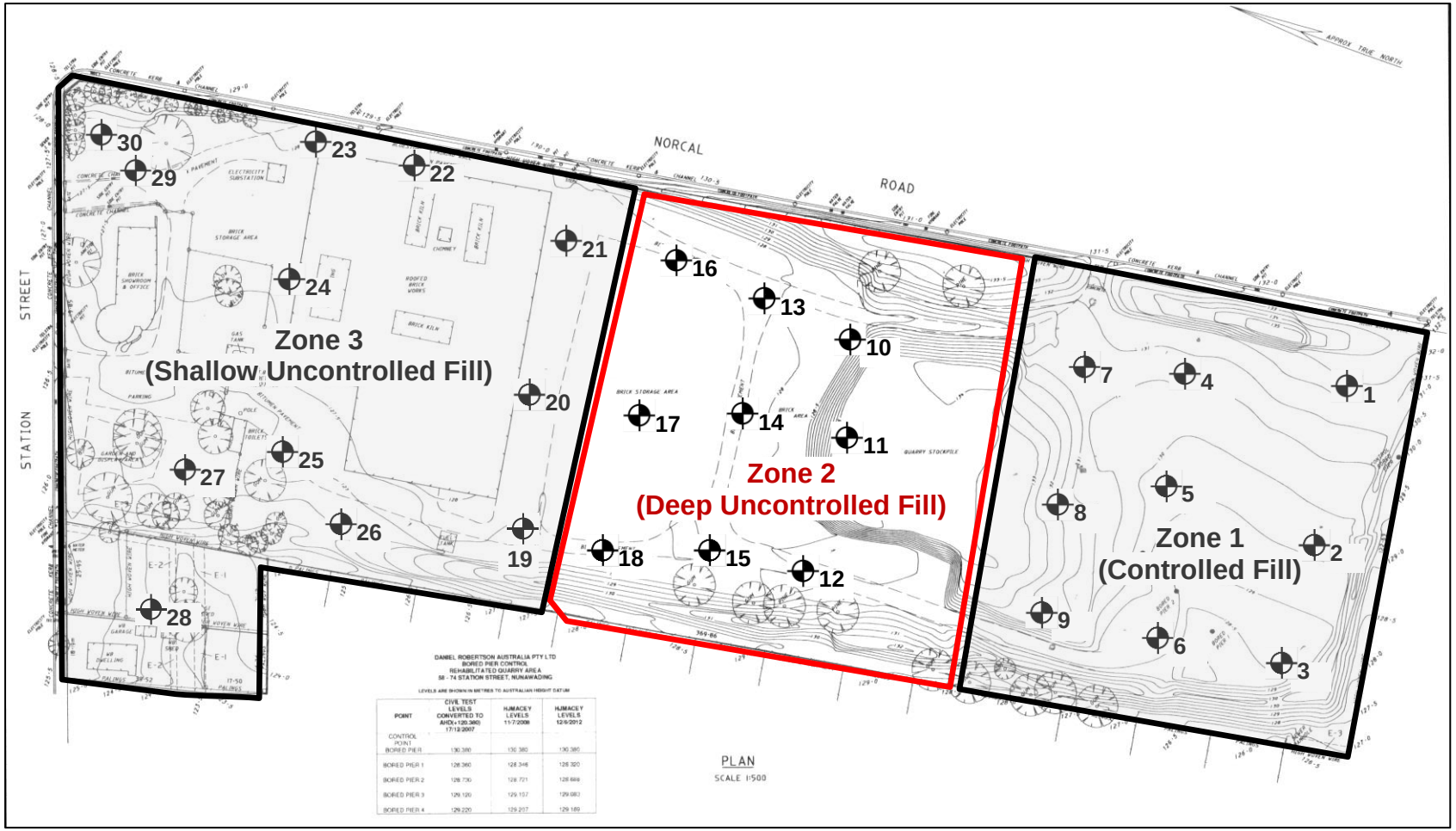
REF: SH/*PO*/mg/*sb*

6 April 2017

AMENDMENT: *This report was first issued on 17 December 2012. Sections of this report were amended on 6 April 2017 and consequently, this revised report now takes precedence over any previously dated report.*

CIV. DOC. 004-006 Reissued 29-06-99

LOCATION OF TEST SITES: 58-74 STATION STREET NUNAWADING



Denotes Test Holes

THIS SKETCH IS NOT INTENDED TO BE AN ACCURATE DEPICTION OF THE NUMBER, SIZE OR LOCATION OF TREES AND/OR SHRUBS

NOT TO SCALE

For Bore Holes 1-9 and 19-30, see Civiltest Reports 2120566-1B & 2120566-3B

Test Hole No 10 **Depth (m)**	**Classifi-cation**	**Shear Vane Strength kPa**	**ENGINEERING LOG**
0.500	x x : x : x x		Red brown Gravelly SILT Medium dense, Dry Minor cobbles present **FILL**
2.500	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Yellow white Extremely weathered ROCK Low strength Moist
3.000	o o o o o o o o o o o o o		Yellow Distinctly weathered ROCK Medium strength Dry
			END OF BORE (15-11-12)

Test Hole No 11 Depth (m)	Classifi-cation	Shear Vane Strength kPa	Engineering Log
7.500	x —— – : x – —— x —— —— x —— —— x —— – : x – —— x —— —— x —— – : x – —— x —— —— x —— —— x —— – : x – —— x —— —— x x —— – : x —— – : x – —— x —— —— x		Yellow white Gravelly silty CLAY FILL Stiff Moist Becoming yellow brown at 1.000 **FILL** Becoming pale brown at 4.500
9.000	o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Yellow Distinctly weathered ROCK Medium strength Dry
			END OF BORE (15-11-12)

Test Hole No 12 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**Engineering Log**
7.000	x ____ _ : x _ ____ x ___ __ x __ ___ x ____ _ : x _ ____ x ___ __ x ____ _ : x _ ____ x ___ __ x __ ___ x ____ _ : x _ ____ x ___ __ x x ____ _ : x ____ _		Yellow brown Gravelly silty CLAY FILL Very stiff Moist Becoming pale brown at 4.000 **FILL**
7.500	o o o o o o o o o o o o o		Yellow Distinctly weathered ROCK Medium strength Dry
			END OF BORE (15-11-12)

Test Hole No 13 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**Engineering Log**
0.450	o°OoO Oo°O o°OoO Oo°Oo		Red brown Crushed ROCK FILL Very dense, Dry Occasional brick pieces present **FILL**
0.900	x ∴ ___ _ ∴ x _ ___ x ∴		Brown mottled orange grey and red Silty sandy CLAY FILL Stiff, Moist Gravel throughout **FILL**
1.500	o o o o o o o o o o o o o o o o o o		Pale yellow brown Extremely weathered ROCK Low strength Dry
			END OF BORE (15-11-12)

Test Hole No 14 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**Engineering Log**
	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Pale brown Soft ROCK FILL Dense to very dense Gravel throughout **FILL** Large gravels and pieces of metal at 4.100
5.700			**REFUSAL ON ROCK**
			END OF BORE (15-11-12)

Test Hole No 15 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**Engineering Log**
1.200	o°OoO Oo°O o°OoO Oo°Oo Oo°Oo o°OO° Oo°Oo o°OoO Oo°O o°OoO		Red brown Crushed ROCK FILL Gravel throughout Very dense Dry **FILL**
2.500	o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Pale grey Extremely weathered ROCK Low strength Dry **REFUSAL ON ROCK**
			END OF BORE (15-11-12)

Test Hole No 16 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**Engineering Log**
1.100	o°OoO Oo°O o°OoO Oo°Oo Oo°Oo o°OO° Oo°Oo o°OoO Oo°O		Red brown Crushed ROCK FILL Very dense Moist **FILL**
4.700	x ___ _ x _ ___ x ___ __ x __ ___ x ___ _ x _ ___ x ___ _ x _ ___ x ___ __ x __ ___ x ___ _ x _ ___ x ___ __ x __ ___		Grey mottled orange Silty CLAY FILL Firm Moist Brick chips throughout Becoming soft and wet at 2.000 **FILL** **REFUSAL ON ROCK**
			END OF BORE (15-11-12)

Test Hole No 17 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**Engineering Log**	
1.200	x : . . . : x . . . x :		Red brown Brick rubble FILL Dense, Moist Silty sand throughout	**FILL**
1.800	x ____ _ x _ ____ x		Green grey Silty CLAY FILL Firm, Moist Brick chips throughout	**FILL**
13.000	x ____ _ x _ ____ x ___ __ x __ ___ x ____ _ x _ ____ x ____ _ x _ ____ x ___ __ x __ ___ x ____ _ x _ ____ x ___ __ x		Green grey Silty CLAY FILL Occasional fine gravels and brick chips throughout Soft Wet Becoming moist and firm at 6.000 Becoming stiff at 10.500	**FILL**
14.000	x ____ _ x _ ____ x		Pale green Silty CLAY Very stiff, Moist	
15.000	o o o o o o o o o o		Pale green grey Extremely weathered ROCK Low strength, Dry	
			END OF BORE (15-11-12)	

Test Hole No 18 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**Engineering Log**
0.600	x : . . . : x . . . x :		Yellow brown Gravelly silty SAND FILL Medium dense Moist **FILL**
2.500	— . . . _ _ . . . _ _ . . . — . . . — . . . _ _		Yellow brown grey Clayey SAND FILL Medium dense Moist **FILL**
3.200	o o o o o o o o o o o o o		Yellow white Extremely weathered ROCK Very low strength Dry
3.500	o o o o o o o o o o o o o		Yellow white Distinctly weathered ROCK Low to medium strength, Dry **AUGER REFUSAL**
			END OF BORE (15-11-12)

REPORT No.	:	2120566-3B
CLIENT	:	Norcal Station Development Pty Ltd C/- Nash Management Suite 5, Level 5, 617 Chapel Street SOUTH YARRA VIC 3141
PROJECT	:	58-74 Station Street - Zone 3 NUNAWADING
PROPOSAL	:	It is proposed to construct three storey townhouses, internal access roads, a recreational park and a bioretention basin at this site.

1. COMMISSION:

Investigation for site classification (Australian Standard 2870-2011 Residential Slabs and Footings), recommend a founding depth and or foundation treatment where appropriate.

2. SITE GEOLOGY:

Geological maps of the area suggest that the site is in an area of Silurian Sediment - CLAYS. The site investigation confirmed this.

3. SITE TOPOGRAPHY:

The site is relatively level and has been cleared.

4. INVESTIGATION:

Twelve boreholes were drilled by mechanical auger at the approximate locations shown on the attached plan.

Soil strengths of the cohesive soils were tested (if considered appropriate) by using a shear vane apparatus and observed densities of non-cohesive soils were noted.

The logs of each bore are attached showing the soil descriptions and depths along with any cohesive strengths measured and observed densities on non-cohesive soils.

This investigation was biased towards the development of townhouses, as no information was provided to Civiltest Pty Ltd regarding the location of access roads, recreational parks or bioretention basins at the time of this investigation.

5. FINDINGS:

The boreholes revealed that the existing soil profile consisted of ASPHALT overlying dark grey brown sandy gravelly SILT FILL followed by grey brown silty CLAY FILL. Underlying this is white grey silty CLAY FILL followed by the naturally occuring brown extremely weathered ROCK overlying yellow distinctly weathered ROCK.

6. 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 due to the depth of fill, with respect to foundation construction (Australian Standard 2870-2011 Residential Slabs and Footings). It is anticipated that the seasonal surface movement at this site will not exceed 40mm.

It must be emphasised that the heave mentioned and recommendations referred to in this report are based solely on the observed soil profile at the time of the investigation for this report without taking into account the effects of any abnormal moisture conditions that may develop after construction as defined in Clause 1.3.3 (A) (B) (C) (D) (E).

7. RECOMMENDED FOUNDATION FOR SLABS AND OR STRIP FOOTINGS:

7.1 Edge Beams and Driven or Bored Piers:

It is recommended that an engineered designed slab, founded on driven or bored piers should be used at this site. The slab should be designed as a suspended slab.

The piers should be founded not less than 100mm into the naturally occurring weathered ROCK as described in the logs of boring, which from the site investigation can be assumed to have an allowable bearing capacity of 450kPa at this depth.

As a guide to the founding depths with regard to the above, along with information obtained from the bores, the founding depth at this site will be approximately up to 3600mm in relationship to the existing surface where this surface is to be the finished surface level surrounding the structure.

In the design of bored piers or driven piles, consideration should be given to the possibility of adverse lateral loading on the piers/piles induced by foundation movements as a result of permanent moisture changes in the foundation material after construction or by variable moisture changes in the foundation material due to seasonal influences. The above is of particular importance at the edge of fill batters and adjacent to service trenches. Changes in moisture contents of the foundation material due to seasonal variation are more prevalent at the edges of the proposed building and in particular, where piers/piles are used to protect the building from the influence of existing trees.

7.2 Skin Friction:

It can be assumed that 25kPa skin friction will exist between the piers and all CLAY soils. However no skin friction will exist within the crack zone which at this site is 1500mm from the finished surface level and/or FILL soils.

An allowable skin friction of 50kPa can be assumed over the pier shaft embedded within the weathered ROCK.

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.

7.3 Stiffened Raft Slab:

Alternatively to using piers or piles, a stiffened raft slab designed by a qualified engineer (as defined in AS2870-2011) that is designed to cater for a loss of support under the slab could be used at this site. In this case, a comprehensive geotechnical investigation will be required at the site in order to provide the design parameters for such a slab. The comprehensive geotechnical investigation must have as a minimum, a soil moisture profile for the depth of the fill but with a minimum depth of 4.0 metres, Penetration Resistance Testing (either SPT, DCP or SCP) for the depth of the fill and/or Inplace Density testing from undisturbed samples or test pits to determine the relative density of the fill material for the depth of the fill. The geotechnical investigation must be able to assess the likely degree of settlement and site seasonal surface movement under the proposed building for the life of the building as defined in AS2870-2011.

7.4 Strip Footings and Stumps:

Although classified as CLASS P due to the depth of fill found, the use of CLASS M (AS 2870-2011) proportioned strip footings and stumps founded at minimum depths of 525mm and 500mm respectively, below the finished surface level surrounding the structure is recommended. However, the founding depth must be at least 100mm into the naturally occurring weathered ROCK as described in the logs of boring, which from the site investigation can be assumed to have an allowable bearing capacity of 450kPa at this depth.

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 3600mm for strip footings and up to 3600mm for stumps in relationship to the existing surface where this surface is to be the finished surface level.

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.

Alternatively, strip footings could be designed (by a qualified engineer as defined by AS28702011) to be supported on piers or piles as recommended in 7.3 above.

7.5 Foundations Adjacent to Easements:

It is recommended that where any footings are to be constructed next to existing underground services (sewers, etc.), then these footings or edge beams should be founded at a depth below the invert of the service at an angle of repose of 45° for CLAYS and 30° for SANDS, unless special consideration has been given to the founding material.

8. RECOMMENDATIONS FOR ADDITIONAL WORK:

It is understood that in addition to the townhouses, a public park, internal access roads and a bioretention retarding basin are proposed within the area covered by borehole 28.

Further appropriate and site specific investigations will be required for the above developments. The investigation and testing will include the following:

- Further boreholes
- Permeability testing
- Emerson class number (for dispersion)
- California Bearing Ratio (CBR)
- Standard Compaction Test
- Atterberg Limit Tests
- Sieve Analysis

We will require a plan showing where the proposed structures will be located in order to devise a suitable/appropriate scope of work.

9. CONDITIONS OF THE RECOMMENDATIONS:

9.1 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.

9.2 Since the soil horizons and layers can vary in depth and thickness over the site, the depths and bearing capacities given above 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 logs of boring for this site, then the requirements of this report have been met.

9.3 The descriptions of the soils found in the boreholes closely follow those outlined in AS1726 -1993 (Geotechnical Site Investigations). Colour descriptions can vary with soil moisture content. It should be noted therefore, colour and shade descriptions mentioned in this report are made when the soil is in a moist condition.

9.4 This report has been compiled and recommendations made based on information supplied in the brief to Civiltest Pty Ltd and from the field investigations 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.

9.5 To ensure acceptable long term performance of the footing systems recommended in this report, care should be taken that the fundamental building, landscaping and long term maintenance procedures are adhered to as set out in the CSIRO Division of Building, Construction and Engineering: Building Technology File 18 [http://www.publish.csiro.au/pid/3612.htm], "Foundation Maintenance and Footing Performance: A homeowners guide". This information sheet forms an integral part of this report.

9.6 The information and any recommendations given in this report are limited to the client named herein.

9.7 Whilst CIVILTEST PTY LTD has accepted the commission for the work reported herein, the ownership of the report and any liabilities associated with it, remain with CIVILTEST PTY LTD until all relevant accounts have been paid.

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

This report consists of eighteen pages including one site plan.

PATRICK OAI
SENIOR GEOTECHNICAL ENGINEER
CIVILTEST PTY LTD

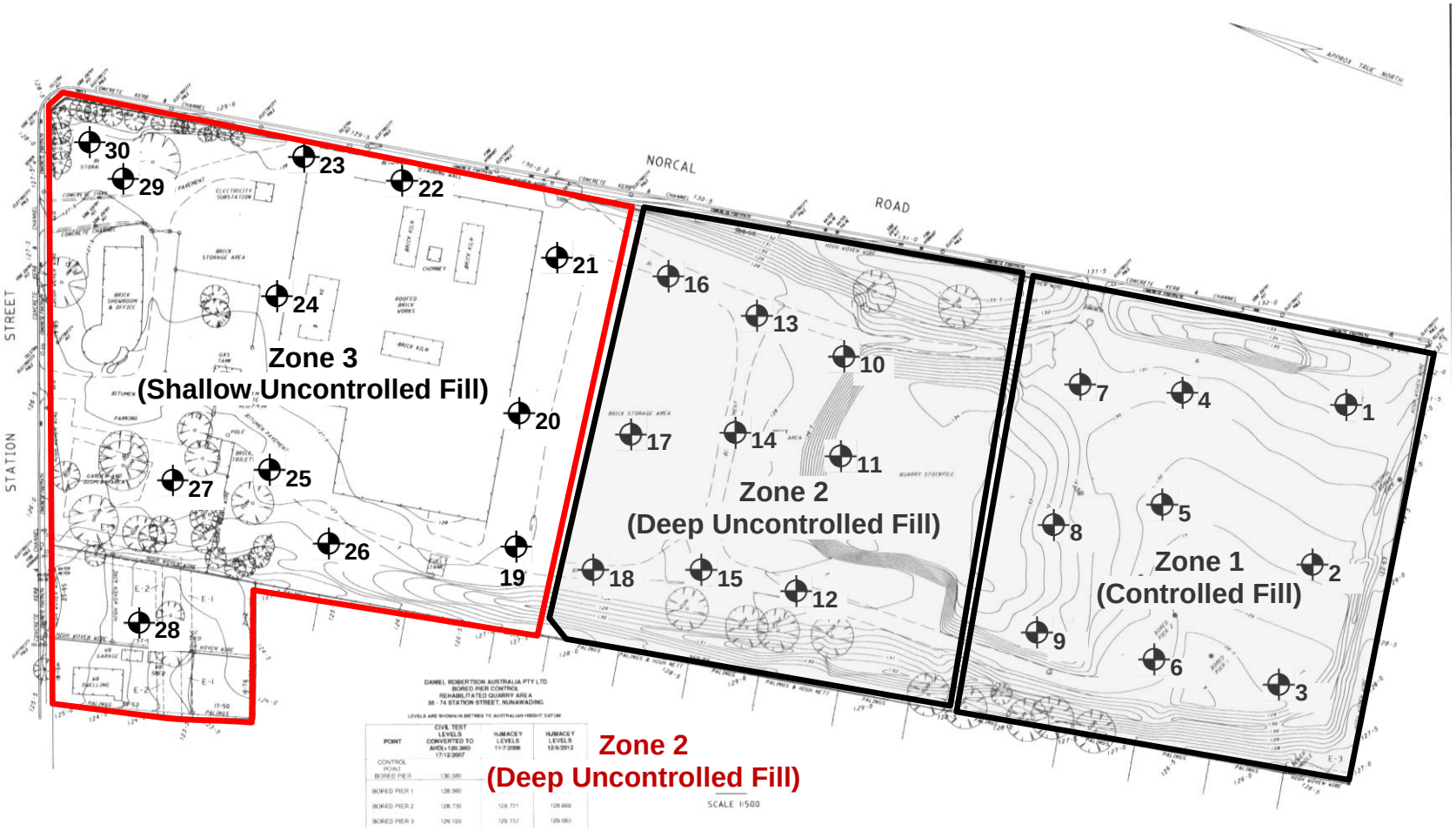
REF: SH/mg/*po/km/sb*

6 April 2017

AMENDMENT: *This report was first issued on 17 December 2012. Sections of this report were amended on 5 and 6 April 2017 and consequently, this revised report now takes precedence over any previously dated report.*

CIV. DOC. 004-006 Reissued 29-06-99

LOCATION OF TEST SITES: 58-74 STATION STREET NUNAWADING



Denotes Test Holes

THIS SKETCH IS NOT INTENDED TO BE AN ACCURATE DEPICTION OF THE NUMBER, SIZE OR LOCATION OF TREES AND/OR SHRUBS

NOT TO SCALE

For Bore Holes 1-18, see Civiltest Pty Ltd Reports 2120566-1B & 2120566-2A

Test Hole No 19 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
0.030			ASPHALT
0.900			Dark grey brown Sandy gravelly SILT FILL Medium dense Moist **FILL**
3.000			Grey brown Silty CLAY FILL Stiff Moist Becoming dark grey at 1.500 **FILL**
3.500			White grey Silty CLAY FILL Stiff Moist **FILL**
4.000			Brown Extremely weathered ROCK Low strength Dry
4.500			Yellow Distinctly weathered ROCK Medium strength Dry
			END OF BORE (04-12-12)

Test Hole No 20 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
0.200	x : . . . : x . . .		Dark brown Gravelly silty SAND FILL Medium dense, Moist **FILL**
0.800	x : . . . : x . . .		White Gravelly silty SAND FILL Medium dense, Moist Becoming red at 0.500 **FILL**
1.000	x ___ _ x _ ___ x		Grey brown Silty CLAY FILL Stiff, Moist **FILL**
1.500	o o o o o o o o o o o o o		Yellow white Extremely weathered ROCK Very low strength Moist
			END OF BORE (04-12-12)

Test Hole No 21 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**ENGINEERING LOG**
0.100	x : . . . : x . . .		Brown Gravelly silty SAND FILL Medium dense, Moist **FILL**
0.600	: : ∴ : ∴ : :		Red Sandy GRAVEL FILL Dense Moist **FILL**
1.500	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Yellow white Extremely weathered ROCK Very low strength Moist Becoming white at 1.000
			END OF BORE (04-12-12)

Test Hole No 22 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
0.025			ASPHALT
0.400	: : ∴ : ∴		Dark grey Sandy GRAVEL FILL Moist, Dense **FILL**
0.600	x x : x x		Grey Gravelly SILT FILL Medium dense, Moist **FILL**
1.500	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		Orange yellow Extremely weathered ROCK Very low strength Moist Becoming orange and dry at 1.200
			END OF BORE (04-12-12)

Test Hole No 23 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**ENGINEERING LOG**
0.700	x : . . . : x . . . x : . . . : x		Brown Gravelly silty SAND FILL Medium dense Moist Becoming red at 0.100 Becoming white yellow at 0.700 ↕ **FILL**
1.500	o o o o o o o o o o o o o o o o o o o o o o o o o o o o o o		White yellow Extremely weathered ROCK Very low strength Moist Becoming dry at 1.000
			END OF BORE (04-12-12)

Test Hole No 24 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
0.100	x : . . . : x . . .		Brown Gravelly silty SAND FILL Medium dense, Moist **FILL**
1.400	x ___ _ x _ ___ x ___ __ x __ ___ x ___ _ x _ ___ x ___ _ x _ ___ x ___ __ x		Red brown Silty CLAY FILL Very stiff Moist Water at 1.100 **FILL**
1.600	x ___ _ x _ ___ x		Orange brown Silty CLAY Stiff, Moist
2.000	o o o o o o o o o o o o o		White yellow Extremely weathered ROCK Low strength Dry
			END OF BORE (04-12-12)

Test Hole No 25 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**ENGINEERING LOG**
0.700			Grey Sandy GRAVEL FILL Dense, Moist Becoming red at 0.100 **FILL**
0.900			Grey Silty CLAY FILL Stiff Moist **FILL**
1.200			Red GRAVEL FILL Medium dense, Dry **FILL**
1.400			Grey SILT Medium dense, Moist
1.600			Orange brown Silty CLAY Very stiff, Moist
			END OF BORE (04-12-12)

Test Hole No 26 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
0.700			Red brown Sandy GRAVEL FILL Dense Dry **FILL**
2.000			Grey Silty CLAY FILL Stiff Moist **FILL** **AUGER REFUSAL**
			END OF BORE (04-12-12)

Test Hole No 27 Depth (m)	Classifi-cation	Shear Vane Strength kPa	ENGINEERING LOG
0.100	x x x x x		Brown, SILT FILL Medium dense , Dry ↑ **FILL** ↓
0.130	: : ∴ : :		Red brown, Sandy GRAVEL Dense, Dry **AUGER REFUSAL**
			END OF BORE (18-12-12)

Test Hole No 28 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**ENGINEERING LOG**
0.300			Brown Sandy SILT Medium dense Moist
0.800			Pale grey yellow Clayey SILT Medium dense Moist
1.500			Orange yellow Silty CLAY Very stiff Moist
			END OF BORE (18-12-12)

Test Hole No 29 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**ENGINEERING LOG**
0.400			Red brown Sandy GRAVEL FILL Dense Moist **FILL**
0.700			Dark grey Clayey SILT FILL Minor vegetation and odour in soil Medium dense, Moist **FILL** **AUGER REFUSAL**
			END OF BORE (18-12-12)

Test Hole No 30 Depth (m)	Classifi-cation	Shear Vane Strength kPa	**ENGINEERING LOG**
0.600			Red brown Gravelly SILT FILL Medium dense Dry **FILL**
1.400			Grey Clayey SILT FILL Medium dense Wet Odour in soil **FILL**
1.600			Yellow red Silty CLAY Very stiff Moist
			END OF BORE (18-12-12)