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Report

**Preliminary Geotechnical Investigation
Proposed Residential Subdivision Development
Lot 11 DP 534539 No 215 Macarthur Road
Spring Farm, NSW**

Prepared for
**Crownland Developments
Suite 502, Level 5, 95 Pitt Street
SYDNEY NSW 2000**

**Ref: JC25487B-r1
May 2025**



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15th May 2025

Our Ref: JC25487B-r1

Crownland Developments
Suite 502, Level 5, 95 Pitt Street
SYDNEY NSW 2000

Attention: Mr Vince Roccisano

Dear Sir

**Re Preliminary Geotechnical Investigation
Proposed Residential Subdivision Development
Lot 11 DP 534539 No 215 Macarthur Road, Spring Farm NSW**

We are pleased to submit our preliminary geotechnical Investigation report for the proposed residential development at the above address.

Should you have any queries, please contact the undersigned.

Yours faithfully

GeoEnviro Consultancy Pty Ltd

Solern Liew CPEng NER CEnvP
Director



Adrian Tejada BE
Geotechnical Engineer



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Document Control

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Address	Lot 11 DP 534539 No 215 Macarthur Road, Spring Farm, NSW
Client	Crownland Developments

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TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1. INTRODUCTION	1
2. SITE INFORMATION.....	1
2.1 Site Location	1
2.2 Surrounding Land Use	2
2.3 Site Topography	2
2.4 Ground Cover and Salinity Indicators	2
2.5 Soil Landscape and Geological Setting.....	2
2.6 Soil Salinity Map	3
2.7 Acid Sulfate Soil Risk Map.....	3
2.8 Site History and Previous Land use.....	3
2.9 Existing Site Conditions and Description.....	4
3. INVESTIGATION METHODOLOGY.....	4
4. SUBSURFACE CONDITIONS	5
5. GEOTECHNICAL COMMENTS AND ASSESSMENT.....	6
6. CONCLUSION	7
7. LIMITATIONS	8

REFERENCES

LIST OF DRAWINGS

Drawing No 1	Site Locality Site Features Plan
Drawing No 2	Soil Landscape Map
Drawing No 3	Geological Map
Drawing No 4	Test Location Plan

LIST OF APPENDICES

Appendix A	Test Pit and Borehole Reports
Appendix B	Historical Photographs
Appendix C	Dynamic Cone Penetrometer Test Reports
Appendix D	A Brief Explanation on Site Classification
Appendix E	Explanatory Notes

1. INTRODUCTION

This report presents our geotechnical assessment for the site referred to as No 215 Macarthur Road Spring Farm in Spring Farm and identified as Lot 11 Deposit Plan (DP) 534539. We understand the proposed development will include subdivision of the site into about 51 residential lots and construction of residential roads.

The objectives of this study are as follows;

- To investigate the historical land use of the site that may pose an adverse impact on the proposed development.
- To investigate the subsurface ground and ground water conditions and to assess the suitability of the site from a geotechnical perspective for the proposed development.
- To provide preliminary comments and recommendations on geotechnical issues considered relevant to the proposed development.

The investigation was commissioned by Mr William Akerboom of Crownland Developments based on our proposal referenced JC25487A-L1 dated 29th April 2025. The scope of this report forms part of a more detailed geotechnical investigation which includes laboratory testing to derive at site specific recommendations on geotechnical design issues.

2. SITE INFORMATION

2.1 Site Location

The subject site is situated on the northern side of Macarthur Road in Spring Farm and is irregular in shape measuring about 300m along the Macarthur Road frontage and extending about 150m along its eastern boundary. Total site area is about 2.4 hectares.

The site is within the jurisdiction of Camden Council.

2.2 Surrounding Land Use

The site is situated within a semi-rural residential and developed residential area with adjoining properties to the north and east consisting of newly developed subdivision developments with residential dwellings. Properties to the west along Macarthur Road consist of semi-rural properties used mainly for residential purposes as well as an old sand quarry immediately south of the site.

2.3 Site Topography

The site is situated on low lying flood plain to very gently undulating terrain on the northern bank of the Nepean River. Natural ground surface within the site slopes down in a southerly direction towards Macarthur Road at angles of less than 3 degrees and across Macarthur Road, ground surface continues to slope down at angles typically between 3 and 5 degrees to the Nepean River approximate 700m to 1.1km to the south.

Based on Google Earth, the ground surface within the site ranges in elevation from about 79m to 81m above sea level. The Nepean River water was at about 58m above sea level and this level will fluctuates with the weather seasons.

2.4 Ground Cover and Salinity Indicators

The site comprised predominantly of grassy areas with some trees within the curtilage. The site generally appeared reasonably well drained with no visible signs of permanent water-logged areas, groundwater or “springs”.

There were no obvious signs and indicators of salinity impacts such as salt crystals on the surface, salt attacks and markings on existing building footings and vegetation distress.

2.5 Soil Landscape and Geological Setting

The 1:100,000 Soil Landscape Map of Wollongong-Port Hacking prepared by the Soil Conservation Services of NSW indicates the site to be underlain by colluvial soil belonging to the Theresa Park landscape group. Refer to Drawing No 2 for Soil Landscape Map

The 1:100,000 Geological Map of Wollongong-Port Hacking indicates the site to be situated on the interface of Quaternary soil (Qal) consisting of quartz and lithic “fluvial” sand, silt and clay to the South western portion of the site and Tertiary soil (Tal) consisting of high-level alluvium to the North eastern portion of the site. Refer to Drawing No 3 for Geological Map.

The underlying bedrock unit at lower depths consists of Bringelly Shale of the Wianamatta Group in the Triassic Period and this unit typically comprising of shale and carbonaceous claystone, siltstone, laminate and interbedded lithic sandstone.

2.6 Soil Salinity Map

Based on Salinity Potential in Western Sydney 2002 prepared by the Western Sydney Regional Organisation of Councils Ltd, the site is situated in area with a moderate salinity potential. Refer to Drawing No 4 for Salinity Potential Map.

2.7 Acid Sulfate Soil Risk Map

Based on acid sulfate soil risk maps prepared by the Department of Land and Water Conservation, the site is situated in an area with no known occurrence of acid sulfate soils.

2.8 Site History and Previous Land use

Based on historical aerial photography dating back to the 1960s, the site appeared to have been used for residential purposes with some minor agricultural use (eg grazing, animal keeping). The site appeared to have been predominantly used for residential since the 1970s with a residential dwelling constructed in the middle

The historical aerial photographs indicate the site to have been on natural (ie virgin) ground over at least the last 50 years and there were no evidence of ground modification by excavation and filling from mining, construction works or waste landfill/recycling activities. There were no evidence of ground disturbance such as scarring of landform, clearing of vegetation, groundworks associated with industrial activities, unauthorised dumping of waste or stockpiling of earthfill.

Reference may be made to Appendix B for historical photographs.

2.9 Existing Site Conditions and Description

At the time of the site investigation, the site was vacant with a curtilage and single storey dwelling with swimming pool in the middle of the site. A large metal shed occupied the north-western corner of the site with the remainder of the site consisting of vacant land. There was also a small metal structure towards the northern portion of the site to the rear of the existing dwelling.

The site was predominantly cleared of trees and bushes with ground surface partially covered with grass and sandy soil was exposed on the surface. The ground surface appeared even and level with no obvious or visible signs of previous ground disturbance by excavation and filling.

Reference may be made to Drawing No 1 for site features.

3. INVESTIGATION METHODOLOGY

Field investigation included excavation of test pits using a rubber tyred backhoe on the 8th May 2025 and drilling of boreholes on the 13th and 14th May 2025.

Ten test pits (ie TP 1 to TP 10) and five boreholes (ie BH 1 to 5) were excavated and drilled across the site. The test locations are shown on Drawing No 5. The test pits were excavated to depths of about 5.5m below existing ground surface. To aid assessment of the densities of the subsurface profile, dynamic cone penetrometer (DCP) tests were undertaken adjacent the test pits. Reference may be made to Appendix C for Dynamic Cone Penetrometer Test Reports.

The boreholes were drilled using a ute mounted drill rig equipped for site investigation purposes with spiral augers attached to a Tungsten Carbide (TC) bit drilling through natural sandy soil to depths of about 9.0m below existing ground level. To assess the strength of the subsurface soil, Standard Penetration Tests (SPT) were carried out in the boreholes. The SPT tests involved driving a split tube steel spoon into the ground using a standard weight (ie 63.5kg) hammer and measuring the penetration resistance in number of blow counts per 150mm penetration.

The test pits and boreholes were observed for groundwater during and upon completion of the site investigation. Upon completion of the investigation, the test pits and boreholes were backfilled with excavation spoil.

Details of the subsurface profiles are summarised on the Test Pits and Borehole Reports in Appendix A of this report.

Explanatory notes defining the terms and symbols used in the preparation of the test pits and borehole reports are attached in Appendix E.

Disturbed and bulk soil samples were taken from the site to our NATA accredited laboratory to assess the physical soil properties and soil samples was also sent to Envirolab Services for salinity analysis to assess soil aggressiveness. At the time of the preparation of this report, the laboratory test results are not available and the results of this laboratory analysis will be included in the detailed geotechnical report in due course.

4. SUBSURFACE CONDITIONS

Reference should be made to the attached Test Pit and Borehole Reports in Appendix A for details of the subsurface profiles encountered in each test location. The following is a summary of the subsurface profiles encountered;

- Minor fill was encountered in TP 1 comprising of Crushed Rock with thickness of about 150mm.
- Topsoil consisting of fine to medium grained Silty Sand was encountered on the surface of all test pits and boreholes except TP 1. The topsoil was generally found to have thickness ranging from 100mm to 500mm.
- Natural soil was encountered below the topsoil and fill in all test pits and boreholes consisting predominantly of fine to medium grained Sand. The natural sandy soil was generally assessed to be dry to moist.

Based on the SPT results, the relative density of the natural sand was found to be variable with very loose to loose sand generally in the upper 2.6m to 3m and improving to medium dense at lower depths. The full depth of natural soil in BH 5 was found to be medium dense.

The DCP test results generally appeared consistent with the SPT test results with variable blow counts at the upper 2m correlating to very loose to medium dense sand and the blow counts increases to medium dense at lower depths.

- Bedrock was not encountered in all test pits or boreholes which were terminated at a maximum depth of 9.0m below existing ground level. Based on our previous investigation of the area, we expect the underlying bedrock to consist of Shale.
- Groundwater was not encountered in all test pits and boreholes which were taken to a maximum depth of 9m below ground surface. Based on our groundwater studies of adjacent site to the south of Macarthur Road, ground water level is expected to be at about Reduced Level (RL) 64 to 68m Australian Height Datum (AHD), therefore permanent groundwater table of about 11m or deeper may be expected.

5. GEOTECHNICAL COMMENTS AND ASSESSMENT

Based on the results of the investigation, the following are our assessment of the site with respect to the proposed residential subdivision development;

- The historical aerial photographs indicate the site to have remained undisturbed since the 1960's with no ground modification by excavation and filling from human activities such as sand extraction/mining, dredging, dam construction and land filling. On this basis, there is a high level of confidence that the insitu foundation material is predominantly in its natural state and homogeneous with no unexpected relict rubbish or compressible burial ground.
- The site investigations revealed the site to comprise of uniform natural sandy soil for the full depth of the investigation to 9m. The upper 3m of the sand was assessed to have variable relative densities ranging from Very Loose to Loose and the relative densities of the sand at lower depths was assessed to be Medium Dense or better. Based on our past experience of adjacent sites, we anticipate the soil profiles at lower depths is expected to become more clayey, with Sandy Clay, Clayey Sand and Silty Clay encountered.

Some densification of the upper Very Loose to Loose sand will be required for the proposed development. The investigation did not encounter soft compressive soil such as Organic Clays or Peat that may pose severe constraints associated with time-related consolidation (ie settlement) on future development.

- The site investigation did not encounter permanent groundwater which is expected to be at significant depth greater than 9m below ground surface. In the absence of shallow groundwater, it is feasible for sand densification works to be carried by conventional earthworks which includes excavation, filling and recompaction. Other densification methods using dynamic compaction methods are also possible from a geotechnical perspective however this should only be implemented after careful consideration to address environmental factors such as vibration, induced settlement and noise impacts to existing adjoining residential housing estate.

6. CONCLUSION

We are of the opinion that the site is suitable for the proposed residential subdivision development subject to implementation of good geotechnical engineering practice and design and this includes but not limited to;

- Densification of the upper 3m of the natural Very Loose to Loose Sand and this may be undertaken by conventional earthworks by excavation, fill and recompaction. Earthworks should be undertaken under Level 1 supervision with adequate density test frequency to AS3798-2007 "Guidelines on Earthworks for Commercial and Residential Sites".
- Assessment of foundation conditions taking into considerations foundation settlement under additional surcharge loads from future building and Shrink-Swell potential in accordance to AS2870-2013 "Residential Slabs and Footings". Subject to adequate earthworks control and testing, shallow and deep footings may be considered suitable.

- Implementation of safe slope batters and retaining walls to ensure site stability is maintained.
- Implementation of adequate surface and subsurface drainage to keep the foundation dry and limit salt mobility to improve durability design.

7. LIMITATIONS

The interpretation and recommendations submitted in this report are based on a limited number of boreholes. There is no investigation which is thorough enough to determine all site conditions and anomalies, no matter how comprehensive the investigation program is as site data is derived from extrapolation of limited test locations. The nature and extent of variations between test locations may not become evident until construction.

Groundwater conditions are only briefly examined in this investigation. The groundwater conditions may vary seasonally or as a consequence of construction activities on or adjacent to the site.

In view of the above, the subsurface soil and rock conditions between the test locations may be found to be different or interpreted to be different from those expected. If such differences appear to exist, we recommend that this office be contacted without delay.

The statements presented in these documents are intended to advise you of what should be your realistic expectations of this report, and to present you with recommendations on how to minimise the risks associated with the ground works for this project. The document is not intended to reduce the level of responsibility accepted by GeoEnviro Consultancy Pty Ltd, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing. Attached in Appendix E are documents entitled "Explanatory Notes" in conjunction with which this report must be read, as it details important limitations regarding the investigation undertaken and this report.

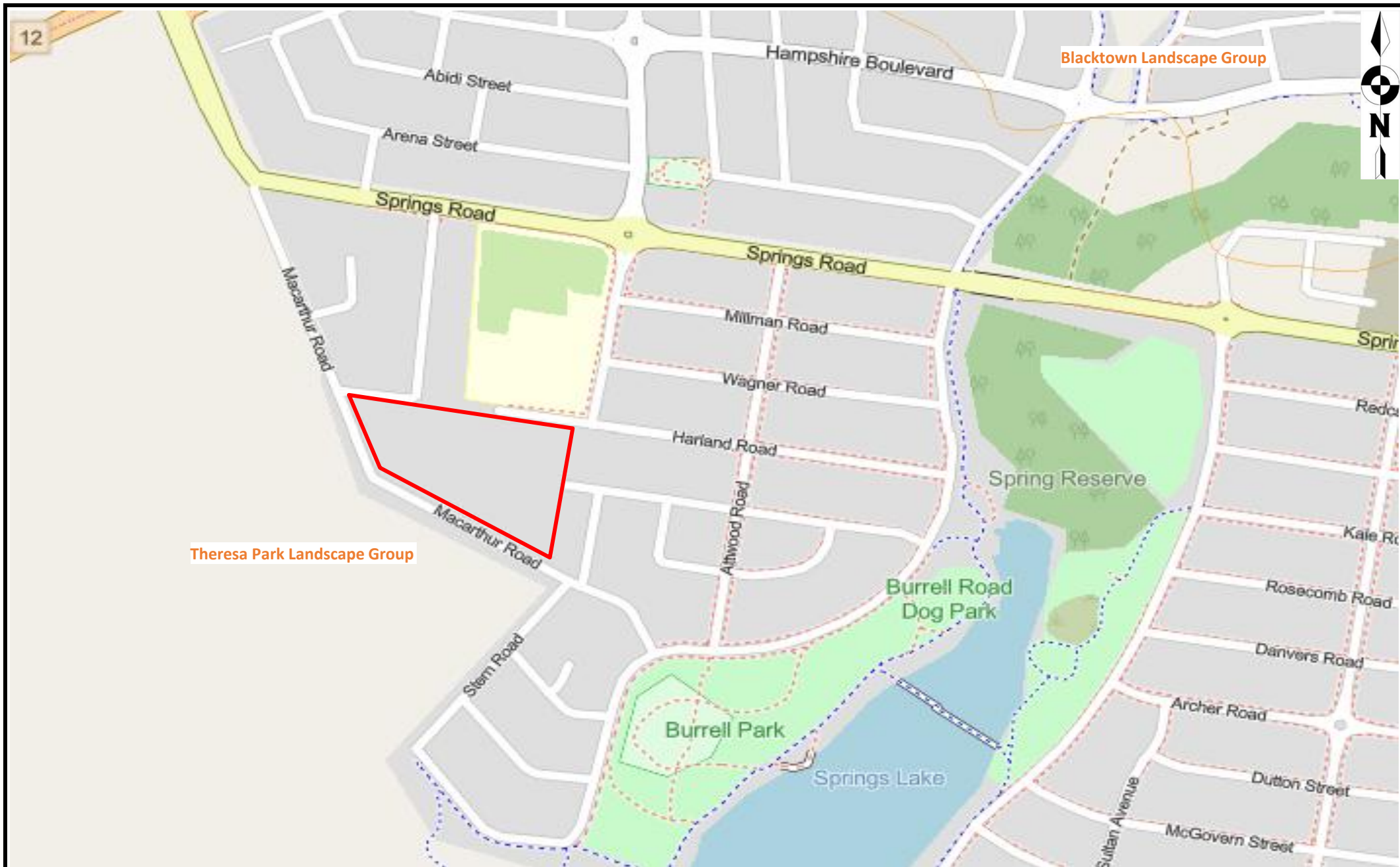
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1. *1:100,000 Soil Landscape Map of Wollongong-Port Hacking – Department of Environment, Climate Change and Water; Soil Landscape Series-*
2. *1:100,000 Geological Map of Wollongong-Port Hacking – Geological Survey of N.S.W, Department of Minerals and Energy, Geological Series*
3. *Department of Land and Water Conservation – “Site Investigation for Urban Salinity”.2002*
4. *Salinity Code of Practice – Western Sydney Regional Organisation of Councils Ltd – 2002*
5. *What do all the numbers mean? A guide for the interpretation of soil test results. – Department of Conservation and Land Management, 1992*
6. *Australian Standard, AS 2159-2009 “Piling – Design and Installation”, 2009*
7. *Australian Standard, AS 3600-2018 “Concrete Structures”.*
8. *Australian Standard, AS 2870-2011 “Residential Slabs and Footings”.*



Legend  Subject Site	 GeoEnviro Consultancy Pty Ltd Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia Tel: (02) 9679 8733 Fax: (02) 9679 8744	Drawn By: AT Date: 15/5/25	Crownland Developments 215 Macarthur Road Spring Farm Site Locality and Site Features Plan Project No: JC25487B Drawing No: 1
		Checked By: SL Date: 15/5/25	
		Revision By: Date: Scale: Not to Scale A3	



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Date:

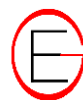
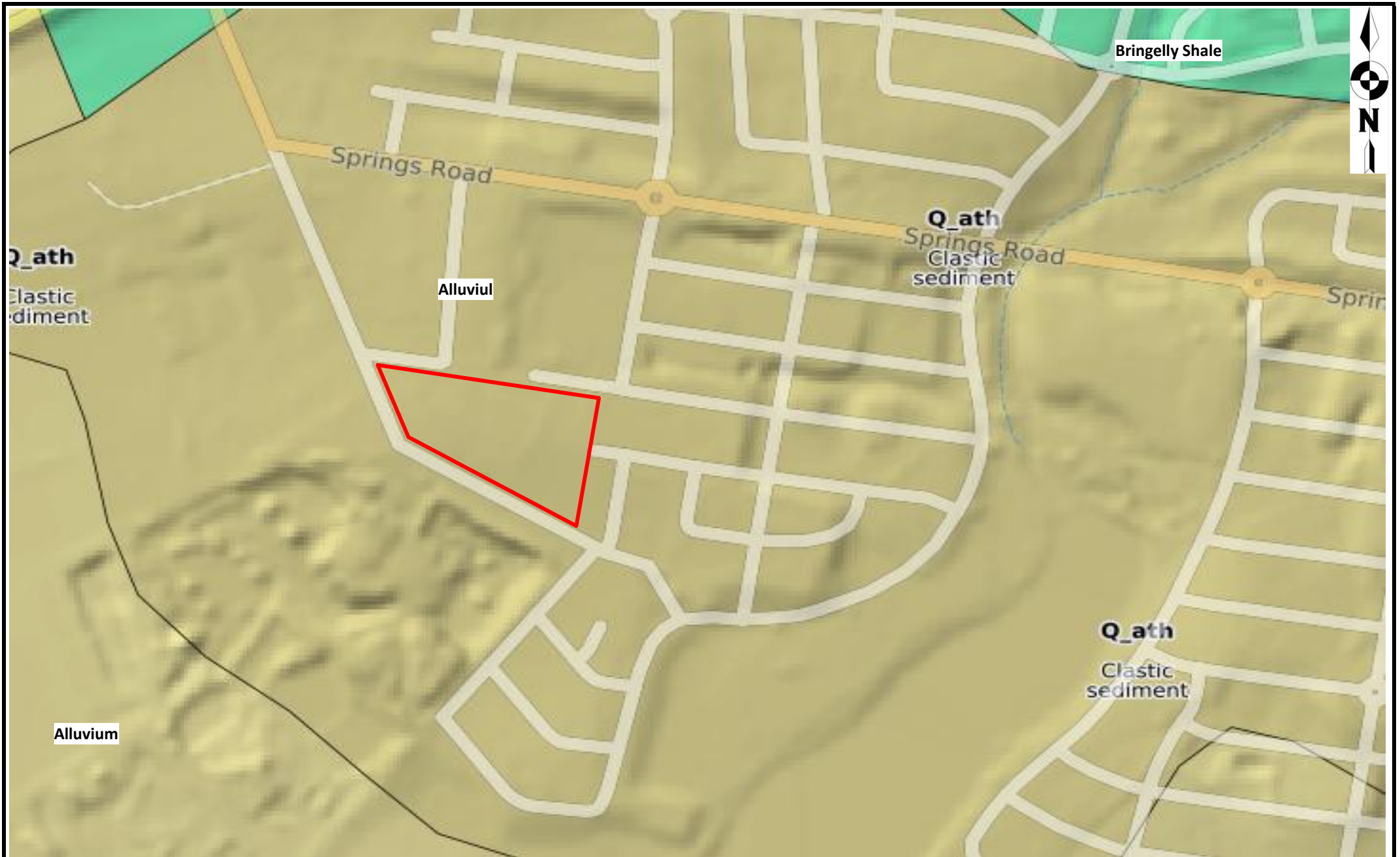
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A3

Crownland Developments
215 Macarthur Road Spring Farm
Soil Landscape Map

Project No: JC25487B

Drawing No: 2



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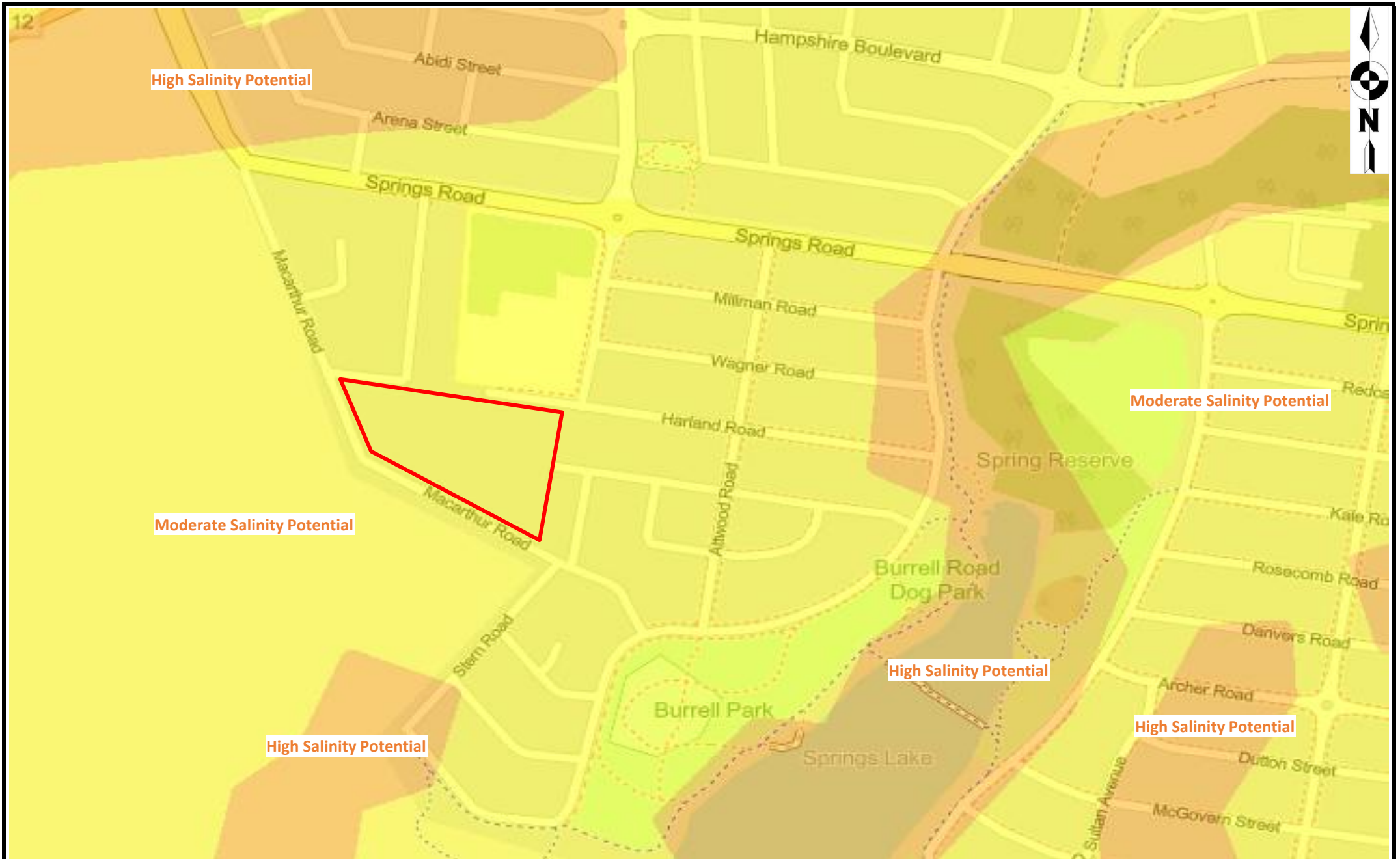
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Crownland Developments
215 Macarthur Road Spring Farm
Geological Map

Project No: JC25487B

Drawing No: 3



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A3

Crownland Developments
215 Macarthur Road Spring Farm
Salinity Potential Map

Project No: JC25487B

Drawing No: 4



Legend

- Test Pit
- Borehole
- DCP



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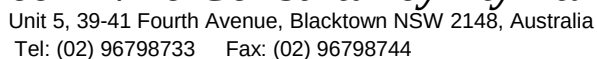
Crownland Developments
215 Macarthur Road Spring Farm
Test Location Plan

Project No: JC25487B

Drawing No: 5

Appendix A

Test Pit and Borehole Reports



Test Pit No: 1

Job no: JC25487B

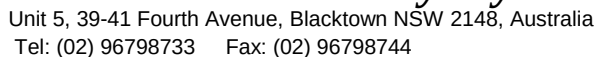
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R.L.Surface:

Datum: - AHD

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Test Pit No: 1

Job no: JC25487B

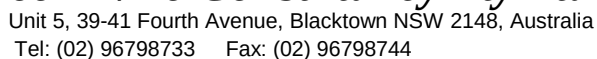
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Datum: - AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		4.5 5.0 5.5		SP	Sand: fine to medium grained, light brown grey	D-M			
				6.0 6.5 7.0 7.5 8.0			End at 5.5m				



Test Pit No: 2

Job no: JC25487B

Date: 8/5/25

Logged by: AT

R.L.Surface:

Datum: - AHD

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Test Pit Report

Test Pit No: 2

Client: Crownland Developments						Job no: JC25487B					
Project: Proposed Residential Subdivision Development						Date: 8/5/25					
Location: 215 Macarthur Road Spring Farm						Logged by: AT					
Equipment: 14t Excavator						R.L.Surface:					
Pit Dimensions: 0.5 x 2m						Datum: - AHD					
Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		4.5 5.0 5.5		SP	Sand: fine to medium grained, brown grey				
				6.0 6.5 7.0 7.5 8.0			End at 5.5m				



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Test Pit Report

Test Pit No: 3

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 8/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Equipment: 14t Excavator

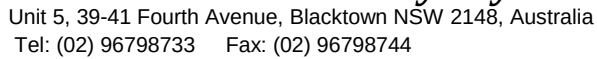
R.L.Surface:

Pit Dimensions: 0.5 x 2m

Datum: - AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		0.5			Topsoil: Silty Sand: fine to medium grained, brown	M			
						SP	Sand: fine to medium grained, light brown	M			
				1.0			brown red				
				1.5							
				2.0							
				2.5							
				3.0							
				3.5			brown grey	D-M			
				4.0							

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Test Pit No: 3

Job no: JC25487B

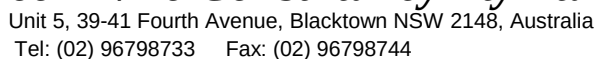
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R.L.Surface:

Datum: - AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		4.5 5.0 5.5		SP	Sand: fine to medium grained, brown grey				
				6.0 6.5 7.0 7.5 8.0			End at 5.5m				



Test Pit No: 4

Job no: JC25487B

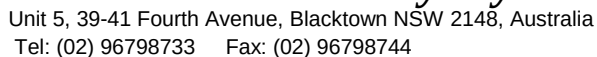
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Test Pit No: 4

Job no: JC25487B

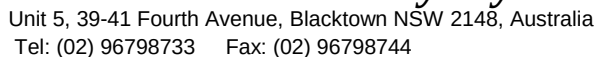
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R.L.Surface:

Datum: - AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		4.5 5.0 5.5 	SP	Sand: fine to medium grained, brown grey	D				
				6.0 6.5 7.0 7.5 8.0		End at 5.5m					



Test Pit No: 5

Job no: JC25487B

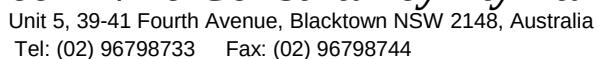
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R.L.Surface:

Datum: - AHD

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Test Pit No: 5

Job no: JC25487B

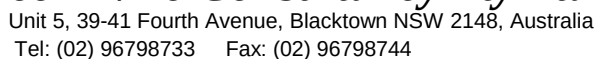
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Datum: - AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		4.5 5.0 5.5		SP	Sand: fine to medium grained, brown grey	M			
				6.0 6.5 7.0 7.5 8.0			End at 5.5m				



Test Pit No: 6

Job no: JC25487B

Date: 8/5/25

Logged by: AT

R.L.Surface:

Datum: - AHD

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Tel: (02) 96798733 Fax: (02) 96798744

Test Pit Report

Test Pit No: 6

Client: Crownland Developments						Job no: JC25487B					
Project: Proposed Residential Subdivision Development						Date: 8/5/25					
Location: 215 Macarthur Road Spring Farm						Logged by: AT					
Equipment: 14t Excavator						R.L.Surface:					
Pit Dimensions: 0.5 x 2m						Datum: - AHD					
Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		4.5 5.0 5.5		SP	Sand: fine to medium grained, brown grey	M			
				6.0 6.5 7.0 7.5 8.0			End at 5.5m				



GeoEnviro Consultancy Pty Ltd

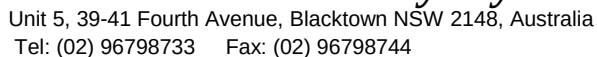
Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
Tel: (02) 96798733 Fax: (02) 96798744

Test Pit Report

Test Pit No: 7

Client: Crownland Developments						Job no: JC25487B					
Project: Proposed Residential Subdivision Development						Date: 8/5/25					
Location: 215 Macarthur Road Spring Farm						Logged by: AT					
Equipment: 14t Excavator						R.L.Surface:					
Pit Dimensions: 0.5 x 2m						Datum: - AHD					
Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		0.5			Topsoil: Silty Sand: fine to medium grained, brown	M			
						SP	Sand: fine to medium grained, brown grey	M			
				1.0			brown red				
				1.5							
				2.0							
				2.5							
				3.0							
				3.5							
				4.0							

Continued on next page



Test Pit No: 7

Job no: JC25487B

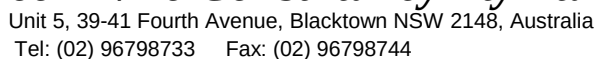
Date: 8/5/25

Logged by: AT

R.L.Surface:

Datum: - AHD

Form no. R008/Ver04/06/10



Test Pit No: 8

Job no: JC25487B

Date: 8/5/25

Logged by: AT

R.L.Surface:

Datum: - AHD

Continued on next page



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Test Pit Report

Test Pit No: 8

Client: Crownland Developments						Job no: JC25487B					
Project: Proposed Residential Subdivision Development						Date: 8/5/25					
Location: 215 Macarthur Road Spring Farm						Logged by: AT					
Equipment: 14t Excavator						R.L.Surface:					
Pit Dimensions: 0.5 x 2m						Datum: - AHD					
Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		4.5 5.0 5.5		SP	Sand: fine to medium grained, brown red	D			
				6.0 6.5 7.0 7.5 8.0			End at 5.5m				



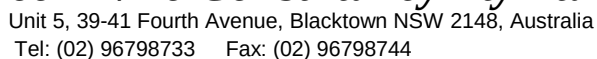
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Tel: (02) 96798733 Fax: (02) 96798744

Test Pit Report

Test Pit No: 9

Client: Crownland Developments						Job no: JC25487B					
Project: Proposed Residential Subdivision Development						Date: 8/5/25					
Location: 215 Macarthur Road Spring Farm						Logged by: AT					
Equipment: 14t Excavator						R.L.Surface:					
Pit Dimensions: 0.5 x 2m						Datum: - AHD					
Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry					Topsoil: Silty Sand: fine to medium grained, brown	M		1	DCP 7
								3			
								3			
								4			
								5			
								5			
							MD	5			
								6			
								7			
								8			
								9			
								9			
							D	10			
								11			
								9			
Continued on next page											



Test Pit No: 9

Job no: JC25487B

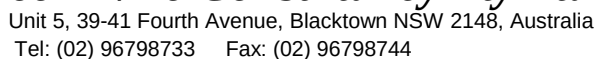
Date: 8/5/25

Logged by: AT

R.L.Surface:

Datum: - AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	DCP Blow Counts	Structure and Additional Observations
Bucket	Nil	Dry		4.5 5.0 5.5		SP	Sand: fine to medium grained, brown red	D			
				6.0 6.5 7.0 7.5 8.0			End at 5.5m				



Test Pit No: 10

Job no: JC25487B

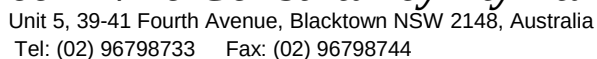
Date: 8/5/25

Logged by: AT

R.L.Surface:

Datum: - AHD

Continued on next page



Test Pit No: 10

Job no: JC25487B

Date: 8/5/25

Logged by: AT

R.L.Surface:

Datum: - AHD

Form no. R008/Ver04/06/10



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Tel: (02) 9679 8733 Fax: (02) 9679 8744

Borehole Report

Borehole no: 1

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry				SP	Topsoil: Silty Sand: fine to medium grained, brown Silty Sand: fine to medium grained, brown red	M			
			2,2,3 N=5	1.0					L		
			3,3,4 N=7	2.0					MD		
			5,5,6 N=11	3.0							
			5,6,5 N=11	4.0			brown grey	D-M			
			5,8,13 N=21	5.0							
				6.0							
				7.0							
				8.0							

Continued on next page



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Borehole Report

Borehole no: 1

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry		9.0		SP	Sand: fine to medium grained, brown grey	D	MD		
				10.0			End at 9.0m				
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							



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Tel: (02) 9679 8733 Fax: (02) 9679 8744

Borehole Report

Borehole no: 2

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry				SP	Topsoil: Silty Sand: fine to medium grained, brown Silty Sand: fine to medium grained, brown red	M			
			1,1,2 N=3	1.0					VL		
			2,3,3 N=6	2.0					L		
			5,5,5 N=10	4.0			brown grey	D-M	MD		
			3,3,3 N=6	6.0					L- MD		
			3,5,5 N=10	7.0					MD		
				8.0							

Continued on next page



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Borehole Report

Borehole no: 2

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry		9.0		SP	Sand: fine to medium grained, brown grey	D	MD		
				10.0			End at 9.0m				
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							



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Borehole Report

Borehole no: 3

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry				SP	Topsoil: Silty Sand: fine to medium grained, brown Silty Sand: fine to medium grained, brown	M			
			1,2,2 N=4	1.0			brown red	D-M	L		
			3,5,5 N=10	2.0					MD		
			4,4,6 N=10	3.0							
			4,4,6 N=10	4.0			brown grey	D-M			
			3,4,5 N=9	5.0							
			5,7,8 N=15	6.0							
				7.0							
				8.0					MD		

Continued on next page



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Borehole Report

Borehole no: 3

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry		9.0		SP	Sand: fine to medium grained, brown grey	D	MD		
							grey yellow with trace clay	D			
				10.0			End at 9.0m				
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							



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Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia

Tel: (02) 9679 8733 Fax: (02) 9679 8744

Borehole Report

Borehole no: 4

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry					Topsoil: Silty Sand: fine to medium grained, brown	M			
			1,1,1 N=2	1.0		SP	Silty Sand: fine to medium grained, brown red	D-M	VL		
			2,2,4 N=6	2.0					L		
			4,5,5 N=10	3.0							
			5,7,8 N=15	4.0			brown grey	D-M	MD		
				5.0							
				6.0				D			
				7.0							
				8.0							

Continued on next page



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Borehole Report

Borehole no: 4

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry		9.0		SP	Sand: fine to medium grained, brown grey yellow grey	D D	MD		
				10.0			End at 9.0m				
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							



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Tel: (02) 9679 8733 Fax: (02) 9679 8744

Borehole Report

Borehole no: 5

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry					Topsoil: Silty Sand: fine to medium grained, brown	M			
			5,7,9 N=16	1.0		SP	Silty Sand: fine to medium grained, brown red	D	MD		
			7,7,9 N=16	2.0							
			6,7,7 N=14	3.0							
			8,8,9 N=17	4.0			brown grey	D			
				5.0							
				6.0							
				7.0							
				8.0							

Continued on next page



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Tel: (02) 9679 8733 Fax: (02) 9679 8744

Borehole Report

Borehole no: 5

Client: Crownland Developments

Job no: JC25487B

Project: Proposed Residential Subdivision Development

Date: 13-14/5/25

Location: 215 Macarthur Road Spring Farm

Logged by: AT

Drill Model and Mounting: GT10

Slope: 90°

R.L. Surface: -

Hole Diameter: 100mm

Bearing: Vertical

Datum: AHD

Method	Support	Water	Notes: Samples, Tests, etc	Depth(m)	Classification Symbol	Unified Soil Classification	Material Description Soil Type, Plasticity or Particle Characteristic, colour, secondary and minor component	Moisture Content	Consistency/Density Index	Hand Penetrometer kPa	Structure and Additional Observations
TC Bit	Nil	Dry		9.0		SP	Sand: fine to medium grained, brown grey grey yellow	D	MD		
				10.0			End at 9.0m				
				11.0							
				12.0							
				13.0							
				14.0							
				15.0							
				16.0							

Appendix B

Historical Photographs



1969



1972



1980



1994



2002



2005



2012



2019

Appendix C
Dynamic Cone Penetrometer Test Reports



GeoEnviro Consultancy Pty Ltd

Unit 5, 39-41 Fourth Avenue, Blacktown NSW 2148, Australia
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Dynamic Cone Penetration Test Report

Sheet 6 of 7

Client / Address: Crownland Developments / Sydney						Job No: JC25487B			
Project: Proposed Residential Subdivision Development						Date: 45797			
Location: 215 Macarthur Road Spring Farm						Report No: R06A			
Test Procedure: AS 1289 1.1, 1.2.1, 6.3.2									
Test Data									
Test No: 1		Test No: 2		Test No: 3		Test No: 4			
Test Date: 8/05/2025		Test Date: 8/05/2025		Test Date: 8/05/2025		Test Date: 8/5/25			
Test Location: DCP 1 See Drawing No 1		Test Location: DCP 2 See Drawing No 1		Test Location: DCP 3 See Drawing No 1		Test Location: DCP 4 See Drawing No 1			
RL: -		RL: -		RL: -		RL: -			
Soil Description:		Soil Description:		Soil Description:		Soil Description:			
Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows
0.0-0.1	6	0.0-0.1	1	0.0-0.1	1	0.0-0.1	1	3.0-3.1	8
0.1-0.2	3	0.1-0.2	2	0.1-0.2	2	0.1-0.2	2	3.1-3.2	9
0.2-0.3	5	0.2-0.3	2	0.2-0.3	2	0.2-0.3	3	3.2-3.3	9
0.3-0.4	5	0.3-0.4	2	0.3-0.4	4	0.3-0.4	4	3.3-3.4	Terminated
0.4-0.5	5	0.4-0.5	1	0.4-0.5	4	0.4-0.5	3	3.4-3.5	
0.5-0.6	3	0.5-0.6	1	0.5-0.6	5	0.5-0.6	2	3.5-3.6	
0.6-0.7	3	0.6-0.7	1	0.6-0.7	5	0.6-0.7	2	3.6-3.7	
0.7-0.8	3	0.7-0.8	2	0.7-0.8	6	0.7-0.8	2	3.7-3.8	
0.8-0.9	2	0.8-0.9	1	0.8-0.9	9	0.8-0.9	2	3.8-3.9	
0.9-1.0	2	0.9-1.0	2	0.9-1.0	7	0.9-1.0	1	3.9-4.0	
1.0-1.1	1	1.0-1.1	2	1.0-1.1	8	1.0-1.1	2	4.0-4.1	
1.1-1.2	2	1.1-1.2	2	1.1-1.2	10	1.1-1.2	2	4.1-4.2	
1.2-1.3	2	1.2-1.3	2	1.2-1.3	Terminated	1.2-1.3	3	4.2-4.3	
1.3-1.4	2	1.3-1.4	2	1.3-1.4		1.3-1.4	3	4.3-4.4	
1.4-1.5	2	1.4-1.5	2	1.4-1.5		1.4-1.5	3	4.4-4.5	
1.5-1.6	2	1.5-1.6	2	1.5-1.6		1.5-1.6	3	4.5-4.6	
1.6-1.7	2	1.6-1.7	3	1.6-1.7		1.6-1.7	4	4.6-4.7	
1.7-1.8	2	1.7-1.8	4	1.7-1.8		1.7-1.8	3	4.7-4.8	
1.8-1.9	1	1.8-1.9	3	1.8-1.9		1.8-1.9	4	4.8-4.9	
1.9-2.0	2	1.9-2.0	4	1.9-2.0		1.9-2.0	4	4.9-5.0	
2.0-2.1	3	2.0-2.1	4	2.0-2.1		2.0-2.1	4	5.0-5.1	
2.1-2.2	3	2.1-2.2	5	2.1-2.2		2.1-2.2	3	5.1-5.2	
2.2-2.3	4	2.2-2.3	5	2.2-2.3		2.2-2.3	4	5.2-5.3	
2.3-2.4	4	2.3-2.4	5	2.3-2.4		2.3-2.4	4	5.3-5.4	
2.4-2.5	4	2.4-2.5	6	2.4-2.5		2.4-2.5	4	5.4-5.5	
2.5-2.6	6	2.5-2.6	5	2.5-2.6		2.5-2.6	5	5.5-5.6	
2.6-2.7	7	2.6-2.7	6	2.6-2.7		2.6-2.7	5	5.6-5.7	
2.7-2.8	8	2.7-2.8	7	2.7-2.8		2.7-2.8	5	5.7-5.8	
2.8-2.9	Terminated	2.8-2.9	9	2.8-2.9		2.8-2.9	6	5.8-5.9	
2.9-3.0		2.9-3.0	Terminated	2.9-3.0		2.9-3.0	6	5.9-6.0	
Remarks:						Weight: 9kg Drop: 510mm Rod Diameter: 16mm			

c:\lab\report\R009

Form No. R009/Ver09/09/21



Accredited for compliance with ISO/IEC 17025 - Field of Testing.

Authorised Signatory: Solem Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 20/05/2025

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Tel: (02) 96798733 Fax: (02) 96798744

Dynamic Cone Penetration Test Report

Sheet 7 of 7

Client / Address: Crownland Developments / Sydney						Job No: JC25487B			
Project: Proposed Residential Subdivision Development						Date: 45797			
Location: 215 Macarthur Road Spring Farm						Report No: R07A			
Test Procedure: AS 1289 1.1, 1.2.1, 6.3.2									
Test Data									
Test No: 5		Test No: 6		Test No: 7		Test No: 8			
Test Date: 8/5/25		Test Date: 8/05/2025		Test Date: 8/05/2025		Test Date: 8/05/2025			
Test Location: DCP 5 See Drawing No 1		Test Location: DCP 6 See Drawing No 1		Test Location: DCP 7 See Drawing No 1		Test Location: DCP 8 See Drawing No 1			
RL: -		RL: -		RL: -		RL: -			
Soil Description:		Soil Description:		Soil Description:		Soil Description:			
Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows	Depth (m)	Blows
0.0-0.1	1	3.0-3.1	8	0.0-0.1	1	0.0-0.1	1	0.0-0.1	2
0.1-0.2	1	3.1-3.2	10	0.1-0.2	1	0.1-0.2	3	0.1-0.2	2
0.2-0.3	3	3.2-3.3	Terminated	0.2-0.3	1	0.2-0.3	3	0.2-0.3	3
0.3-0.4	5	3.3-3.4		0.3-0.4	2	0.3-0.4	4	0.3-0.4	2
0.4-0.5	4	3.4-3.5		0.4-0.5	2	0.4-0.5	5	0.4-0.5	2
0.5-0.6	3	3.5-3.6		0.5-0.6	1	0.5-0.6	5	0.5-0.6	2
0.6-0.7	2	3.6-3.7		0.6-0.7	2	0.6-0.7	5	0.6-0.7	3
0.7-0.8	2	3.7-3.8		0.7-0.8	3	0.7-0.8	6	0.7-0.8	2
0.8-0.9	2	3.8-3.9		0.8-0.9	4	0.8-0.9	7	0.8-0.9	4
0.9-1.0	3	3.9-4.0		0.9-1.0	8	0.9-1.0	8	0.9-1.0	6
1.0-1.1	3	4.0-4.1		1.0-1.1	6	1.0-1.1	9	1.0-1.1	6
1.1-1.2	4	4.1-4.2		1.1-1.2	4	1.1-1.2	9	1.1-1.2	8
1.2-1.3	4	4.2-4.3		1.2-1.3	8	1.2-1.3	10	1.2-1.3	9
1.3-1.4	4	4.3-4.4		1.3-1.4	10	1.3-1.4	11	1.3-1.4	9
1.4-1.5	3	4.4-4.5		1.4-1.5	9	1.4-1.5	9	1.4-1.5	10
1.5-1.6	3	4.5-4.6		1.5-1.6	10	1.5-1.6	Terminated	1.5-1.6	Terminated
1.6-1.7	3	4.6-4.7		1.6-1.7	Terminated	1.6-1.7		1.6-1.7	
1.7-1.8	4	4.7-4.8		1.7-1.8		1.7-1.8		1.7-1.8	
1.8-1.9	4	4.8-4.9		1.8-1.9		1.8-1.9		1.8-1.9	
1.9-2.0	3	4.9-5.0		1.9-2.0		1.9-2.0		1.9-2.0	
2.0-2.1	3	5.0-5.1		2.0-2.1		2.0-2.1		2.0-2.1	
2.1-2.2	4	5.1-5.2		2.1-2.2		2.1-2.2		2.1-2.2	
2.2-2.3	4	5.2-5.3		2.2-2.3		2.2-2.3		2.2-2.3	
2.3-2.4	4	5.3-5.4		2.3-2.4		2.3-2.4		2.3-2.4	
2.4-2.5	5	5.4-5.5		2.4-2.5		2.4-2.5		2.4-2.5	
2.5-2.6	5	5.5-5.6		2.5-2.6		2.5-2.6		2.5-2.6	
2.6-2.7	5	5.6-5.7		2.6-2.7		2.6-2.7		2.6-2.7	
2.7-2.8	5	5.7-5.8		2.7-2.8		2.7-2.8		2.7-2.8	
2.8-2.9	7	5.8-5.9		2.8-2.9		2.8-2.9		2.8-2.9	
2.9-3.0	8	5.9-6.0		2.9-3.0		2.9-3.0		2.9-3.0	
Remarks:						Weight: 9kg Drop: 510mm Rod Diameter: 16mm			

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Form No. R009/Ver09/09/21



Accredited for compliance with ISO/IEC 17025 - Field of Testing.

Authorised Signatory: Solern Liew

NATA Accredited Laboratory Number: 14208.

Date of Issue: 20/05/2025

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reproduced except in full.

Appendix D

A Brief Explanation on Site Classification



A BRIEF EXPLANATION OF SITE CLASSIFICATION

1. Introduction

The intention of the Australian Standard 2870-2011, "Residential Slabs and Footings" is to provide guidance on footing design for residential buildings with a particular emphasis on reactive clay sites. Footing design and construction involves the following steps:

- site classification
- selection of an appropriate footing system
- structural design
- construction in accordance with the required design details and construction methods
- proper site maintenance after construction

The classification assessed in this report is the first step in providing an economical footing system for a residence which will limit cracking of footings, floor slabs and masonry walls to an extent normally considered acceptable. (Performance expectations are explained in AS 2870- 2011). It is necessary that each subsequent step be diligently observed to achieve acceptable performance.

It is imperative when applying the site classifications presented in this report to residential footing design, that these performance expectations are acceptable to the home owner.

2. What is a Reactive Soil?

A reactive soil undergoes appreciable volume change when its moisture content changes. This causes ground surface movements which can result in footing movements. The extent of ground movement that can occur depends on the clay mineralogy, the depth of clay in the soil profile, the depth of potential moisture variation in the soil and the change in soil suction that occurs from dry to wet soil conditions. AS2870 provides a classification system to quantify the range of ground surface movements anticipated (defined as having less than 5% chance of being exceeded in the design life of the structure).

3. How are Sites Classified in the Sydney Region

Experiment and observation within the Sydney Region indicates a high variability in the potential for reactive movements, which is not clearly related to soil association, terrain location or visual appearance and may not be accurately predicted by simple soil tests. Intense, complex and expensive testing is required at a site to accurately predict its potential for reactive behaviour. To avoid this, a simplified classification procedure for the Sydney region has been devised which is based on the depth of clay in the soil profile. This procedure is detailed in AS2870 – 2011.

4. What is a Class P Site?

Footing design may need to consider other factors beside reactive soils. Such factors include the presence of filling, the presence of compressible or collapsible soils, or the need to consider slope stability aspects. When these or other factors need to be considered the site may be classified P. The footing "solution" for Class P sites requires special engineering consideration. On many sites the "solution may the straight forward and may not necessarily incur major cost increases.



5. Filled Sites

The most common "problem" associated with residential lots is the presence of fill, compacted or otherwise, overlying the natural soils. If the fill is uncompacted, or if there are no records of adequate compaction, a piered footing system is usually adopted which penetrates the fill and found on natural ground.

AS2870 - 2011 indicates that a compacted fill site may be given a less severe classification than P if assessed in accordance with engineering principles. Subdivision developments often include areas of compacted filling which will usually have been required to have been compacted to the relevant Council Specifications. Adequately compacted filling will usually provide sufficient bearing capacity for residential footing loads, but the clay in the fill will also experience reactive soil movements. Depending on the moisture content at which the fill is placed and the compaction which has been achieved, reactive soil movements may exceed those experienced by the natural soil from which the fill has been derived. As a result, classification of compacted fill sites sometimes needs to be conservative.

6. Site Classifications should be Project Specific

Many Councils require that all lots within a new subdivision be classified prior to subdivision approval. This practice precludes a consideration of the impact of site preparation works on the classification. Sites which are not level are often cut and filled to provide a level platform for floor slab construction. AS2870 specifies that the classification shall be reconsidered if:

- (a) the depth of cut exceeds 500mm, or
- (b) the depth of compacted fill exceeds 400mm for clay (or 800mm for sand).

Where the classification provided in this report is carried out prior to the site development details being known it is a condition of this report that plans for future development of the block be reviewed by a geotechnical engineer to assess the impact of proposed site works and also the impact of work which may have occurred on adjacent sites since the date of this classification. Altering the site classification may be required in some cases.

7. Site Maintenance

The classifications presented in this report have been assessed for moisture variations caused by climatic and "normal" garden conditions. More severe moisture variation can be caused by other common factors, such as removing or planting trees, leaking plumbing, irrigation systems etc. Guidelines to appropriate site maintenance are provided in CSIRO 10-91 "A Guide to Home Owners on Foundation Maintenance and Footing Performance". Most Damage to residences on reactive sites is due to poor site maintenance. Footings designed to AS2870 may not perform satisfactorily if sites are not properly maintained.

Appendix E

Explanatory Notes



EXPLANATORY NOTES

Introduction

These notes have been provided to amplify the geotechnical report with regard to investigation procedures, classification methods and certain matters relating to the Discussion and Comments sections. Not all notes are necessarily relevant to all reports.

Geotechnical reports are based on information gained from finite sub-surface probing, excavation, boring, sampling or other means of investigation, supplemented by experience and knowledge of local geology. For this reason they must be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods

The methods the description and classification of soils and rocks used in this report are based on Australian standard 1726, the SSA Site investigation Code, in general descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions. Identification and classification of soil and rock involves to a large extent, judgement within the acceptable level commonly adopted by current geotechnical practices.

Soil types are described according to the predominating particle size, qualified by the grading or other particles present (eg sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	Less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2.00mm
Gravel	2.00mm to 60.00mm

Soil Classification	Particle size
Clay	less than 0.002mm
Silt	0.002 to 0.06mm
Sand	0.06 to 2.00mm
Gravel	2.00mm to 60.00mm

Cohesive soils are classified on the basis of strength, either by laboratory testing or engineering examination. The strength terms are defined as follows:

Classification	Undrained Shear Strength kPa
Very Soft	Less than 12
Soft	12 - 25
Firm	25 - 50
Stiff	50 - 100
Very Stiff	100 - 200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer test (CPT), as below:

Relative Dense	SPT 'N' Value (blows/300mm)	CPT Cone Value (q _c -Mpa)
Very Loose	Less than 5	Less than 2
Loose	5 - 10	2 - 5
Medium Dense	10 - 30	5 - 15
Dense	30 - 50	15 - 25
Very Dense	> 50	> 25

Rock types are classified by their geological names, together with descriptive terms on degrees of weathering strength, defects and other minor components. Where relevant, further information

regarding rock classification, is given on the following sheet.

Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provided information on plasticity, grained size, colour, type, moisture content, inclusions and depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin walled sample tube (normally known as U₅₀) into the soil and withdrawing a sample of the soil in a relatively undisturbed state. Such Samples yield information on structure and strength and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Details of the type and method of sampling are given in the report.

Field Investigation Methods

The following is a brief summary of investigation methods currently carried out by this company and comments on their use and application.

Hand Auger Drilling

The borehole is advanced by manually operated equipment. The diameter of the borehole ranges from 50mm to 100mm. Penetration depth of hand augered boreholes may be limited by premature refusal on a variety of materials, such as hard clay, gravels or ironstone.

Test Pits

These are excavated with a tractor-mounted backhoe or a tracked excavator, allowing close examination of the insitu soils if it is safe to descend into the pit. The depth of penetration is limited to about 3.0m for a backhoe and up to 6.0m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Care must be taken if construction is to be carried out near, or within the test pit locations, to either adequately recompact the backfill during construction, or to design the structure or accommodate the poorly compacted backfill.

Large Diameter Auger (eg Pengo)

The hole is advanced by a rotating plate or short spiral auger generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5m) and are disturbed, but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers and is usually supplemented by occasional undisturbed tube sampling.

Continuous Spiral Flight Augers

The hole is advanced by using 90mm - 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling or insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the augers flights, but they are very disturbed and may be highly mixed with soil of other stratum.

Information from the drilling (as distinct from specific sampling by SPT or undisturbed samples) is of relatively low reliability due to remoulding, mixing or softening of samples by ground water, resulting in uncertainties of the original sample depth.

Continuous Spiral Flight Augers (continued)

The spiral augers are usually advanced by using a V - bit through the soil profile refusal, followed by Tungsten Carbide (TC) bit, to penetrate into bedrock. The quality and continuity of the bedrock may be assessed by examination of the recovered rock fragments and through observation of the drilling penetration resistance.

Non - core Rotary Drilling (Wash Boring)

The hole is advanced by a rotary bit, with water being pumped down the drill rod and returned up the annulus, carrying the cuttings, together with some information from the "feel" and rate of penetration.

Rotary Mud Stabilised Drilling

This is similar to rotary drilling, but uses drilling mud as a circulating fluid, which may consist of a range of products, from bentonite to polymers such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg SPT and U_{50} samples).

Continuous Core Drilling

A continuous core sample is obtained using a diamond tipped core barrel. Providing full core recovery is achieved (which is not always possible in very weak rock and granular soils) this technique provides a very reliable (but relatively expensive) method of investigation. In rocks an NMLC triple tube core barrel which gives a core of about 50mm diameter, is usually used with water flush.

Portable Proline Drilling

This is manually operated equipment and is only used in sites which require bedrock core sampling and there is restricted site access to truck mounted drill rigs. The boreholes are usually advanced initially using a tricone roller bit and water circulation to penetrate the upper soil profile. In some instances a hand auger may be used to penetrate the soil profile. Subsequent drilling into bedrock involves the use of NMLC triple tube equipment, using water as a lubricant.

Standard Penetration Tests

Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils, as a means of determining density or strength and of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289 "Methods of testing Soils for Engineering Purpose"- Test F31.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63Kg hammer with a free fall of 769mm. It is normal for the tube to be driven in three successive 150mm increments and the "N" value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rocks, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In a case where full penetration is obtained with successive blows counts for each 150mm of, say 4, 6, and 7 blows.

$$\begin{array}{l} \text{as 4, 6, 7} \\ N = 13 \end{array}$$

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm.

$$\text{as 15,30/40mm}$$

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally the test

methods is used to obtain samples in 50mm diameter thin walled samples tubes in clays. In these circumstances, the best results are shown on the bore logs in brackets.

Dynamic Cone Penetration Test

A modification to the SPT test is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The cone can be continuously driven into the borehole and is normally used in areas with thick layers of soft clays or loose sand. The results of this test are shown as ' N_c ' on the bore logs, together with the number of blows per 150mm penetration.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch Cone-CPT) described in this report, has been carried out using an electrical friction cone penetrometer and the test is described in Australian Standard 1289 test F5.1.

In the test, a 35mm diameter rod with cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig, which is fitted with a hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130mm long sleeve, immediately behind the cone. Transducer in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output on continuous chart recorders. The plotted results in this report have been traced from the original records. The information provided on the charts comprises:

- Cone resistance - the actual end bearing force divided by the cross sectional area of the cone, expressed in Mpa.
- Sleeve friction - the frictional force on the sleeve divided by the surface area, expressed in kPa.
- Friction ratio - the ratio of sleeve friction to cone resistance, expressed in percentage.

There are two scales available for measurement of cone resistance. The lower "A" scale (0-5Mpa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main "B" scale (0-50Mpa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative frictions in clays than in sands. Friction ratios of 1% to 2% are commonly encountered in sands and very soft clays, rising to 4% to 10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

$$q_c \text{ (Mpa)} = (0.4 \text{ to } 0.6) N \text{ (blows per 300mm)}$$

In clays the relationship between undrained shear strength and cone resistance is commonly in the range:

$$q_c = (12 \text{ to } 18) C_u$$

Interpretation of CPT values can also be made to allow estimate of modulus or compressibility values to allow calculation of foundation settlements. Inferred stratification, as shown on the attached report, is assessed from the cone and friction traces, from experience and information from nearby boreholes etc.

Cone Penetrometer Testing and Interpretation continued

This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties and where precise information or soil classification is required, direct drilling and sampling may be preferable.

Portable Dynamic Cone Penetrometer (AS1289)

Portable dynamic cone penetrometer tests are carried out by driving a rod in to the ground with a falling weight hammer and measuring the blows per successive 100mm increments of penetration.

There are two similar tests, Cone Penetrometer (commonly known as Scala Penetrometer) and the Perth Sand Penetrometer. Scala Penetrometer is commonly adopted by this company and consists of a 16mm rod with a 20mm diameter cone end, driven with a 9kg hammer, dropping 510mm (AS 1289 Test F3.2).

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedures are given on the individual report forms.

Engineering Logs

The engineering logs presented herein are an engineering and/or geological interpretation of the sub-surface conditions and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, however, this is not always practicable or possible to justify economically. As it is, the boreholes represent only a small sample of the total sub-surface profile. Interpretation of the information and its application to design and construction should take into account the spacing of boreholes, frequency of sampling and the possibility of other than "straight line" variations between the boreholes.

Ground water

Where ground water levels are measured in boreholes, there are several potential problems:

- In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all, during the investigation period.
- A localised perched water table may lead to a erroneous indication of the true water table.
- Water table levels will vary from time to time, due to the seasons or recent weather changes. They may not be the same at the time of construction as indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole if any water observations are to be made.

More reliable measurements can be made by installing stand pipes, which are read at intervals over several days, or weeks for low permeability soils. Piezometers sealed in a particular stratum may be interference from a perched water table or surface water.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal is changed, say to a twenty storey building. If this occurs, the company will be pleased to review the report and sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussions of geotechnical aspects and recommendations or suggestions for design and construction. However, the company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on bore spacing and sampling frequency.
- Changes in policy or interpretation of policy by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, the company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the company request immediate notification. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information trader Documents", published by the Institute of Engineers Australia. Where information obtained for this investigation is provided for tender purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or make additional copies of the report available for contract purpose, at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspect of work to which this report is related. This could range from a site visit to confirm that the conditions exposed are as expected, to full time engineering presence on site

Review of Design

Where major civil or structural developments are proposed, or where only a limited investigation has been completed, or where the geotechnical conditions are complex, it is prudent to have the design reviewed by a Senior Geotechnical Engineer.



Graphic Symbols For Soil and Rock

SOIL		ROCK	
	Fill		Shale
	Topsoil		Sandstone
	Gravel (GW , GP)		Siltstone, Mudstone, Claystone
	Sand (SP, SW)		Granite, Gabbro
	Silt (ML, MH)		Dolerite, Diorite
	Clay (CL, CH)		Basalt, Andesite
	Clayey Gravel (GC)	Other Materials	
	Silty Sand (SM)		Concrete
	Clayey Sand (SC)		Bitumen, Asphaltic Concrete, Coal
	Sandy Silt (ML)		Ironstone Gravel
	Gravelly Clay (CL, CH)		Organic Material
	Silty Clay (CL, CH)		
	Sandy Clay (CL, CH)		
	Peat or Organic Soil		