

APPENDIX J

PRELIMINARY SITE INVESTIGATION AND URBAN CAPABILITY ASSESSMENT

Cardno

Preliminary Site Investigation and Urban Capability Assessment

Maitland Urban Settlement Strategy –
Anambah Road, Maitland

Prepared for
HDB Town Planning and Design

25 August 2017



Contact Information

Cardno (NSW/ACT) Pty Ltd

ABN 95 001 145 035

1/10 Denney Street
 Broadmeadow NSW 2292
 PO Box 74
 Broadmeadow NSW 2292,
 Australia

Telephone: 02 4965 4555
 Facsimile: 02 4965 4666
 International: +61 2 4965 4555

geotech@cardno.com.au
 www.cardno.com.au

Document Information

Prepared for	HDB Town Planning and Design
Project Name	Maitland Urban Settlement Strategy – Anambah Road, Maitland
Job Reference	CGS3225
File Reference	CGS3225-002.1
Date	25 August 2017

Author(s):



Dimce Stojanovski
 Geotechnical Scientist

Version Number	0
Effective Date	25/08/17

Approved By:



Ian Piper
 Reviewer position

Date Approved: 25/08/17

Document History

Version	Effective Date	Description of Revision	Prepared by:	Reviewed by:
0	15/08/17	First issue	DS	Ian Piper
1	25/08/17	Included Dates	DS	Ian Piper

© Cardno. Copyright in the whole and every part of this document belongs to Cardno and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person other than by agreement with Cardno.

This document is produced by Cardno solely for the benefit and use by the client in accordance with the terms of the engagement. Cardno does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by any third party on the content of this document.

Table of Contents

1	Introduction	1
1.1	Background	1
1.2	Purpose and Objectives	2
1.2.1	Preliminary Site Investigation	2
1.2.2	Urban Capability Assessment	2
1.3	Scope	2
1.3.1	Preliminary Site Investigation	2
1.3.2	Urban Capability Assessment	2
2	Site Identification	3
3	Site Inspection and Surrounding Environment	3
3.1	Site Condition	3
3.2	Surrounding Environment and Land uses	4
4	Previous Reports and Reviews	4
4.1	Douglas Partners Report [1]	4
4.2	Cardno Geotech Solutions Reports	5
4.2.1	Supplementary Urban Capability Assessment – Anambah Release Area [4]	5
4.2.2	Geotechnical Investigations - Sandstone Drive, Windella	5
5	Published Data	6
5.1	Regional Geology	6
5.2	Acid Sulfate Soils	6
5.3	Hydrogeology	6
5.4	EPA records Search	7
5.4.1	Contaminated Land Record of Notices	7
5.4.2	PoEO Public Register	7
5.4.3	List of NSW Contaminated Sites Notified to the EPA	7
6	Site History	7
6.1	General	7
6.1.1	Maitland City Council (MCC) Section 149 Planning Certificate	7
6.1.2	Historical Title Deeds Search	9
6.1.3	Review of the Historical Aerial Photos	9
6.2	Summary of Site History	10
7	Areas and Contaminants of Potential Concern	11
8	Preliminary Conceptual Site Model	12
8.1.1	General	12
8.1.2	Areas of Environmental Concern (AEC)	12
8.1.3	Media potentially impacted	12
8.1.4	Human and Ecological Receptors	12
8.1.5	Potential Exposure Pathways	13
9	Discussion	13
9.1	Potential Acid Sulfate Soils	13
9.2	Potential Groundwater Contamination	13
9.3	Potential Soil Contamination	13
9.4	Site Contamination Constraints	14
10	Urban Capability Assessment	14

10.1	Geology	14
10.2	Soil Landscape	14
10.3	Topography and Slope Stability	15
10.4	Soil Erosion	15
10.5	Salinity	16
10.6	Mine Subsidence	16
10.7	Acid Sulfate Soils	16
10.8	Potential Pavement Designs	16
10.9	Footings and Potential Site Classifications	18
11	Conclusions	18
11.1	Recommendations	19
12	Limitations	20
13	References	21

Appendices

Appendix A	Figures and Photographs
Appendix B	Public Searches
Appendix C	149 Certificates and title Deeds
Appendix D	Douglas Partners Report

Tables

Table 2-1	Site Details	3
Table 3-1	Surrounding Land Use	4
Table 5-1	Registered Groundwater Bore Search Summary	6
Table 6-1	Aerial Imagery Review	10
Table 7-1	Site Activities and Potential Contaminants of Concern	11
Table 10-1	Typical Pavement Thickness Summary	17

1 Introduction

1.1 Background

Cardno was engaged by HDB Town Planning and Design (“the client”) to prepare a Preliminary Site Investigation (PSI) and Urban Capability Assessment on the proposed *Maitland Urban Settlement* located at Anambah Road, Maitland (“the Site”) as shown in the figure below. The nominated Site comprises of three (3) allotments, Part of Lot 71 DP 714785 and Part of Lots 721 and 722 DP 1191240 (highlighted yellow). The rural residential Lot 690 DP597283 was excluded in the assessment.



Figure 1-1 Site location (Site A-Outlines in orange), adopted from HDB supplied brief.

A preliminary assessment of Lot 71 DP 714785 (southern portion of the Site) was previously undertaken by Douglas Partners (DP) referenced “*Report on Preliminary Contamination and Urban Capability Assessment, Proposed Residential Development - Lot 71 DP 714785, Anambah Road, Anambah*”, Project 39878 dated July 2008” [1].

The current PSI comprised of a site inspection, desktop study within the subject Site (highlighted yellow) and utilising information and available data provided within the previous DP report [1]. The previous DP Report was undertaken only on Lot 71 DP 714785 and not the remaining subject areas (Part of Lots 721 and 722 DP 1191240).

The PSI was prepared in accordance with the scope presented in Cardno’s proposal 48982217-0165.0, dated 21 April 2017, accepted by the client on 11 June 2017.

The assessment was undertaken with reference to NSW EPA “*Guidelines for Consultants Reporting on Contaminated Sites*” [2]. The assessment was undertaken to assess the current Site status in relation to potential contamination to support the proposed residential development. The findings and results are presented herein.

1.2 Purpose and Objectives

1.2.1 Preliminary Site Investigation

The purpose of this PSI is to provide the client with preliminary advice on the contamination status of the current Site conditions and the consequent implications for its intended use. Douglas Partners have undertaken an assessment which only covered the southern portion of the subject site. The PSI reviews current and historical activities undertaken at the Site and provides a preliminary environmental assessment of the potential for soil and/or groundwater contamination to be present on the Site.

The objectives of the PSI are to:

- > Identify the potential for past or present activities on the Site and to the extent practicable surrounding the Site to cause contamination of land or groundwater at the Site
- > Identify potential areas and contaminants of concern at the Site
- > Identify potential receptors of concern and assess the potential for the protected beneficial uses of the land and groundwater to be impacted due to contamination
- > Assess the requirement, if any for further environmental investigation to assess or make the Site suitable for the proposed use
- > Comment on any change noted in the potential contamination status from the previous DP Report [1] to in relation to the southern portion of the current subject site.

The investigation and reporting is preliminary in nature and is undertaken in general accordance with the National Environment Protection (Assessment of Site Contamination) Measure NEPM 2013 guidelines [3] adopted by NSW EPA. The report is not considered to be a Detailed Site Investigation (as defined in NEPM) and as such has not been prepared as the basis of a Site Audit (there is no known requirement for an audit).

1.2.2 Urban Capability Assessment

The objectives of the assessment were to provide a preliminary assessment of the following

- > Salinity
- > Erosion Potential
- > Acid Sulfate Soils
- > Indicative Site Classification
- > Indicative Pavement Thickness
- > Slope stability.

1.3 Scope

1.3.1 Preliminary Site Investigation

This Preliminary Site Investigation comprised a desktop study of NSW EPA Records, utilising information and data from the previous Douglas Partners report [1], the S149 Planning certificate, review of historical and current site inspection.

Commentary on any change noted in the contamination status from the previous report [1] to current Site conditions was also part of the scope.

1.3.2 Urban Capability Assessment

The assessment comprised of desktop study utilising available data and field investigations undertaken by Cardno within the immediate surrounding areas and data provided within the previous Douglas Partners report [1] of the site.

2 Site Identification

The subject site details are presented in Table 2-1. For location site please refer to Figure 1-1 in Section 1.

Table 2-1 Site Details

Site Address	118, 200 & 204 Anambah Road, Maitland, NSW 2320
Lot Number and Deposited Plan	Part of Lot 71 DP 714785 and Part of Lots 721 and 722 DP 1191240.
Site Area	Approx. 35.55 ha
Local Government Area	Maitland City Council
Current Zoning	RU2 Rural Landscape, R1 General Residential and E2 Environmental Conservation

3 Site Inspection and Surrounding Environment

3.1 Site Condition

A site inspection was undertaken by a Principal Technical Officer from Cardno on 27 June 2017 in order to map salient features of the site and the surrounding area. The inspection comprised a walkover assessment with no restrictions to onsite access.

Overall, the site is irregular in shape and bounded by Anambah Road to the west, undeveloped land to the north and rural residential properties to the east and south.

At the time of inspection, features and observations within the site include the following:

- > The site is generally comprised of grassland and is used for grazing purposes. Tree coverage was noted around the existing dwelling and structures. Scattered mature trees were located across the site but were predominately observed around the existing dwellings and access tracks
- > A rural residential dwelling was located within the central portion of the site. Several sheds / building structures (sheds) were present east of the dwelling. The sheds stored agricultural machinery and potential pesticides. The sheds were constructed on hardstand areas and sealed floor and were either constructed using fibrous sheeting or tin / colorbond materials. For location of sheds please refer to Figure 4.
- > Cattle pens were located within the central portion of the site
- > Fibrous sheeting was noted within the structure as shown in Figure 4.
- > Two (2) gravel access tracks traversing east-west from Anambah Road to the dwelling were present
- > A former gravel access track appears to be traversing north-south through the site
- > Fibrous pipe was observed within the vicinity of the south-western boundary of the site. It is unknown whether the pipe falls within the subject the area. The location of the pipe can be seen in Figure 4.
- > The site is located on undulating terrain with general slopes of between 5° and 10°, locally steeper within gully formations.
- > Vinyard / crops are present east of the residential dwelling, bordering the eastern portion of the site.
- > Site slopes and incised drainage lines generally fall towards the wetland located south-east of the site
- > The gullies converge within the central portion of the site and form a low lying wetland.
- > Two rural dams are present within the northern portion of the site and one dam is present within the central region of the site

- > Drainage appears to comprise of infiltration or surficial runoff following the existing contours and gullies of the site, ultimately to the existing wetland, south of site.

3.2 Surrounding Environment and Land uses

The site is located within an rural residential and industrial / commercial district of Maitland. Land uses around the site are detailed in the table below.

Table 3-1 Surrounding Land Use

Direction	Land Use or Activity
North	Undeveloped land adjacent to the site. Approx. 4km north from the site a quarry is present
West	Rural residential development and development land
East	Hunter River (approx. 500m from site). Rural residential development present beyond the Hunter River
South	Low density residential development and commercial development, former Anambah Landfil 700m to the south. Royal Newcastle Aero Club

The area is serviced by public roads and access to the Site is available Anambah Road. It is noted that the Royal Newcastle Aero Club is located approximately 250 - 300m to the south-west and the Maitland City Council's former landfill located approximately 700m south of the subject site.

Several small shed structures and a residential dwelling were located within Lot 690 DP597283 (excluded from the assessment) which borders the western boundary of the Site. A gravel track provides access to the dwelling from Anambah Road. Grass covered stockpiles of unknown origin were also present within the allotment

4 Previous Reports and Reviews

4.1 Douglas Partners Report [1]

A preliminary contamination assessment and urban capability assessment on Lot 71 DP 714785 was previously undertaken by Douglas Partners (DP) referenced "*Report on Preliminary Contamination and Urban Capability Assessment - Proposed Residential Development Lot 71 DP 714785, Anambah Road, Anambah*", Project 39878, dated July 2008 [1].

The objectives of the assessment were to provide a preliminary assessment of Site contamination and geotechnical aspects to support the proposed residential development and rezoning application with Maitland City Council.

The typical subsurface soil profile encountered within the field investigation comprised of silty sand topsoil; overlying silty sand; overlying silty clay. Depth of sandy materials varied from 0.3 -2.0m depending on the terrain (low lying areas and ridgeslopes)

The Douglas Partners report [1] indicated that a number of features would require consideration prior to development. Review of the report [1] revealed the following potential sources of contamination:

- > Abandoned fibre cement pipe located within the south-western corner of the site
- > Timber and scrap metal stockpile within the south-western corner of site
- > Potential former cropping area to the north of the drainage channel
- > Possible imported fill to form dam embankments
- > Stockpiles of potentially imported along excavated drainage channel
- > Royal Newcastle Aero Club is located to the south west of the site and a main flight path crosses the centre of the site.

Then DP report [1] suggested further assessment will be required to address potential contaminant sources which should include targeted sampling and analysis of:

- > Potentially imported soils
- > Potential former cropping area to the north of the excavated drainage channel (appears to be outside of subject area)
- > Surface soils within the flight path of the adjacent airport runway
- > Fibrous cement pipe assessed for asbestos and surrounding soils (appears to be on the south-western boundary of the site).

The report [1] concluded that the available information suggests that impacts from the above contamination sources are likely to be localised and further assessment will be required to confirm contaminant levels within the site.

It must be appreciated that the DP report was undertaken only on Lot 71 DP 714785 and not the remaining subject areas (Part of Lots 721 and 722 DP 1191240). A copy of the report is attached in Appendix D.

4.2 Cardno Geotech Solutions Reports

4.2.1 Supplementary Urban Capability Assessment – Anambah Release Area [4]

Geotech Solutions have undertaken an Urban Capability Assessment for the proposed residential development are on the western side of Anambah Road, Anambah. The report addressed slope stability, soil erosion, potential site classifications, mine subsidence, earthworks, salinity and pavement thickness.

The report [4] indicated that site classifications would range from Class M, Moderately Reactive to Class E, Extremely Reactive. The depth of rock would govern classifications in elevated areas potentially classifying lots as Class M and it was suggested that majority of the site would likely be classified as Class H1 to H2, Highly Reactive. The treatment and earthworks within the gullies and lower parts of the site would likely classify the area as Class E, Extremely Reactive.

The report indicated that a design subgrade of 5% for lime modified clay or select subgrade or CBR of 8% for weathered rock. Typical pavement thickness was in the range of 300mm to 420mm.

4.2.2 Geotechnical Investigations - Sandstone Drive, Windella

Cardno Geotech Solutions (CGS) provided two (2) reports for the proposed residential development located at Sandstone Drive, Windella. The investigation area was located west of the current subject area. The reports presented pavement design for the extension of Sandstone Drive and preliminary site classifications of the proposed allotments.

Cardno Geotech Solutions have undertaken pavement design for the proposed extension of Sandstone Drive referenced “Report on Pavement Design, Windella Waters – Sandstone Drive, Windella” [5]. The report [5] concluded that a design CBR of 7% was adopted for pavement design purposes, following removal of clay subgrade and replaced with a nominal 0.50m of select quality material or alternatively 1.0m of lesser quality material if commercially available.

Preliminary site classifications were undertaken within CGS report referenced “Report on Site Classification, Windella Waters – Sandstone Drive, Windella” [6]. Based on soil profiles encountered at the site and laboratory shrink swell results, the report [6] concluded that preliminary site classifications of the site were classified as Class H2, Highly Reactive.

5 Published Data

5.1 Regional Geology

The Newcastle 1:100,000 Geology Map, Geological Series Sheet 9232, indicates the site is situated within the Rutherford Formation of the Dalwood Group which is known to comprise Early Permian Age deposits of siltstone, marl, minor sandstone and soils derived from the weathering of these rock types.

Referring to the Soil Landscapes of the Newcastle 1:100 000 Sheet (Sheet 9232) indicates that the area being investigated is underlain by three (3) different soil landscapes. The area is underlain predominantly by the North Eelah (ne) landscape from the western portion of the site. The area is also most likely underlain by the Paterson River (pa) landscape in the east portion of the site and by a Wallalong Landscape Variant (wga) in the far southern portion of the site. For further details on Soil Landscapes, refer to Section 10.2

5.2 Acid Sulfate Soils

Review of available published data, indicates that the subject site is situated within no known occurrence of acid sulfate soil materials with reference to the “Department of Land and Water Conservation, Maitland Acid Sulfate Soil Risk Map”, Edition 2, dated December 1997.

Further review of the “Maitland City Council - Local Environmental Plan 2011, Acid Sulfate Soils Map”, Sheet ASS_01 and ASS_004A, dated 2011, indicates that the site is classified as Class 5. Class 5 indicates that development consent is required for works within 500 metres of adjacent Class 1, 2, 3 or 4 land that is below 5 metres Australian Height Datum and by which the watertable is likely to be lowered below 1 metre Australian Height Datum on adjacent Class 1, 2, 3 or 4 land.

Based on review data Acid Sulfate Soils are unlikely to be encountered onsite.

5.3 Hydrogeology

A search of the NSW Groundwater Database from Department of Primary Industries – Office of Water NSW accessed on 26 July 2017 identified four (4) bores within a 2 km radius of the Site. The 4 bores are summarised in the table below. Copy of the licensed bore information is presented in Appendix B

Table 5-1 Registered Groundwater Bore Search Summary

Well Number	Intended Purpose	Coordinates	Depth of Bore (m)	SWL (m)	Water Bearing Zone (m)	Proximity to Site (m)
GW027289	Not Known	32° 014' 33.3" S 151° 29' 37.1" E	5.50	-	-	0.88 km west
GW080337	Test Bore	32° 040' 48.3" S 151° 30' 47.1" E	-	-	-	1.43 km north-east
GW201738	Stock, Domestic, Irrigation	32° 040' 55.0" S 151° 31' 19.0" E	80	20	-	1.93 km east
GW201981	Monitoring Bore	32° 042' 25.8" S 151° 30' 47.6" E	10.50	8.70	8.00 - 8.20	1.99 km south

5.4 EPA records Search

5.4.1 Contaminated Land Record of Notices

Cardno searched the Record of Notices searched on 15 August 2017. Two (2) notices were listed within the suburb of Maitland.

- > Corner Melbourne Street and Brisbane Street, East Maitland – Former Gasworks Site; and
- > Charles Street, Maitland – Maitland Gasworks

Search results are provided in Appendix B

5.4.2 PoEO Public Register

The PoEO Public Register under Section 308 of the *Protection of the Environment Operations (PoEO) Act 1997* contains Environment Protection Licences (EPLs), applications and notices issued by the EPA. The Public Register was searched on 28 July 2017 within the suburb of Maitland to identify any issues of relevance to the Site. Search results are provided in Appendix B.

5.4.3 List of NSW Contaminated Sites Notified to the EPA

Cardno searched the List of NSW Contaminated Sites Notified to the EPA on 15 August 2017. Three (3) sites were listed on the list of notified sites within the suburb of Maitland. The notified sites are detailed below:

- > 164 Newcastle Street, East Maitland – Caltex East Maitland Service Station.
- > Corner Melbourne Street and Brisbane Street, East Maitland – Former Gasworks Site; and
- > 358 New England Highway, East Maitland – Caltex Service Station.

Search results are provided in Appendix B.

6 Site History

6.1 General

The site history was based on the information below.

The site history comprised:

- > Review of Section 149 Planning Certificate of Maitland City Council (MCC)
- > Review of historical aerial photos
- > Review of Title Deeds.

6.1.1 Maitland City Council (MCC) Section 149 Planning Certificate

The complete S149 certificates are attached within Appendix C and are summaries below.

6.1.1.1 Lot 71 DP 714785

A review of the Section 149 Planning Certificates indicates the following:

- > No draft Local Environmental Plans have been on public exhibition under the act
- > Maitland Development Control Plan applies to the land
- > Maitland LEP 2011 identifies the zone applying to land as RU2 Rural Landscape, R1 General Residential and E2 Environmental Conservation
- > The land does not comprise of a critical habitat
- > The land is not within a Heritage Conservation Area

- > The land is not affected by Coastal Protection
- > The land is not within a proclaimed Mine Subsidence District
- > The land is not affected by a road widening or realignment
- > All land within MCC has the potential to contain acid sulfate soils. Development consent is required where works proposed on land shown on the Maitland LEP as being of the class of specified for those works
- > The land is not mapped as “bushfire prone land”
- > Development on this land is subjected to flood related development controls
- > No environmental planning instrument applies to land for the acquisition of the land by a public authority
- > Contribution plans apply to the land
- > The land is not affected by the Native Vegetation Act 2003
- > The land is not affected by the Order Under Trees (Disputes Between Neighbours) Act 2006
- > Council is unaware of whether a valid site compatibility certificate has been issued
- > The land is not significantly contaminated within the meaning of the *Contaminated Land Management Act 1997*.

6.1.1.2 Lot 721 DP 1191240

A review of the Section 149 Planning Certificates indicates the following:

- > No draft Local Environmental Plans have been on public exhibition under the act
- > Maitland Development Control Plan applies to the land
- > Maitland LEP 2011 identifies the zone applying to land as RU2 Rural Landscape
- > The land does not comprise of a critical habitat
- > An Item of environmental heritage is situated on the land
- > The land is not affected by Coastal Protection
- > The land is not within a proclaimed Mine Subsidence District
- > The land is not affected by a road widening or realignment
- > All land within MCC has the potential to contain acid sulfate soils. Development consent is required where works proposed on land shown on the Maitland LEP as being of the class of specified for those works
- > The land is not mapped as “bushfire prone land”
- > Development on this land is subjected to flood related development controls
- > No environmental planning instrument applies to land for the acquisition of the land by a public authority
- > Contribution plans apply to the land
- > The land is not affected by the Native Vegetation Act 2003
- > The land is not affected by the Order Under Trees (Disputes Between Neighbours) Act 2006
- > Council is unaware of whether a valid site compatibility certificate has been issued
- > The land is not significantly contaminated within the meaning of the *Contaminated Land Management Act 1997*.

6.1.1.3 Lot 722 DP 1191240

A review of the Section 149 Planning Certificates indicates the following:

- > No draft Local Environmental Plans have been on public exhibition under the act
- > Maitland Development Control Plan applies to the land
- > Maitland LEP 2011 identifies the zone applying to land as RU2 Rural Landscape
- > The land does not comprise of a critical habitat
- > The land is not within an Environmental Conservation Area
- > The land is not affected by Coastal Protection
- > The land is not within a proclaimed Mine Subsidence District
- > The land is not affected by a road widening or realignment
- > All land within MCC has the potential to contain acid sulfate soils. Development consent is required where works proposed on land shown on the Maitland LEP as being of the class of specified for those works
- > The land is not mapped as “bushfire prone land”
- > Development on this land is subjected to flood related development controls
- > No environmental planning instrument applies to land for the acquisition of the land by a public authority
- > Contribution plans apply to the land
- > The land is not affected by the Native Vegetation Act 2003
- > The land is not affected by the Order Under Trees (Disputes Between Neighbours) Act 2006
- > Council is unaware of whether a valid site compatibility certificate has been issued
- > The land is not significantly contaminated within the meaning of the *Contaminated Land Management Act 1997*.

6.1.2 Historical Title Deeds Search

A Land Title Search was undertaken by Scott Ashwood for Lot 71 DP 714785, Lots 721 and 722 DP 1191240. Results of the search are provided in Appendix C. Review of the title deed searches indicates that the site was generally owned by graziers.

6.1.3 Review of the Historical Aerial Photos

Cardno has conducted a review of the description of the historical aerial photographs provided in the Douglas Partners report [1]. Cardno have utilised information from the Douglas Partners report for the current subject area.

Overall, Cardno’s historical aerial review was based on current site inspection, previous investigations and knowledge of the area. As historical aerial documentation was limited to 1984 in the Douglas Partners report, Cardno have undertaken additional aerial review of available Google Earth and Nearmap imagery post 1984. Cardno have obtained aerial imagery dated 1958 and 1993 which were also reviewed.

A summary of the interpreted site features is provided in Table 6-1 below.

Table 6-1 Aerial Imagery Review

Date	Reference	Observations
December 1958	Black and White Lands Photo Newcastle Run 4 NSW 188 5019 Scale 1:42 000	Onsite: - The conditions of the site generally comprised of undeveloped land comprised of grass cover and no obvious signs of tilling or crops on site. A tree line is present within the central portion of the site. - Appears “Anambah house” is located within the central portion of site (Lot 721 DP 1191240) with trees surrounding the immediate vicinity of the dwelling. Offsite: - The surrounding land uses remain consistent with land uses identified in the Douglas Partners Report. - Anambah Road is located on the western boundary of the site. It appears the area immediately west of the site was used for cropping / agricultural activities. - A wetland with a large water body is located south-east of the site and the Hunter River is located further east. - The position of the Hunter River appears to be consistent with present day positioning. - The immediate site surroundings generally comprise of undeveloped land.
12/02/1993	Colour Newcastle Scale 1:2500	Onsite: - Generally consistent with the 1984 photograph detailed within the DP Report which show the residential property with constructed sheds, alternate dirt road along the central portion of the site and the construction of a dam along the southern boundary of the site., Offsite: - Generally consistent with the 1984 photograph detailed within the DP Report with areas to the site comprising rural land, a drive through theatre with a dam and the former council land fill.
17/01/2014	Colour Nearmap	Onsite: - Generally consistent with the 1998 photograph detailed within the DP Report with the original access road to Anambah house vegetated over. - A structure was in the process of being demolished and a new structure to be erected within the footprint – located along the eastern boundary of the site, near Anambah house. Offsite: - Increase of commercial development towards to the south-west a number of newly constructed buildings and structures - Increase of residential development towards to the south-west a number of newly constructed dwellings.

6.2 Summary of Site History

Based on the available historical data, Cardno site inspections, public searches and discussions with Ms Debra Bird documented within the previous DP Report [1], the current subject site has been used for cattle grazing to present day.

It is understood that Ms Bird’s father purchased the site of approximately 930 ha parcel of land which included the Anambah house and was subdivided and sold at various times. For further information, refer to the Douglas Partners report [1] attached as Appendix D to this report.

7 Areas and Contaminants of Potential Concern

The assessment has identified several potential sources of contamination which are summarized in Table 7-1 below.

Table 7-1 Site Activities and Potential Contaminants of Concern

Area of Environmental Concern	Site Activity / Potential Source	Contaminants of Potential Concern	Comments
Onsite Sources			
Surficial disturbance and filling	Potential minor cut and fill operations	Possible contaminants include: Metals Petroleum hydrocarbons (Polycyclic Aromatic Hydrocarbons [PAHs], Total Recoverable Hydrocarbons [TRH], Benzene, Toluene, Ethylbenzene, Xylenes [BTEX]) Organochlorine and Organophosphate Pesticides (OCP/OPP) asbestos	Uncontrolled fill material may be present onsite (for site levels and construction of dams) and offsite (excavated drainage channel). Gravel access tracks
Cropping and cattle pens	Historical agricultural activities	Organochlorine and Organophosphate Pesticides (OCP/OPP)	Potential use of pesticides during mid 20 th century .
Under the concrete slab and buildings	It is possible that imported fill has been placed in the footprint of the buildings and carpark areas for the purpose of levelling the site.	TRH/BTEXN/PAHs/Metals, asbestos, OCP/OPPTRH/BTEXN/PAHs/Metals/OCP OPP and asbestos.	Contaminated soils and waste products were commonly used for filling purposes in the time period in which the site was developed.
Buildings	Potential hazardous building materials and storage of chemicals	ACM (asbestos containing materials) and lead paint. Potential storage of pesticides and chemicals within sheds.	Age of the structures indicate that ACM may have used in construction materials
Offsite Sources			
Aero Club	Direct flight path across the site	TRH/BTEXN/PAH, PFAS and metals	Potential hydrocarbon storage, lubricants for aircraft maintenance. Potential use of AFFF containing PFAS
Former Waste Land Fill	Waste	Metals/TRH/PAH/PCB/alkanes/sulphides/nutrients/ammonia, landfill gas	New residential developments have been erected between the subject site and the former land fill.
Anthropogenic Materials	Fibrous cement pipe	-Asbestos containing materials -Asbestos fibres in soils	Localised dumping of pipe. Potential soil contamination within the immediate vicinity.

8 Preliminary Conceptual Site Model

8.1.1 General

A Conceptual Site Model (CSM) is “a description of a site including the environmental setting, geological, hydrogeological and soil characteristics together with the nature and distribution of contaminants. Potentially exposed populations and exposure pathways are identified” (NEPM, 2013) [3]. The development of a CSM comprises an iterative process of characterising site contamination on the basis of available information or data. This Preliminary CSM has been prepared to summarise the currently known or suspected contaminants at the Site, their locations, potential receptors of these contaminants and to assess whether linkages may be present between the contaminants and receptors. This Preliminary CSM is the first iteration of the CSM process and should be updated following subsequent rounds of assessment (where applicable) when additional information becomes available.

The site is situated within undulating terrain with site slopes general slopes of between 5° and 10°, locally steeper within gully formations. The soil conditions generally comprised of silty sand topsoil; overlying silty sand; overlying silty clay. The depth of sandy materials appear to be dependent on site slopes and formations.

Based on the findings of the PSI the following Potential Sources of Contamination (PSOC) have been identified on the Site:

8.1.2 Areas of Environmental Concern (AEC)

Areas of Environmental Concern (AEC) are associated with:

- > Potential contamination associated with minor areas of filling and surficial disturbance on site - onsite
- > Potential pesticide and herbicide use within cropping areas - onsite
- > Fibrous materials within structures– onsite
- > Potential contaminated soils beneath building pads – onsite
- > Fibrous cement pipe – offsite (bordering subject area)
- > Potential contamination associated with excavated drainage channel - offsite
- > Potential contamination associated with agricultural activities within surrounding areas – offsite
- > Potential contamination associated with a main flight path across the centre of site – offsite

For areas of concern and potential contamination sources refer to Figure 4, attached in Appendix A.

8.1.3 Media potentially impacted

The potential media impacted by contamination may include:

- > Potentially contaminated surficial soils onsite.
- > Potentially contaminated underlying soils onsite.
- > Potentially contaminated fill materials onsite.
- > Potentially contaminated groundwater under the site

8.1.4 Human and Ecological Receptors

The potential human and ecological receptors include the following:

- > Workers involved in the remediation / restoration or development of the site (onsite)
- > Site users – residential use (onsite)
- > Receiving water bodies including local dams (onsite), wetland and the Hunter River (offsite).
- > Local residents and surrounding properties (offsite).

8.1.5 **Potential Exposure Pathways**

The potential exposure pathways identified include;

- > Air – ingestion
- > Soil – dermal / direct contact
- > Vapour – Inhalation
- > Lateral migration via surface water.

Based on the current site assessment and review of the past DP report [1], it is considered that all pathways are addressed

9 Discussion

9.1 **Potential Acid Sulfate Soils**

Based on the published data of the subject site and previous investigations, the presence of acid sulfate soils onsite is considered highly unlikely.

With reference to the Douglas Partners report [1], acid sulfate soils are not anticipated within the site. Based on laboratory testing undertaken by DP, the pH testing indicated the absence of actual acid sulphate soils (pH soil >4.0). The report concluded that the testing of surface waters indicated neutral to lightly alkaline conditions which suggest the absence of actual acid sulphate soil conditions.

The testing undertaken within the DP report [1] would be considered appropriate for the overall site based on the published data, likely subsurface conditions and current Cardno site inspection.

9.2 **Potential Groundwater Contamination**

Based on the site history and the hydrogeology conditions inferred from available data and site topographical condition, the likelihood of groundwater contamination at and from the site is considered to be negligible.

The groundwater is unlikely to be contaminated by sources at nearby sites to the extent that it would constrain the use of the site.

It should be noted that an intrusive investigation of the groundwater contamination conditions was outside of this assessment scope of works.

9.3 **Potential Soil Contamination**

As no intrusive sampling and testing regime has been undertaken to provide an assessment of the identified AEC's or to address issues previously outlined by Douglas Partners report [1], it is recommended that an intrusive sampling and testing regime be undertaken.

The available information suggests that impacts from the potential contaminant sources are likely to be localised and further assessment will be required to confirm contaminant levels within the site. The AEC's would likely not pose any significant constraints towards the proposed development / rezoning.

Offsite sources are believed to not pose a significant risk to soil and groundwater contamination due to the elevated topography of the Site in relation to former land fill located approximate 1km south of Site. It is noted that new residential developments are present immediately north of the former landfill and between the subject site.

It is unlikely the site would contain contamination associated with Aeroclub flight paths located within the southernmost portion of the site.

9.4 Site Contamination Constraints

Based on the review of historical data, site inspection undertaken by Cardno, and data collected from the previous Douglas Partners Report [1], the potential or known contamination at this site is not considered to present a significant constraint on site for the proposed residential use and development. It is recommended that intrusive investigations are undertaken at the Areas of Environmental Concern listed in Table 8-1.

It is also noted that care should be taken to ensure that any soil removed from the site is properly assessed for its waste classification in accordance with EPA guidelines and applicable regulations in NSW.

10 Urban Capability Assessment

The Urban Capability Assessment comprised appraisal of the site land form, soil exposures, review of published data, data collected from previous geotechnical investigations undertaken by Douglas Partners within the southern portion of the site and investigations undertaken by Cardno within the surrounding areas.

It must be appreciated that no intrusive field investigation or sampling was undertaken within the site and the assessment is preliminary in nature. It is recommended once design plans are final that intrusive investigations should be undertaken to confirm stability assessments, pavement thickness and site classifications on site.

10.1 Geology

The Newcastle 1:100,000 Geology Map, Geological Series Sheet 9232, indicates the site is situated within the Rutherford Formation of the Dalwood Group which is known to comprise Early Permian Age deposits of siltstone, marl, minor sandstone and soils derived from the weathering of these rock types.

10.2 Soil Landscape

Referring to the Soil Landscapes of the Newcastle 1:100 000 Sheet (Sheet 9232) indicates that the area being investigated is underlain by three (3) different soil landscapes. The area is underlain predominantly by the North Eelah (ne) landscape from the western portion of the site. The area is also most likely underlain by the Paterson River (pa) landscape in the east portion of the site and by a Wallalong Landscape Variant (wga) in the far southern portion of the site.

The soil landscapes likely to be encountered have been defined as being comprised of the following characteristics:

North Eelah (ne);

- > Undulating low hills on Permian sediments and basalt in the East Maitland Hills region;
- > Slopes in the range of 5-12% with Local relief to 70m and elevation up to 130m;
- > Commonly occurring banded rock outcrops;
- > Soils usually consisting of
 - Moderately deep well-drained clays, some deep well-drained non-calcic brown and chocolate soils with deep imperfectly drained black earths and prairie soils on basaltic parent material; OR
 - Moderately deep, well to imperfectly drained yellow Soloths and shallow to moderately deep, Lothosols on sandstone and conglomerate.
- > Hazards including water erosion localised shallow soils, rock outcrops, low fertile acid soils on sedimentary parent material and foundation on basaltic parent material.

Paterson River (pa);

- > Level to gently undulating narrow alluvial plain with slopes less than 3%;

- > Soils including deep occurring rapidly drained sands, well-drained alluvial soils and loams. On alluvial fans deep Brown Podzolic soils and some Prairie soils may occur; and
- > Hazards including high floods, stream bank erosion, ground water pollution, localised wind erosion, localised low fertile non-cohesive soils of low water-holding capacity.

Wallalong Landscape Variant (wga);

- > Alluvial fans and drainage plains with slopes of 1 to 3%;
- > Soils including moderately deep to deep imperfectly drained, yellow and black Soloths with shallow Lithosols. Some brown and yellow Podzolic soils also occurring at shallow to moderate depths.
- > Hazards including high water erosion and foundation risks and localised occurrences of high run-on, waterlogging and shallow, very high acidic soils of low fertility.

10.3 Topography and Slope Stability

Previous geotechnical investigations undertaken by Cardno [4] within the surrounding areas of the site and investigations undertaken by Douglas Partners [1] within the southern portion of the site have assessed the risk of slope instability using the classification system formulated by the Australian Geomechanics Society Sub-committee on landslide risk management and published in the AGS (2007e). The Australian GeoGuides for slope management and maintenance – Australian Geomechanics Society, Australian Geomechanics, Vol 42, No 1 [7].

The following risks of the overall site have been identified:

- > General slopes of between 5° and 10° that are assessed as being of low risk;
- > Some localised steepening within alluvial or colluvial profiles in the vicinity of gullies that are considered to be of medium risk and will require minor earthworks to render them suitable for development.
- > Dam embankments on the site have not been assessed and if they are to be retained as part of the development they will require further detailed investigation and assessment.

It is noted that the above referenced reports assess the risk of slope instability and recommend geotechnical development guidelines in light of the assessed risk of slope instability. The onus is on the owner, developer and/or appropriate regulatory authority to decide whether the assessed level of risk is acceptable, taking into consideration likely economic and legal consequences of the risk and the recommended geotechnical development guidelines.

10.4 Soil Erosion

The magnitude of erosion that can occur at a particular location is dependent on the potential of erosive elements such as wind, rain and runoff to erode soils and the erodibility of the soil. Assessment of soil erodibility takes into consideration soil properties such as texture, structure, dispersion, depth and infiltration and provides a general indication of relative resistance to water erosion.

Douglas Partners [1] have undertaken Emerson Class sampling and testing from samples collected within gullies and hill slopes with Emerson Class ranging from 5 – 6, indicating non-dispersive soils. It was noted within the report [1] that hill slopes generally comprised of a surficial silty sand layer ranging in depth from 0.30m within the western and central portion of the site to depths greater than 2.0m within the eastern portion of the site. The testing undertaken within the DP report [1] would be considered appropriate for the overall site based on the published data and current Cardno inspection

Emerson Class testing undertaken within the Cardno field investigation [4] of soils north of the site indicated Class 4 and judged to be slightly dispersive.

Based on the onsite testing undertaken by Douglas Partners and field investigations undertaken within the area by Cardno / Geotech Solutions indicates that the overall site soils are prone to some degree of structural breakdown.

The following guidelines can be adopted in planning and development to minimise the impact of erosion and sedimentation:

- > Undertake development in accordance with an erosion and sediment control plan.
- > Undertake erosion control involving managing runoff at a non-erosive velocity, controlling runoff onto, through and from the site, minimising the duration and area of soil exposed during earthworks and providing protection for the soil surface.
- > Undertake sediment control involving trapping and containing soil particles that have been eroded.
- > Undertake rehabilitation and re-vegetation of disturbed areas within 14 days of completion of earthworks. Re-use topsoil.
- > Maintain erosion and sediment control measures.

10.5 Salinity

Based on the current site inspection by Cardno and laboratory testing previously undertaken within the southern portion of the subject site, it is considered that the site does not pose a salinity risk.

The Electrical Conductivity (EC) results of testing indicated that the soils within the area are slightly acidic and non saline. The testing undertaken within the DP report [1] and previous Cardno investigations of the surrounding areas would be considered appropriate for the overall site based on the published data and current Cardno inspections.

During the course of the Cardno site inspection no indicators of major salinity issues were observed.

10.6 Mine Subsidence

Based on the 149 certificates and previous Douglas Partners report [1], the property is not within a proclaimed mine subsidence district and is not subjected to any building restrictions imposed by the MSB. There are no recorded workings under or adjacent to the site.

10.7 Acid Sulfate Soils

Review of available published data, indicates that the subject site is situated within no known occurrence of acid sulfate soil materials with reference to the “Department of Land and Water Conservation, Maitland Acid Sulfate Soil Risk Map”, Edition 2, dated December 1997.

Acid sulfate soils are not anticipated within the overall subject site therefore it is considered that no screening or detailed analytical testing is required.

Furthermore, The field investigation undertaken by Douglas Partners [1] within the southern portion of the site concluded the pH testing of soils indicated the absence of actual acid sulfate soils (pH > 4.0).

10.8 Potential Pavement Designs

Based on the previous investigations undertaken by Douglas Partners within the southern portion of the current subject site and Investigations undertaken by Cardno within the surrounding properties, subgrade conditions are likely to comprise of clayey soils and weathered bedrock onsite. These materials are suitable for pavement subgrade formation however will require suitably design subsoil drainage. It must be noted that the site also comprises areas of silty sand / gravelly sand ranging from depths of 0.1 – 1.6m. The area is known to comprise of low bearing CBR clay profile.

The requirement for subgrade replacement or treatment in these soils will depend to a degree on the weather conditions prior to and during construction. Trafficability may also be an issue following period of heavy rainfall. Specific geotechnical investigation for pavement design should be undertaken at the appropriate stage of development.

Conceptual design should take potential excavation constraints in the rock into consideration. Provision pavement design can be undertaken using a design CBR of 5% for lime modified clay or select subgrade or CBR of 8% for weathered rock.

Maitland City Council's "Manual of Engineering Standards" [8] was adopted for likely design traffic loadings and determination of preliminary pavement thicknesses. Table 10-1 details the preliminary pavement thicknesses for a range of road categories. We have assumed that the clay subgrade will need treatment either by in situ stabilisation or the use of a select layer.

Table 10-1 Typical Pavement Thickness Summary

Road Category	Max No. Lots	Total Thickness(mm)		Comment
		Min CBR 5 %	Min CBR 8%	
Distributor-Secondary 2×10 ⁶ ESA's	200	420 ⁽¹⁾	320 ⁽¹⁾	⁽¹⁾ 40mm Dense Grade Asphalt & pavement Material complying with MCC Engineering requirements
Local – Primary 5×10 ⁵ ESA's	100	380	300 ⁽²⁾	⁽²⁾ Min MCC pavement thickness of 300mm 30mm Dense Grade Asphalt & pavement Material complying with MCC Engineering requirements
Local – Access 1×10 ⁵ ESA's	20	300	300 ⁽²⁾	⁽²⁾ Min MCC pavement thickness of 300mm 30mm Dense Grade Asphalt & pavement Material complying with MCC Engineering requirements
Select Subgrade		300 ⁽³⁾	0	⁽³⁾ Either lime stab or 300 select
Subgrade		Clay	Weathered rock	

Notes to Table 6

- (1) Allowance for greater thickness of AC on collector roads
- (2) Minimum pavement thickness for MCC
- (3) Subject to testing for lime additive rate & minimum CBR for select of 10%.

As detailed in Table 10-1, typical pavement thickness for clay subgrade will be in the order of 600mm – 720mm and 300mm – 320mm for weathered bedrock profile, in the absence of any sandy soils and unsuitable materials on site. Soft soils are likely to be present within the gullies and low lying areas. The presence of soft / wet soils would not impede the development but would require treatment.

The laboratory testing on the adjacent Stockland site has identified that the high plasticity clay encountered in the pits has a moderate to high potential for swelling. It is expected that the majority of high plasticity clay would tend to the higher potential swell. This can be problematic for the long term performance and can create issue associated with surface cracking. The in situ stabilisation of the clay or adoption of a select subgrade on non reactive material can aid in minimising the impacts associated with volume change in subgrade soil. In allowing for these treatments it is suggested that the full formation including footpaths should be subject to the adopted treatment.

It must be appreciated that pavement thickness is preliminary in nature and will require intrusive field investigation and testing once road alignments have been finalised, to confirm pavement design and thickness.

10.9 Footings and Potential Site Classifications

Based on the Cardno site inspection, review of available data and previous investigations, it is anticipated that footings for residential structures for majority of site will comprise of shallow footings within residual or alluvial soils. Site classifications and footing design should be confirmed with subsurface investigation with shrink swell testing prior to development and in accordance with AS2870-2011 [9].

From a geotechnical viewpoint there are no constraints on the type of residential structures that may be constructed on the site provided all foundations are designed and constructed in accordance with AS2870-2011, Residential Slabs and Footings [9]. Soft soils are likely to be present within the gullies and low lying areas. The presence of soft / wet soils would not impede the development but may require treatment.

The site conditions do not preclude larger structures; however they would require detailed assessment. AS2870-2011 [9] establishes performance requirements and specific designs for common foundation conditions as well as providing guidance on the design of footing systems using engineering principles.

Site classification in accordance with AS2870-2011 [9] should be undertaken at the appropriate stage of development. Based on the subsurface conditions noted in the test pits and limited testing on the adjacent Stocklands site, it is expected that site classification would range from Class M, Moderately Reactive to Class E, Extremely Reactive.

It is suggested that the majority of the site in the existing condition would likely be Class H1 to H2, Highly Reactive. In the higher portion of the site actual classifications will be dependent on the depth to rock and may be classified as Class M, moderately reactive. Consideration of the treatment in the gullies and lower parts of the site should take into consideration the reactivity of the site clay as filling of these areas would create Class E, Extremely Reactive lots.

Details on appropriate site and foundation maintenance practices are presented in Appendix B of AS 2870-2011 [9] and in CSIRO Information Sheet BTF 18, Foundation Maintenance and Footing Performance: A Homeowner's Guide [10]. Construction on sloping sites should be undertaken in accordance with The Australian GeoGuide LR8 (Hillside Construction Practice) [11].

All structures and earthworks should be subject to specific geotechnical investigation.

11 Conclusions

This report represents the findings of PSI undertaken on the subject Site, located at Anambah Road, Maitland. The assessment aimed to address the objectives outlined in Section 1.2 of this report, namely, to assess at a preliminary level.

The objectives of the PSI was to identify any past or present potentially contaminating activities and to provide a preliminary assessment of the overall site contamination status. The PSI comprised an assessment of the available historic data, site inspection and review of the previous Douglas Partners report [1] undertaken within the southern portion of the current subject site.

Based on the findings and assessments, the PSI has concluded the following:

- > Based on the available data, the presence of acid sulfate soils onsite is considered highly unlikely;
- > The groundwater is unlikely to be contaminated by sources at nearby sites to the extent that it would constrain the use of the Site; and
- > Impacts with the potential contaminant sources are likely to be localised and further assessment will be required to confirm contaminant levels within the Site. Potential sources are detailed in Table 7-1 and shown on Figure 4.

The potential or known contamination at this Site is not considered to present a significant constraint on site for the proposed residential use and a limited intrusive sampling and testing regime should be undertaken to confirm suitability.

Typical pavement thickness for clay subgrade will be in the order of 600mm – 720mm and 300mm – 320mm for weathered bedrock profile, in the absence of any sandy soils and unsuitable materials on site.

Based on the subsurface conditions noted in the test pits and limited testing on the adjacent Stocklands site, it is expected that site classification would range from Class M, Moderately Reactive to Class E, Extremely Reactive.

It is considered that no identified geotechnical constraint has been identified that would restrict the potential residential development of the site.

11.1 Recommendations

As some potential sources of contamination have been identified, intrusive investigations should be undertaken in the areas where potential sources of contamination have been identified to confirm the contamination status and suitability of the Site for the proposed land use. These areas include:

- > Potentially imported soils (across the site, dams and under slabs)
- > Cropping east / south-east of Anambah House;
- > Potential contamination of soils within the flight path.
- > ACM within structures;
- > Surficial soils across the site; and
- > Fibrous cement sheeting pipe and surrounding soils if within subject area.

These investigations should be undertaken in accordance with relevant regulatory guidance including the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013 [3]. It must be noted that fibrous sheeting was present within onsite structures.

As the proposed development layout has not been finalised, additional geotechnical works and laboratory testing will be required once the development arrangement is known. The geotechnical investigation would be required to address the following:

- > Pavement thickness and design;
- > Site Classification;
- > Earthworks procedures and specifications;
- > Assessment of onsite dams and embankments; and
- > Depth and extent of potential soft soils and unsuitable materials.

12 Limitations

Cardno have performed investigation and consulting services for this project in general accordance with current professional and industry standards. The extent of testing was limited to discrete test locations and variations in ground conditions can occur between test locations that cannot be inferred or predicted.

Cardno, or any other reputable consultant, cannot provide unqualified warranties nor does it assume any liability for the site conditions not observed or accessible during the investigations. Site conditions may also change subsequent to the investigations and assessment due to ongoing use.

The review of the Douglas Partners report has taken their data and observations on face value as a review of the validity of their data, observations and site history research was beyond our scope of work. To the extent that those reports are found to be inaccurate or misleading, Cardno disclaims any reliance on those reports and cannot be liable for any loss consequent to issuing this report.

This report and associated documentation was undertaken for the specific purpose described in the report and shall not be relied on for other purposes. This report was prepared solely for the use by HDB Town Planning and Design

13 References

- [1] Douglas Partners Pty Ltd, "Report on Preliminary Contamination and Urban Capability Assessment ,Proposed Residential Development - Lot 71 DP 714785 Anambah Road, Anambah", Project 39878, July 2008.
- [2] NSW EPA, ""Contaminated Sites: Guidelines for Consults on Contaminated Sites," NSW Environmental Protection Authority, 1997.
- [3] National Environment Protection (Assessment of Site Contamination) Measure 1999, "Schedule B1 Guidelines on Investigation Levels For Soil and Groundwater," National Environment Protection Council (NEPC), 16 May 2013.
- [4] Geotech Solutions, ""Supplementary Urban Capability Assessment, Anambah Release Area - Anambha", Ref. GS347-012/0, dated 31 January 2012".
- [5] Cardno Geotech Solutions, ""Report on Pavement Design, Windella Waters - Sandstone Drive, Windella", Ref. CGS2931-002.2, dated 9 May 2016".
- [6] Cardno Geotech Solutions, ""Report on Site Classification, Windella Waters - Sandstone Drive, Windella", Ref. CGS2931-003.0, dated 21 October 2016".
- [7] AGS Landslide Taksforce, "Commentary on Practice Note Guidelines for Landslide Risk Management 2007," *Journal and News of the Australian Geomechanics Society*, vol. 47, no. 1, pp. 115-158, 2007d.
- [8] MCC Manual of Engineering Standards, "Chapter 5 - Pavement Design," Maitland City Council, 2014.
- [9] Australian Standard AS2870-2011, "Residential Slabs and Footings," Standards Australia, 2011.
- [10] Building Technology File 18 (BTF 18), "Foundation Maintenance and Footing Performance: A Homeowner's Guide," CSIRO Publishing , 2003.
- [11] Australian Geoguide LR8, "Hillside Construction Practice," Australian Geomechanics journal, Volume 42, No 1, March 2007.