Nimble Estates Pty Ltd

Preliminary Geotechnical Assessment

Proposed Commercial / Residential Subdivision

1055 Bruxner Highway, Goonellabah

Report No. RGS33375.1 - AA

15 September 2022

FINAL

REGIONAL GEOTECHNICAL SOLUTIONS

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Manning-Great Lakes
Port Macquarie
Coffs Harbour

RGS33375.1 - AA

04 October 2022

Nimble Estates Pty Ltd

Federal Drive, Eureka NSW 2480

Attention: Brian Grant

Dear Brian,

RE: Proposed Commercial / Residential Subdivision – 1055 Bruxner Highway, Goonellabah

Preliminary Geotechnical Assessment

Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken geotechnical assessment for the proposed commercial and residential subdivision at 1055 Bruxner Highway, Goonellabah NSW.

The report was undertaken using data and information obtained from two previous investigations including:

- Slope Stability Assessment by North Coast Geomechanical Consultants (Ref: 15/8039 dated 7 December 2015).
- Additional data supplied by South East Soil Testing (Ref: Report No. 784 dated 22 October 2015)

In addition to the above, RGS undertook a site walkover which included observations and mapping of geotechnical conditions and geotechnical features on the 12th of September 2022.

This assessment provides comments and recommendations regarding the proposed development from a geotechnical perspective.

If you have any questions regarding this project, please contact the undersigned.

For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

Prepared by

Deni Rahman

Senior Engineering Geologist

Reviewed by

Adam Holzhauser

Principal Geotechnical Engineer

Regional Geotechnical Solutions Pty Ltd
ABN 51141848820

Unit 14, 25-27 Hurley Drive
Coffs Harbour NSW 2450
Ph. (02) 6650 0010

Email deni.r@regionalgeotech.com.au
Web: www.regionalgeotech.com.au

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1 INTRODUCTION

Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical assessment for the proposed commercial and residential subdivision to be developed at 1055 Bruxner Highway, Goonellabah (Lot 42 DP868366 and Lot 1 DP957677).

The drawings provided indicate that the site is to be subdivided into 13 residential lots in the northern portion of the site and 11 business and industrial lots in the southern portion. The development will also include the construction of internal roads throughout the subdivision.

Diagram 1: Project Overview

Illustrative concept plan extracted from client supplied drawings.

The purpose of the assessment was to give a establish if the site is suitable for the proposed development at a high level. Comments and recommendations will be provided on the following:

- General site conditions and geology including;
  - General soil profile and properties based on previous data and reporting of others.

- Other potential geotechnical constraints (if any) and associated with construction Including but not limited to:
    - Soil capability and suitability of material for construction.
    - Excavatability.
    - Foundations.
    - Retention and batters
    - Off-site disposal of material.
- Preliminary slope stability assessment relevant to the proposed development.

2 PREVIOUS INVESTIGATIONS

2.1 Geotechnical Assessment and Laboratory Testing

A geotechnical assessment was undertaken previously across the site by North Coast Geomechanical Consultants (Ref: 15/8039 dated 7 December 2015). Information obtained from the investigation is summarised below.

Field work comprised the excavation of 33 test pits to depths of up to 4.0m. Logs for the test pits are in the report in Appendix A and generally comprise topsoil overlying residual silty clays with weathered rock at depth. Localised areas of fill were observed.

Laboratory testing was undertaken by South East Soil Testing (Report No. 784 dated 22 October 2015) on samples collected from the above investigation. The testing included:

- Ten (10) California Bearing Ratio (CBR) tests;
- Thirty-three (33) Pocket Penetrometer tests;
- Fourteen (14) Atterberg Limits and Linear Shrinkage tests.

The test result sheets are attached in Appendix B.

3 SITE WALKOVER

A Geotechnical Engineer from RGS completed a site walkover on September 12, 2022. The walkover included observation of relevant surface features on the site including:

- Site observations and mapping of geotechnical features and conditions.
- Identification of any geotechnical hazards relevant to the proposed development.
- Quality control and assurance of previous geotechnical data and reporting.

Plate 1: Site Walkover Photos

A panoramic view looking northeast illustrating undulating rolling hills which typifies the site.

Looking southeast illustrating site slopes.

Outcropping basalt boulders were estimated to be of at least high strength.

Out cropping basalt bedrock prevalent in creek lines.

A creek incision reveled a soil profile of residual clay soils and weathered basalt.

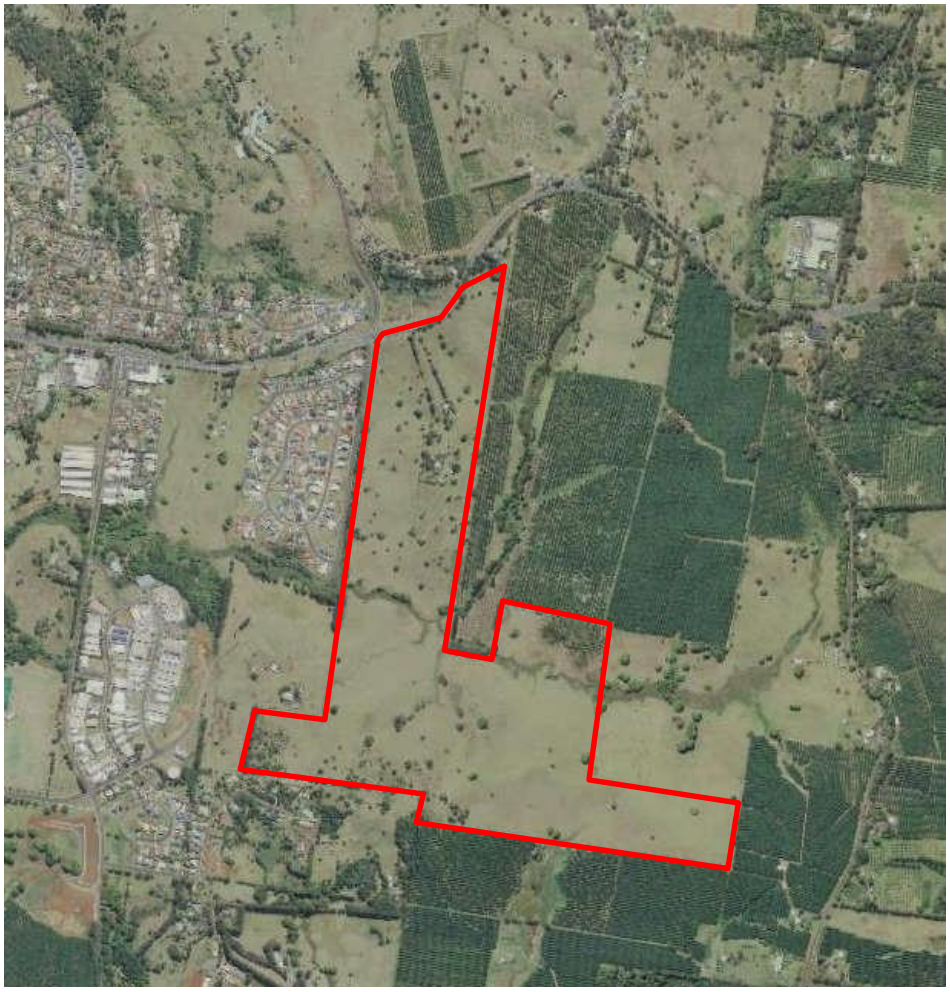
4 SITE CONDITIONS

4.1 Surface Conditions

The site is located on a hill within a region characterised by undulating residual terrain. Across the site there are several ridges and gullies with a distinct creek line which bisects east west through the central portion of the site.

Slopes vary across the site but are generally in the order of 4-8°. Localised slopes up to 15° were noted. Slope directions follow drainage lines to the central portion of the site generally. Surface soils comprise of red-brown silty clays with basalt boulders/scree and flow deposits commonly observed.

Diagram 2: Aerial Image of Site



Aerial image of subject site illustrating site location and setting.

Two structures were observed during the site visit which were dilapidated but were noted that the foundations were observed to be good for the age of the structures.

Basalt boulders and outcrops were observed across the site with larger flow type deposits found in the topographically lower portions of the site e.g creek lines. In situ strength tests conducted on out cropping rock were high to very strength in nature.

No signs of previous instability were observed e.g. tension cracking, hummocky ground or terracing of the steeper slopes. Some possible spring activity was observed within the higher points of the drainage gullies in the south, but this could not be confirmed, due to the recent rainfall in the area.

5 SOIL CAPABILITY AND EARTHWORKS CONDITIONS

5.1 Subsurface Conditions

The 1:250,000 geological series sheet of Tweed Heads indicates the site is underlain by Lismore Basalt.

The materials encountered during previous investigations are presented on the engineering logs in Appendix A. A summary of site soils is described in Section 5.2.

Groundwater was not noted in the provided engineering logs. It should be noted that fluctuations in groundwater levels can occur because of seasonal variations, temperature, rainfall and other similar factors, the influence of which may not have been apparent at the time of the assessment.

5.2 Nature of Site Soils & Suitability for Reuse as Engineered Fill

The site generally had a subsurface profile comprising:

- Topsoil; Silty CLAY medium to high plasticity, brown-red, to depth of up to 0.3m overlying;
- Residual soil comprising Silty CLAY medium to high plasticity, red/brown to purple, firm to very stiff, in all test pits at depths between 0.3 and 4m overlying;
- Weathered rock comprising weathered basalt boulders, flow bedrock and extremely weathered basalt returned as clayey gravel to termination depths in some test pits between depths of approximately 1.7-4m.

A summary of the suitability of the site materials for reuse as controlled fill is presented below:

- Topsoil will not be suitable for reuse as controlled fill, however, the material may be reused for landscaping purposes;
- The residual soils will be suitable for reuse as controlled fill, however, the material is moderately reactive and consideration is required for future foundation designs as discussed in Section 5.6. Any firm residual material would need to be moisture conditioned
- The weathered rock profile will be suitable for reuse as rock fill, landscaping or could potentially be processed for reuse as a gravel product for future site works.

5.3 Excavatability

An earthworks cut to fill plan has not been provided at the time of the writing the report herein. It is assumed that cuts will predominantly encounter topsoil, residual soils overlying low to medium strength extremely weathered basalt that will generally be excavatable with the use of a medium to large excavators. Note should be made that large boulders are likely to be encountered across the site and may need to be broken down or removed. This should be treated on a case-by-case basis.

Previous investigations were undertaken with a 12 tonne excavator that achieved excavation within topsoil, residual soils and in some test pits, weathered basalt. Practical refusal was not detailed in the previous reporting.

Due to the nature of the weathering process of the basalt materials, some areas will encounter higher strength less weathered boulder areas underlain by silty clay residual soils.

It should be noted that high strength basalt will likely require ripping and tynes or rock hammers. The use of rock hammers may be required in detailed excavations such as service trenches, or to avoid overbreak in detailed excavations.

5.4 Preliminary Earthworks Requirements

Site preparation prior to the proposed site regrade will involve selective stripping and stockpiling of vegetation, topsoil and any organic, deleterious or otherwise unsuitable materials. These should be removed to spoil or stockpiled for re-use as landscaping materials within the proposed subdivision.

Residual soils and weathered rock excavated within the proposed cuts can be stockpiled for later use. Some material may need to be moisture conditioned. Stripped surfaces should be proof rolled to identify any soft, excessively wet or heaving areas that should be removed and replaced with approved engineering fill prior to placement of further fill above.

Groundwater was not noted in previous investigations. RGS noted in the site walkover observations that upper portions of the drainage channels did appear to have some water seepage. Water flows through the profile are considered normal for the area and may be encountered during excavations.

It is recommended that if temporary site access is required to traverse and low-lying gullies or soft drainage channel areas a rock mattress with a drainage blanket should be ultilised. The blanket should comprise a geofabric wrapped drainage blanket of durable hard crushed rock placed in the base of the gully or channel.

Minor scouring/erosion of the surface was observed during the RGS site walkover generally at the mid slope or lower slope portions of the site where surface sheet flows are at their highest velocity. The soils identified on site and in previous engineering logs indicate the soils are not overly erodible in nature. Scour and erosion are expected to be managed by controlling stormwater runoff to divert away from the site into the stormwater system and re-establishing vegetation. Erosion protection such as geosynthetic meshes, geo-cells, etc will be required on cut/fill batter faces.

5.5 Batters and Retention

Temporary batters through the existing soils should be cut no steeper than 1V:1H for heights up to 1.5m. Permanent batters within the soils encountered up to 1.5m can be constructed at no steeper than 2H:1V. Batters should be trimmed smooth to reduce moisture ingress and protected from erosion. Permanent batters should be rapidly vegetated.

Surface runoff from above should be collected and diverted away from the face of the batters.

Permanent support of cut and fill could be provided by engineered retaining walls. As a preliminary guide gravity or cantilever retaining walls can be adopted for the support of batters and can be designed based on a triangular lateral earth pressure distribution using the characteristic earth pressure coefficients and subsoil parameters provided below:

- Angle of internal friction (ϕ) = 27º
- Cohesion (c') = 5kPa
- A bulk unit weight of 20kN/m^3.

An active earth pressure coefficient (k_a) of 0.38 should be adopted for fill and natural clay soils.

Any surcharge affecting the walls should be allowed for in the design. Appropriate drainage should be installed behind the walls that provide complete and permanent drainage. The wall backfill should comprise free draining granular material. Subsoil drains should comprise a recomposite drain or geotextile (Bidim A34 or similar) wrapped gravel drain at the toe of the back of the wall. The drains should discharge to the stormwater system, which in turn discharges to the creek below.

5.6 Preliminary Foundation Conditions

Proposed foundation levels at this stage are unknown. Based on the current site conditions, shallow or piled footings are considered feasible support of structures at the site at a preliminary level. Generally, footings should adhere to the following:

- All footings including slab thickenings should be founded within the residual soils or basalt bedrock only below all topsoil, uncontrolled fill or basalt boulders.
- Based on previous geotechnical data from others, shallow footings founded within the residual silty clay of at least stiff strength can be designed based on an allowable base bearing pressure of **100kPa;** and
- All footings should be entirely founded on similar material and outside or below all zones of influence resulting from existing or future service trenches.

The Atterberg limits and linear shrinkage testing undertaken by others indicates the residual silty clay a shrink swell index range of between 3.5% and 4.2%. The use of this material in the upper 1.5m would be expected to produce a site classification of Class H1 or even higher.

Subgrades beneath proposed pavements are likely to comprise of residual silty clay. Previous test results supplied by the client indicate these materials are likely to produce subgrades with four day soaked CBR values of between 3.5 and 5.0%. Test pit BH19 produced a CBR result of 7.5%. This is considered an outlier result considering the homogenous nature of the residual soil encountered across the site.

Investigations will need to be undertaken at completion of the bulk earthworks to confirm subgrade conditions and resultant pavement thickness designs.

5.7 Material Disposal

Offsite material disposal is not known at this point. Previous investigations and reporting indicate that the majority of the site would be classed as either Virgin Excavated Natural Material (VENM), Excavated Natural Materials (ENM). If offsite disposal is required in should be treated as below.

Offsite disposal of soil will require a waste classification assessment in accordance with the NSW DECC (2009) Waste Classification Guidelines, Part 1: Classifying Waste. This will assess if the material classifies as Virgin Excavated Natural Material (VENM), Excavated Natural Materials (ENM), general solid waste or restricted solid waste and determine if the materials can be reused on another approved fill site,

disposed of site at a licensed landfill or if disposal at a facility licensed to accept restricted solid waste if required.

Excavated fill (non-virgin) and material excavated from contaminated areas must be classified using the procedures in Appendix 1 of the NSW DECC (2009) guidelines prior to offsite disposal.

6 SLOPE STABILITY

6.1 Risk Assessment

The risk of slope instability has been assessed using the principles and procedures of the Australian Geomechanics Society publication *Practice Note Guidelines for Landslide Risk Management, 2007*. This methodology represents the currently accepted state of practice for landslide risk assessment in Australia.

The slope risk assessment process involves identification of a potential slope failure event, or hazard, followed by an estimation of the likelihood of the event occurring, and the potential consequences should the event occur. The onus is on the property owner, potential owner, or other interested party to decide whether the assessed level of risk is acceptable taking into account likely economic consequences of the risk and the recommended geotechnical constraints.

The terms used in the risk assessment process are defined below:

Hazard: A condition with the potential for causing an undesirable consequence.

Likelihood: The estimated probability that the hazardous event will occur.

Consequence: Loss or damage resulting from a hazard event.

Risk: A term combining the likelihood and consequence of an event in terms of adverse effects to property or the environment.

6.2 Hazard Identification

The following potential slope stability hazards were assessed in relation to the site and the consequences to surrounding properties:

Hazard 1: Soil creep. Creep is an imperceptibly slow movement that takes place on sloping soil sites. It is an ongoing, natural slope process involving the progressive downslope movement of soils over the underlying rock profile.

Hazard 2: Failure within the natural slopes (rotational, translational or debris / earthflow).

Hazard 3: Rotational / translational failure within fill over the underlying natural soil profile.

Hazard 4: Rotational, wedge or toppling failure within unsupported excavations.

6.3 Risk Evaluation for Existing Site Conditions

Table 1 summarises the factors affecting slope stability in relation to each of the hazards identified and assesses the risk of slope instability for each using the risk assessment matrix provided in Appendix C of the Australian Geomechanics Society (AGS) publication *Practice Note Guidelines for Landslide Risk Management, 2007*.

A copy of the risk matrix from the AGS document is presented in Appendix C.

Table 1: Assessed risk of Slope Instability

Hazard	H1 Soil Creep	H2 Failure Within Natural Slope	H3 Instability in Fill	H4 Unsupported Excavations
Slope Height	N/A	Approx. 5m	Estimated up to 2m	Estimated up to 2m
Cause or Trigger	Ongoing process of imperceptibly slow soil movement	Leaking underground services, poor drainage, Extreme rain event (e.g. 1 in 100yr event)	Poorly constructed fill platforms. Surface water flows. Adverse weather (1 in 100yr event)	Unsupported excavations. Surface water flows. Adverse weather (1 in 10yr event)
Proportion of Slope Affected	1	0.1	0.1	0.1
Estimated Annual Probability	10^{-1}	10^{-4}	10^{-3}	10^{-2}
Likelihood	Almost Certain	Unlikely	Possible	Possible
Consequence	Insignificant	Minor to Medium	Medium	Minor to Medium
Risk	**Low**	**Low**	**Moderate**	**Moderate**

6.4 Evaluation of Risk Level

The assessment presented in Table 1 indicates that there is a **Low to Moderate** risk of slope instability within inappropriately constructed fill slopes (H3) and excavations (H4) respectively. The risk of instability for hazard H3 and H4 can be reduced to **Low** by adhering to the advice provided herein.

Providing the recommendations as detailed in the subsequent sections of this report are implemented, the risks associated with stope stability can be reduced to **Low**.

This risk rating would normally be considered acceptable in Australia for hillside residential construction.

A reassessment may be required once details of proposed earthworks are known.

The Australian Geomechanics Society published a series of documents providing guidelines for Landslide Risk Management in 2007. The documents included recommendations on Good Hillside Practice, a copy of which is included in the attachments. The proposed development should proceed in consideration of this documentation and the comments and recommendations provided in the following sections of this report.

7 SITE SUITABILITY

Based on the results of the assessment as outlined herein the site is considered suitable for the proposed residential and commercial development from a geotechnical perspective.

Further geotechnical assessment will be required for the purpose of specific earthworks, road pavement, and foundation design.

8 LIMITATIONS

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the document. The report should not be used by other parties or for purposes or projects other than those assumed and stated within the report, as it may not contain adequate or appropriate information for applications other than those assumed or advised at the time of its preparation. The contents of the report are for the sole use of the client and no responsibility or liability will be accepted to any third party. The report should not be reproduced either in part or in full, without the express permission of Regional Geotechnical Solutions Pty Ltd.

Geotechnical site investigation is based on data collection, judgment, experience, and opinion. By its nature, it is less exact than other engineering disciplines. The findings presented in this report and used as the basis for the recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

The recommended depth and properties of any soil, rock, groundwater, or other material referred to in this report is an engineering estimate based on the information available at the time of its writing. The estimate is influenced and limited by the fieldwork method and testing carried out in the site investigation, and other relevant information as has been made available. In cases where information has been provided to Regional Geotechnical Solutions for the purposes of preparing this report it has been assumed that the information is accurate and appropriate for such use. No responsibility is accepted by Regional Geotechnical Solutions for inaccuracies within any data supplied by others.

If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

Prepared by

Deni Rahman

Senior Engineering Geologist

Reviewed by

Adam Holzhauser

Principal Geotechnical Engineer

Appendix A

Village Brook Biosphere

Sustainable Community Supported Agriculture

SLOPE STABILITY ASSESSMENT

PROPOSED MANUFACTURED HOME ESTATE
LOCATION: LOT 42 DP 868366 & LOT 1 DP 957677 1055BRUXNER HIGHWAY
GOONELLABAH

NOVEMBER 2016

D.A. ATTACHMENT 13

PREPARED FOR AARIAN PTY LTD ATF

7th DECEMBER 2015 REFERENCE: 15/8039

NORTH COAST GEOMECHANICAL CONSULTANTS

CONSULTING ENGINEERS
K.N. CROCKER, Dip. C.E. MIE.Aust
CPEng. No. 86019
RPEQ No. 638
LGEQ No. 544

36 Maud Street
MAROOCHYDORE QLD 4558
Phone 07 5443 2988
Fax 07 5443 5157
Email: crockergroup1@bigpond.com

SLOPE STABILITY ASSESSMENT

PROPOSED MANUFACTURED HOME ESTATE

LOT.42 DP868366 & LOT.1 DP957677
1055 BRUXNER HIGHWAY
GOONELLABAH

FOR AARIAN PTY.LTD.

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1. INTRODUCTION:

At the request of Mr. R. Shelley of Aarian Pty. Ltd., North Coast Geomechanical Consultants have undertaken a Slope Stability Assessment on two parcels of land located at 1055 Bruxner Highway GOONELLABAH, approximately 7 kilometres east of Lismore. The land parcels are described as Lot. 42 DP868366 with an area of 28.29 hectares and Lot. 1 DP957677 with an area of 46.95 hectares. A Locality Plan is attached as ***APPENDIX A***.

2. PROJECT DETAILS:

The total area of the two lots is 75.24 hectares. Aarian Pty. Ltd. propose a lifestyle development over both lots consisting of a manufactured home estate. A proposed development layout plan is attached as ***APPENDIX B***.

3. DESKTOP STUDY:

The site is a former farm and grazing property with deep ferro soils characteristic of the area. Soils around the Lismore region resulted from volcanic activity some 20 to 30 million years ago. The extensive lava flows have left weathered Basalt rock to decompose to produce the deep red ferro soils evident in the area. A detailed and level survey of the site is attached as ***APPENDIX C***.
Photographs are attached as ***APPENDIX D***, a Slope Analysis Layout Plan attached as ***APPENDIX E*** and an Earthworks Plan as ***APPENDIX F***. From the above information it can be expected road gradients will range up to 16% with the slope analysis showing areas on allotments up to 20%.

4. SITE INSPECTION:

An inspection of the site was carried out on Wednesday 25th November 2015 and photographs were taken. The site inspection confirmed the presence of red soils and weathered basalt and the general topography recorded in the detail and level survey. During the inspection, it was noted the adjoining land to the west bounded by Oliver Avenue, Callune Terrace and Kallee Place had been successfully developed despite gradients and slopes greater than this subject property. The site is undulating & generally well drained. It is cleared grassland containing scattered trees. Previous farming has impacted the native flora. No erosion or land instability was evident.

5. SUB-SURFACE INVESTIGATION:

On Thursday 22nd October 2015 a total of 33 test pits ranging up to 4.0 metres depth were excavated across the property using a 12 tonne excavator and the locations are shown on ***APPENDIX G***. Logs of the test pits were recorded and are attached as ***APPENDIX H***. The general profile was found to be moist, stiff red, medium to high plasticity silty clays underlain by rock at depths ranging from 2.0 metres and upwards. No groundwater was observed in any of the test pits.

A shallow layer of fill was evident in the topsoils shown in borehole 26.

Soil samples were taken and tested in the NATA Laboratory of South East Soil Testing. Plasticity and shrinkage tests indicate the red silty clays to be moderately to highly reactive to soil moisture variations. The test results are attached as ***APPENDIX I***. Future site classifications are likely to reflect this.

6. STABILITY ASSESSMENT:

Zones of Slope Instability likelihood can be assigned on the basis of slope angle as follows:-

Barely Credible: Gently sloping to flat lying areas with slope angles of less than 7˚. This does not include the potential for localised instability on drainage ditches, fill stockpiles or other man-made features.

Rare: Gently sloping areas and the crests and upper slopes of ridge and spurs with angles of greater than 7˚ to 12˚.

Unlikely: Areas with slope angles of greater than 12˚ to 18˚.

Possible: Areas with slope angles of greater than 18˚ to 25˚.

Likely: Very steep slopes in residual and colluvial soils with slope angles generally steeper than 25˚

It should be appreciated that the likelihood of slope instability is not defined by slope angle alone and hazard zoning needs to be also taken into account many other parameters including drainage, observations on site and site geology as understood from subsurface investigations.

Preliminary development constraints below may be considered typical for a site of this type and may be considered for preliminary concept planning purposes.

PROPOSED DEVELOPMENT CONSTRAINTS ON SLOPING LAND
Residential Structures

Barely Credible (<7°)	• No specific constraints other than good engineering & construction practice. • May be settlement issues if areas of uncontrolled fill are present.
Rare (7°-12°)	• Minimise earthworks. Maximum unsupported cut depths & fill thickness of 2 metres battered no steeper than 1V:2H are recommended unless subject to site specific engineering investigation & design. • Steeper & deeper unsupported cuts/fills should be supported with engineered retaining walls. • Pre-strip the vegetation & topsoil prior to placement of any filling, & bench engineering fill into the natural slope & compact to standards appropriate to its purpose. • Provide appropriate surface & sub-surface drains, & direct water collected by these drainage systems, together with run-off from gutters, downpipes, driveways & paved areas, into the stormwater reticulation system.
Unlikely (12°-18°)	For residential buildings constructed on the natural slopes & founded in residual soils, it is recommended that the type of building generally be restricted to lightweight slope-sensitive structures of timber or similar construction to limit surcharge loadings on the slopes. Depending on the results of an appropriate, site-specific geotechnical assessment, the constraints on development are expected to typically include: • Avoid development near locally over-steepened areas or gullies. • Pre-strip vegetation/topsoil prior to placement of any fill, bench engineered fill into the natural slope & compact to standards appropriate to its purpose. • Locate footings on weathered rock where practical or in engineered fill. • Found engineered retaining walls in rock where practicable, & designed to resist applied soil & water forces, allowing for the sloping ground & any surcharge loadings. • Minimise bulk earthworks. Maximum unsupported cut depths & fill thicknesses of 1 metre & batters no steeper than 1V:2H are recommended unless subject to site-specific engineering investigation & design. Steeper & deeper cuts/fills supported with engineered retaining walls. • Provide appropriate surface & sub-surface drains, & direct water collected by these drainage systems, together with run-off from gutters, downpipes, driveways & paved areas, into the stormwater reticulation system.

	• Pay particular attention to drainage & erosion control measures during site development. Areas where surface groundwater seepage currently exists or becomes apparent during or immediately after periods of heavy rainfall may require sub-soil drains. • Assess the potential effects on slope stability if septic systems are to be used for the development & make recommendations accordingly.
Possible (18˚-25˚)	On this site, it is recommended that the residential development should not extend into areas of Possible instability unless sufficient, appropriate geotechnical studies are carried out to enable the area to be re-zoned as Unlikely or better. This may result in modification of the natural ground surface to achieve the same outcome. Residential allotments, houses & other structures should not be located within 10 metres of Possible or Likely zones of instability. Access roads have more potential for the design & construction of risk mitigation measures than other structures & may be permitted in areas of Possible instability provided sufficient, appropriate geotechnical studies are carried out to demonstrate that the road can be constructed with an acceptable risk level.
Likely (>25˚)	On this site, it is recommended that development areas should not extend into areas of Likely instability. In general, areas considered to be of Likely instability are considered unsuitable for development other than parkland. Houses & other structures should not be located within 15 metres of zones of Likely instability

In general it is recommended that all development on hillside areas should follow good hillside construction practice in accordance with the information sheets presented in ***APPENDIX J***. These were taken from the Australian Geomechanics Society "Practice Note Guidelines for Landslide Risk Management", Australian Geomechanics Vol 42 No.1 March 2007.

7. RISK ASSESSMENT:

"Risk" is defined in the Australian Geomechanics Society publications as a measure of the probability and severity of an adverse effect to health, property or environment. Risk is often estimated by the product of numerical probability and consequences. However, a more general interpretation involves a comparison of the probability and consequences in a non-product form. To carry out a full risk assessment of each individual site would require a full understanding of the type of structure proposed and the associated earthworks along with the likely consequences should failure occur.

It is our opinion based on Appendix C of Australian Geomechanics Society, "Practice Note Guidelines for Landslide Risk Management 2007" (***APPENDIX K***) that. If development is restricted to zones Barely Credible, Rare or Unlikely instability and the geotechnical development constraints presented, are strictly followed, the areas can be developed with a Low to Very Low risk of damage to property.

8. OUTCOMES OF THE RISK ASSESSMENT:

The assessed likelihood and consequences of the relevant hazards are presented in a table included in ***APPENDIX L*** . A summary of the assessed risks are shown below. The assessed risk assumes the recommendations presented in this report to facilitate construction of the works are adopted.

HAZARD	ASSESSED RISK AT EXISTING CONDITIONS	ASSESSED RISK WITH DESIGN RECOMMENDATIONS
Shallow failure in the fill soil in & below the footing zone of the structure.	High	Low to Very Low
Shallow failure in the footing zone of the structure in residual soil & weathered rock.	Moderate	Low to Very Low
Deep failure below the footing zone of future structures in the residual soils & weathered rock.	Low	Low
Failure of engineered retaining structures or cut/fill batters on the site.	High	Low
Slumping failure on the slopes adjacent to, or away from building envelopes.	Low	Low to Very Low

The risks assessed using these methods are generally ranges, and in some cases span two or more categories of risk. The range of values indicates the uncertainty in the data used to estimate the likelihood and consequences of events. Further investigation work may be required to reduce this uncertainty in areas of higher level risk.

9. BUILDING DESIGNS:

The following recommendations are made with respect to the design of structures on site.

a) Further assessment of the footing system should be undertaken prior to the construction approval stage when specific details of the final proposed design is known.

b) On the steeper and more reactive sites, flexible service connections may be required to connect services.

c) All roof water drainage should be piped and collected into on-site storage tanks with overflows piped away from buildings, filled areas and wastewater disposal into the drainage system provided. Surface and driveway runoff shall discharge away from all structures. Drainage should be provided to minimise variations in moisture content in soils surrounding and below site and prevent concentrated run-off causing erosion.

During construction, measures will be required to prevent erosion, undercutting and over saturating soil areas that may lead to slope instability.

The basic principles of managing stormwater on any development site are:
- Control The Flow Volume; Control The Flow Path; Reduce Run Off Velocity.

Plants provide a means of retarding surface flow as well as acting as a natural filter. Where possible, natural vegetation should be left undisturbed. Establishing plaints in potential problem areas (steep slopes, gullies etc.) will also assist in reducing erosion.

d) Any site earthworks carried out must comply with A.S. 3789, "Guidelines on Earthworks for Commercial and Residential Development".

Cuts on slopes greater than 20% shall be retained using walls or other approved methods. Drainage should be provided behind any retaining walls. Batters shall be keyed into downhill slopes or held in place with designed and approved retaining walls designed by suitably qualified engineers with experience of this geological area.

e) The earth-fill wall of the stormwater holding dam D1 should be constructed under level one geotechnical supervision.

9. BUILDING DESIGNS (Cont.):

Well grassed diversion drains provided above exposed surfaces redirect water around erosion prone areas. These should be used in conjunction with level spreading devices to disperse fast moving, concentrated surface flows.

A level spreader typically consists of a coarse gravel filled trench running parallel to the natural surface contours. This redistributes surface water and allows concentrated flows to spread over a large area and decreasing the velocity.

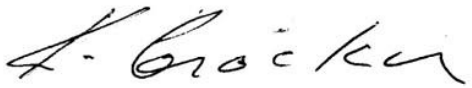
10. CONCLUSION:

Provide the recommendations in this report are followed the risk of landslip is low to very low and manageable by normal engineering and construction methods and the site can be considered suitable for the development proposed.

11. LIMITATIONS:

The assessment presented in this report is based on limited investigation consisting of visual assessment of the current site conditions and observations. Engineering judgement has been used to assess potential geotechnical conditions at the time of the investigations. The nature and extent of variations from the inferred conditions may not become evident until construction. If variations then appear evident, it may be necessary to re- evaluate the recommendations of this report.

The conclusions drawn in this report are applicable to the existing site, and manufactured home development proposed. The report must be reviewed and updated should any alternative usage be considered or additional earthworks undertaken which do not conform to the recommendation, as these may alter the assessed risks on the site.



K.N. CROCKER M.I.E. AUST. R.P.E.Q. NO. 638

APPENDIX A

LOCALITY PLAN


LOT 42
DP 868366
T 1
957677

APPENDIX B

AARIAN PTY LTO ATF

QT CONSULTING DESIGN

APPROVED

COTOATF AARJANPTY LTD

QT VINEYARD BROOK BIOSPHERE

1055 BRUXNER HIGHWAY, LISMORE, NSW

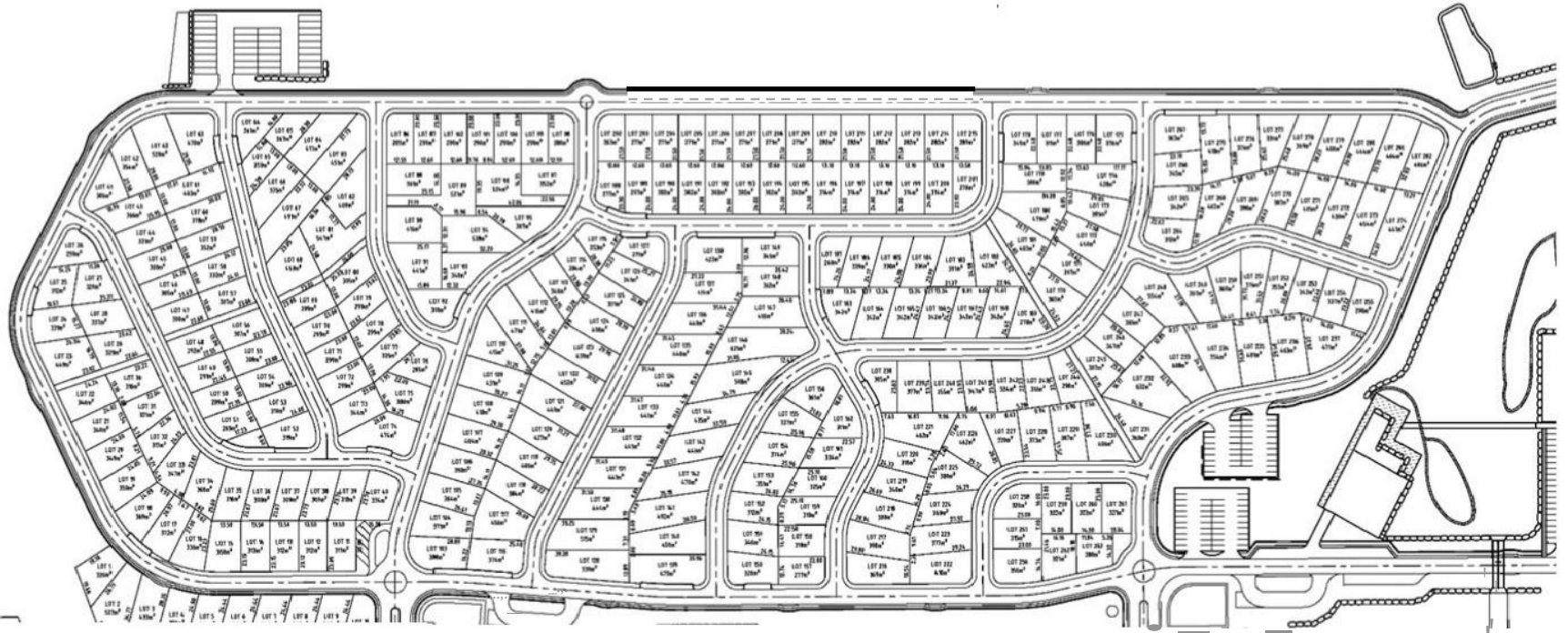
LOT 42 ON DP868366 AND LOT 1 ON DP957836

ESTATE PLAN

COLJ.NCa.WII.QJiCJ

ARRO0/15/C101 A

APPENDIX C



OL1VERAVENUE

W!..A
TOTAL LOTS: 282
AVERAGE ARfA: 363m'

HASTER LAYOUT P-LAN

1Ne tN11 Rltl

AARIAN PTY LTD ATF	QT CONSULTING DESIGN	APPROVED	OUEHT AARIANPTYLTDATF VILLAGE BROOK BIOSPHERE 1055BRUXNER HIGHWAY. LISMORE, NSW LOT 42 ON DP868366 AND LOT 1 ONDP9576n MASTERLAYOUTPLAN
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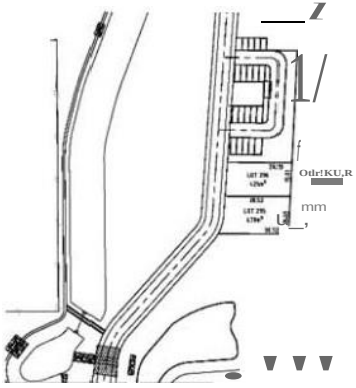

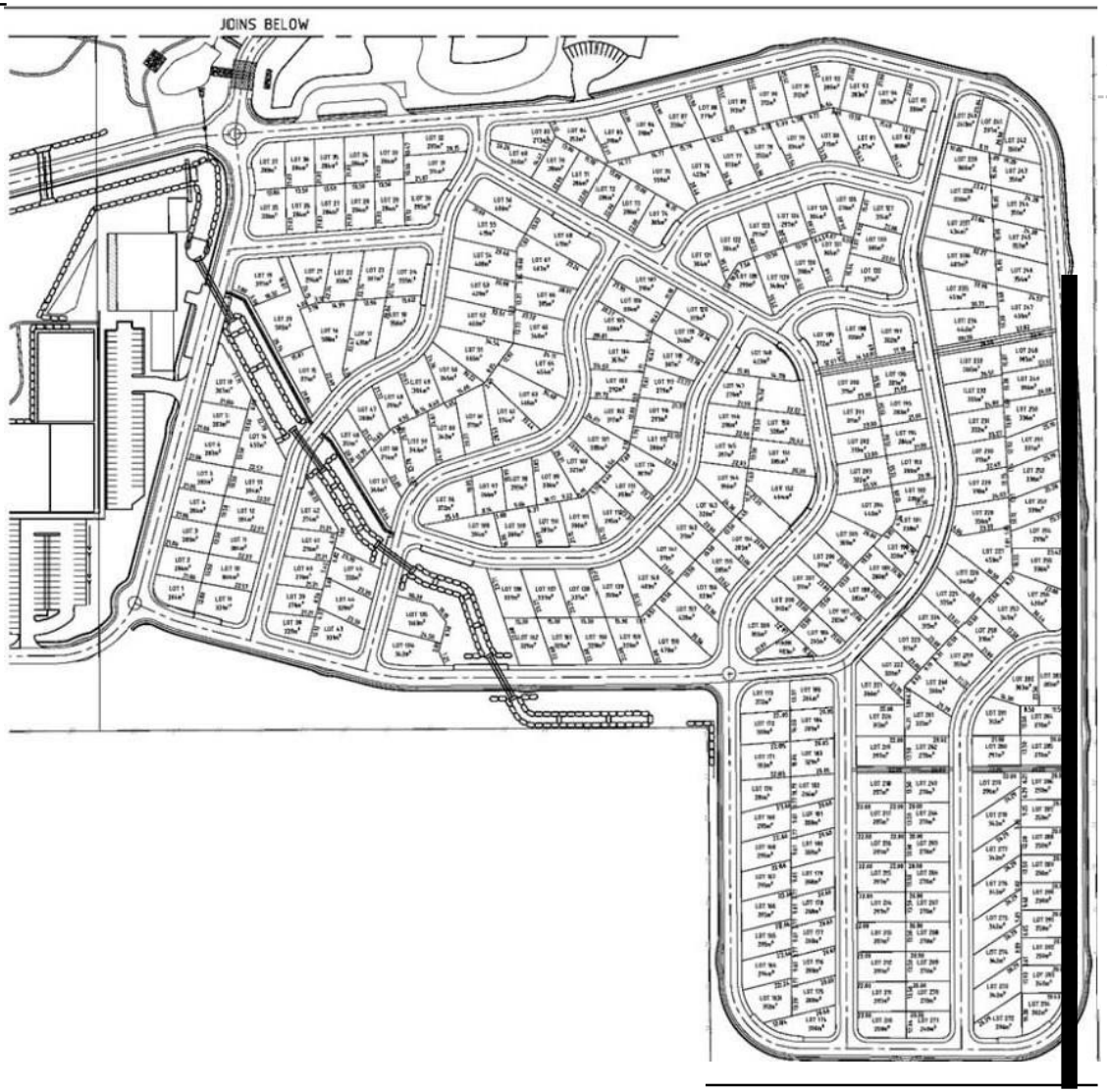

eARil

TOTAL LOTS. 296

AVERAGE AREA: 121m'

MASTER LAXOYI PLAN

APPROVED AARIAN PTY LTD ATF

e-r VILLAGE BROOK BIOSPHERE

tM5 ARIJXNER HIGHWAY. LISMORE, NSW

LO11, '42 ON DP868366 AND LOT 1 ON DP9S7677

AARIAN PTY LTDATF

CONSULTING @ DESIGN

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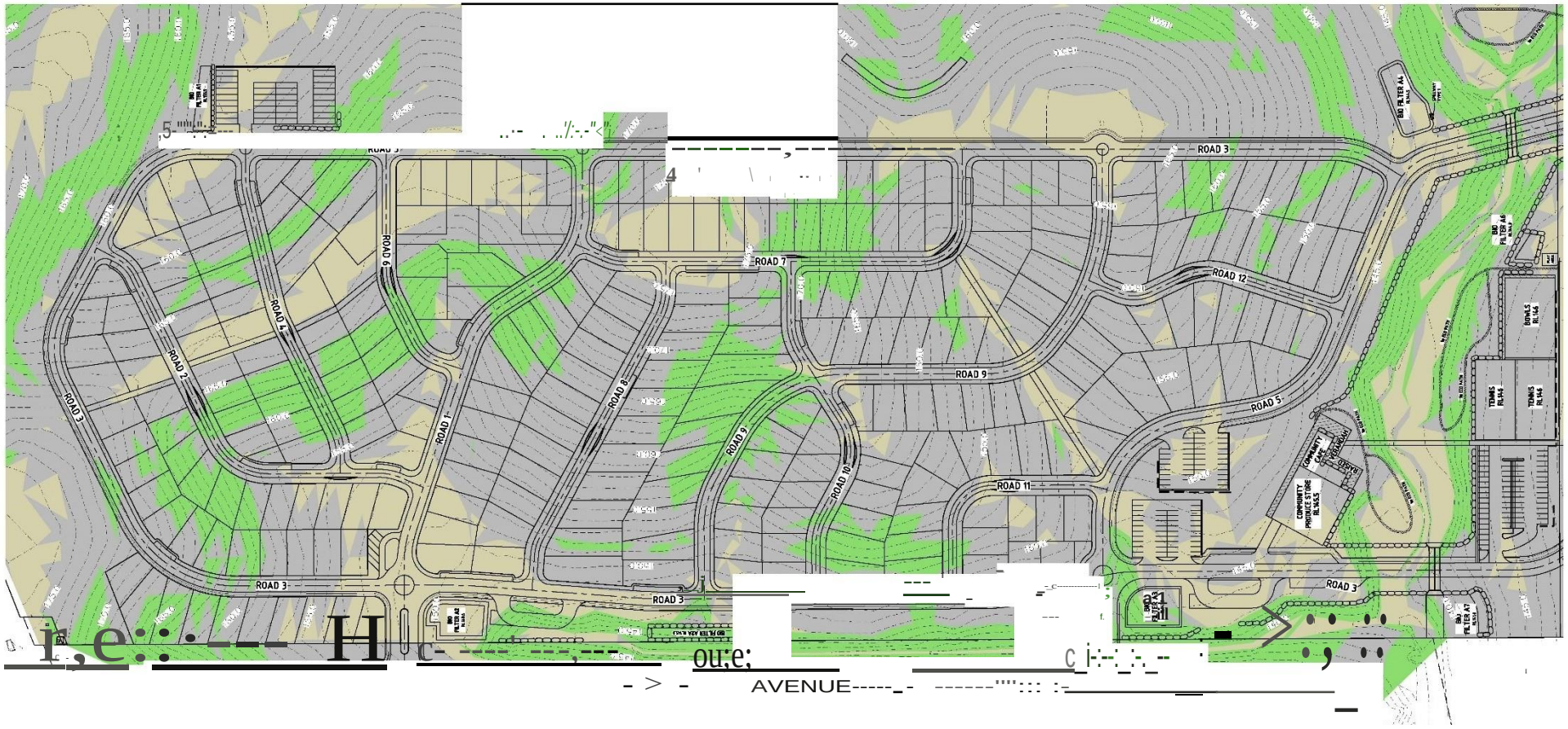
APPENDIX D

Regatta Estate, construction on areas of natural slopes and gradients in excess of subject property.

Lot 42 view south

Lot 1 view east and south

APPENDIX E



SLOPE ANALYSIS LAYOUT PLAN

SCALE 10 0 10 20 30 40 50 (metres)
1 : 1000 AT A1

SLOPES ANALYSIS	
0% - 10%	
10% - 20%	
20+	

SURVEY DATA• IAND SURVEYING DYNAMICS FILE 12213-0TM

AARIAN PTY LTD ATF

QT CONSULTING DESIGN

Designr
Date:
Checked

APPROVED
DATE:

CLIENT: AARIAN PTY LTD ATF
PROJECT VILLAGE BROOK BIOSPHERE
AT: 1055 BRUXNER HIGHWAY, LISMORE, NSW
LOT 42 ON DP868366 AND LOT 1 ON DP957677
TITLE: SLOPE ANALYSIS LAYOUT PLAN

COUNCIL REFERENCE

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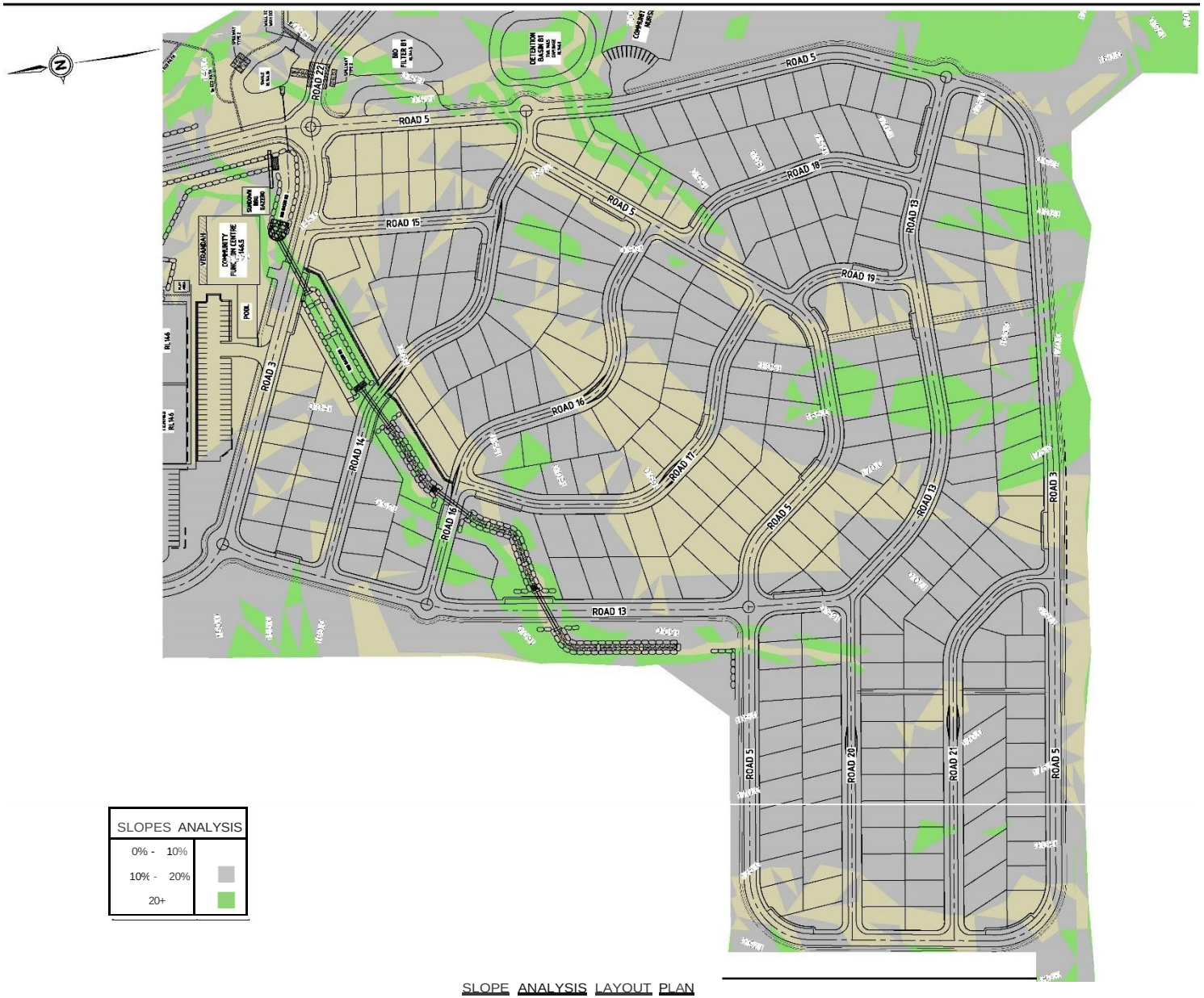

SLOPES ANALYSIS	
0% - 10%	
10% - 20%	
20+	

SLOPE ANALYSIS LAYOUT PLAN

SCALE ,.O.._O..._10__20___30__10

(metres)

1: 1000 AT A1

SURVEY DATA- LAND SURVEYING DYNAMICS FILE 12213-0IM

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FULL SIZE A1

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PROJECT VILLAGE BROOK BIOSPHERE

AT 1655 BROXNER HIGHWAY, LISMORE, NSW

TITLE SLOPE ANALYSIS LAYOUT PLAN

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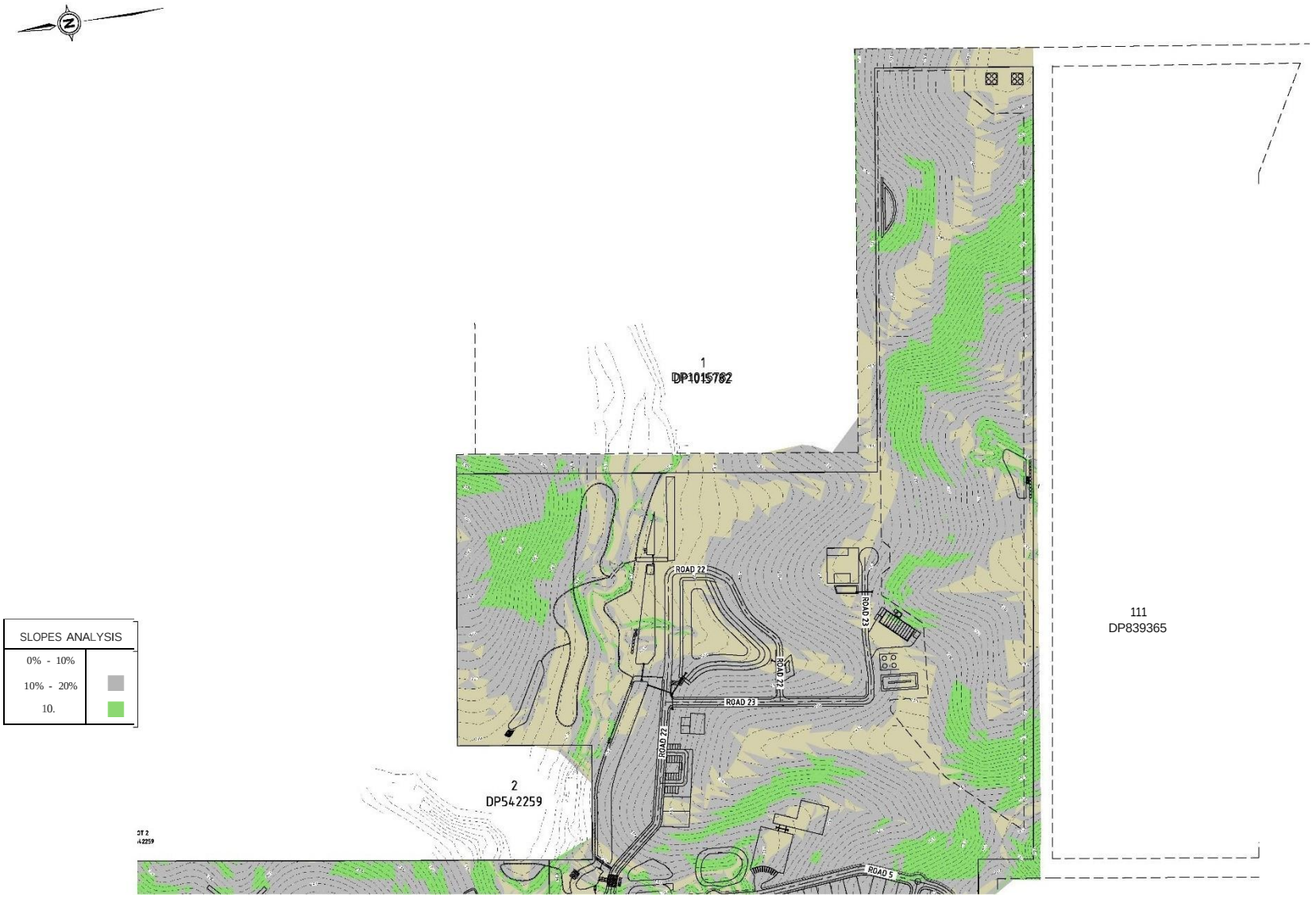

SLOPE ANALYSIS LAYOUT PLAN

SCALE _____ (metres)

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QT CONSULTING DESIGN

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CLIENT· AARIAN PTY LTD ATF

PROJECT VILLAGE BROOK BIOSPHERE

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TITLE: SLOPE ANALYSIS LAYOUT PLAN

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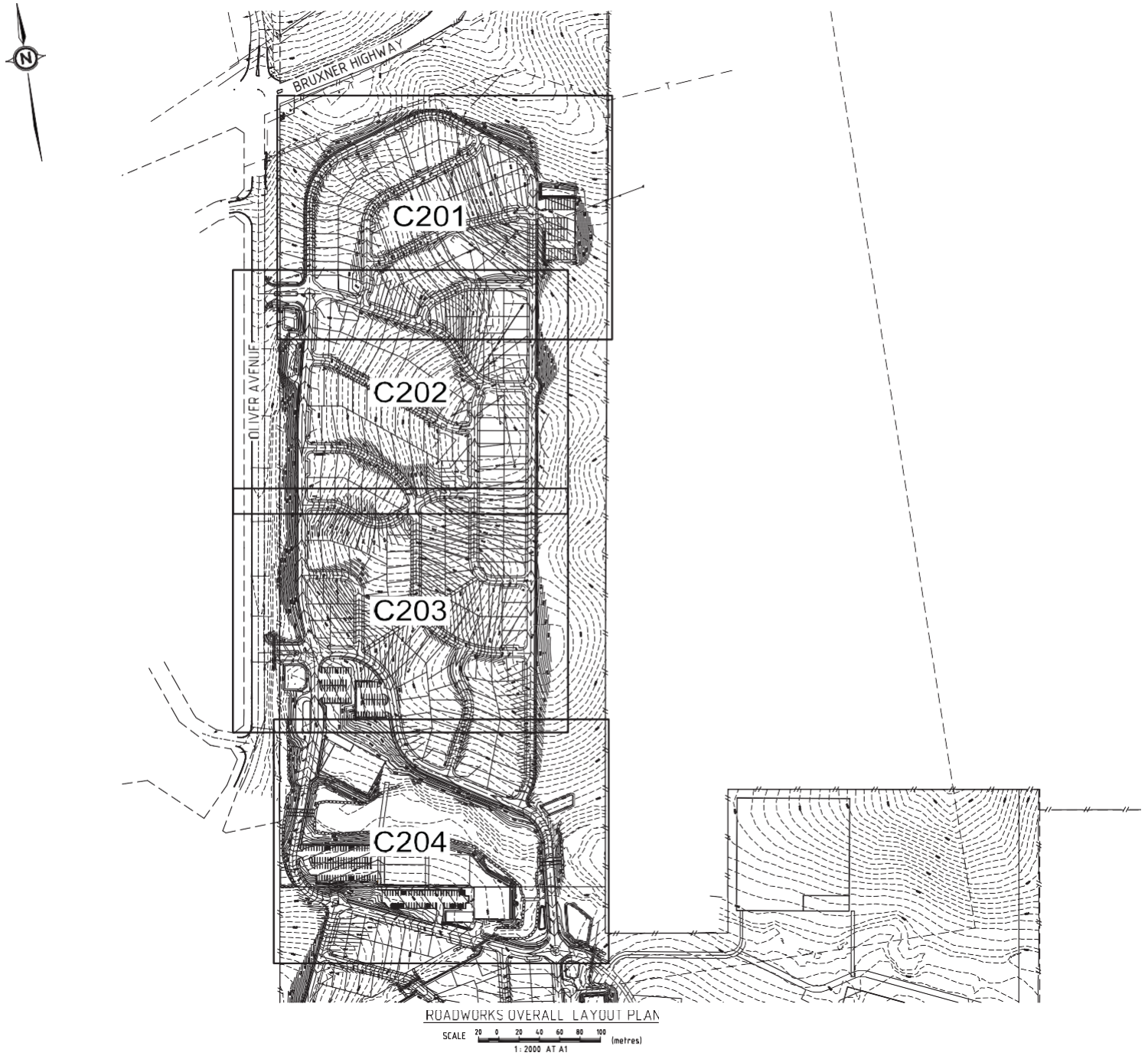
APPENDIX F



EARTHWORKS VOLUME
(SURFACE TO SURFACE ESTIMATE. NO ALLOWANCE FOR TOPSOIL, COMPACTION, PAVEMENT THICKNESSES)
CUT 87,690m^3
FILL: 111,400m^3

ROADWORKS OVERALL LAYOUT PLAN
SCALE 20 0 20 40 60 80 100 (metres)
1 : 2000 AT A1

AARIAN PTY LTD ATF

FILENAME: ARROA-15-C200-A.dwg - DATE : 11/11/15 | XREF's: x-base; x-Titleblock A1; x-survey

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Checked:
Datum: A.H.D.

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DATE: .....
FULL SIZE A1

CLIENT: AARIAN PTY LTD ATF
PROJECT
AT: 1055 BRUXNER HIGHWAY, LISMORE, NSW
LOT 42 ON DP868366 AND LOT 1 ON DP957677
TITLE: EARTHWORK OVERALL LAYOUT PLAN

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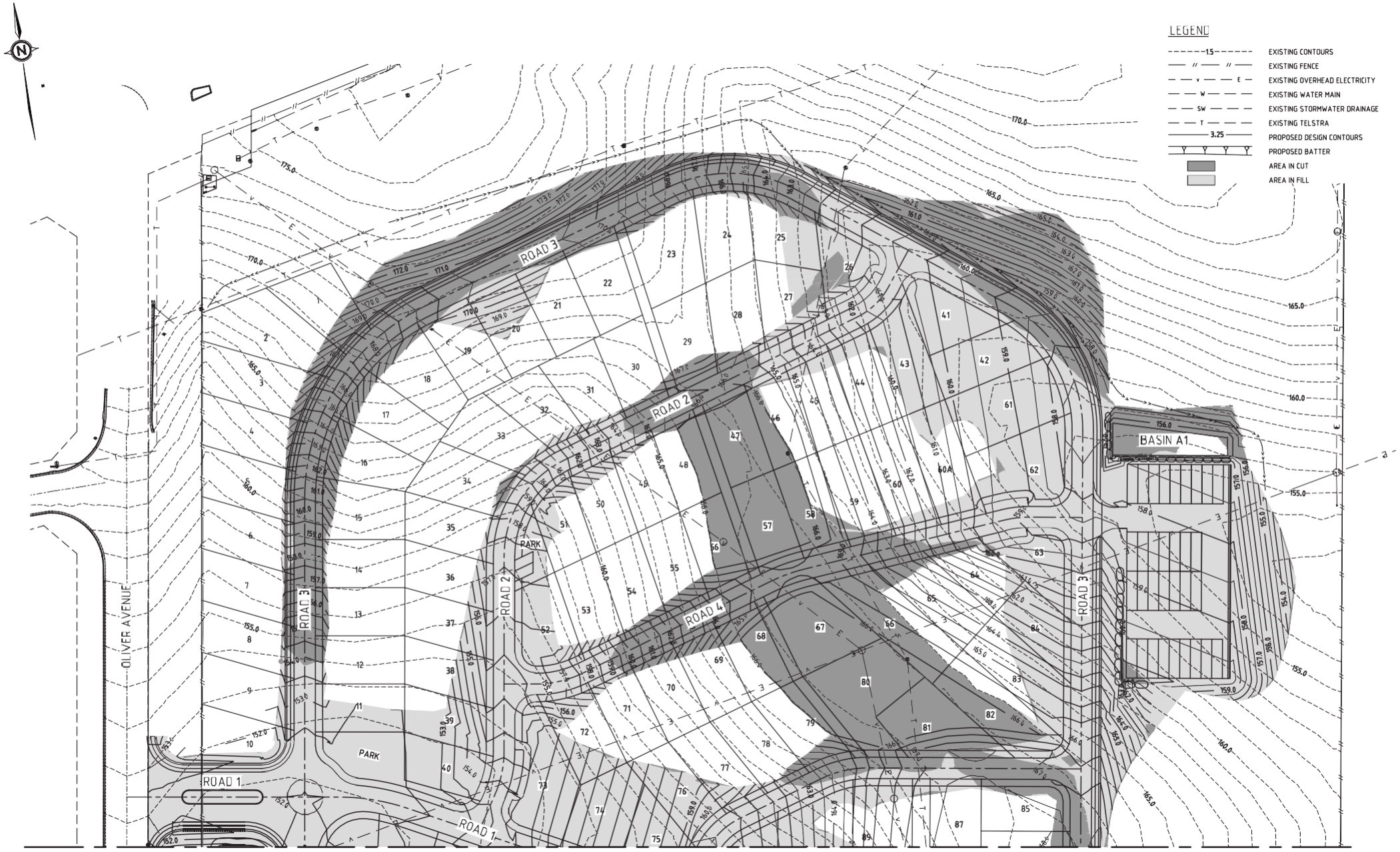

EARTHWORKS LAYOUT PLAN

SCALE 5 0 5 10 15 20 25 (metres)
1:500 AT A1

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LOT 42 ON DP868366 AND LOT 1 ON DP957677
TITLE: EARTHWORKS LAYOUT PLAN - SHEET 1 OF 4

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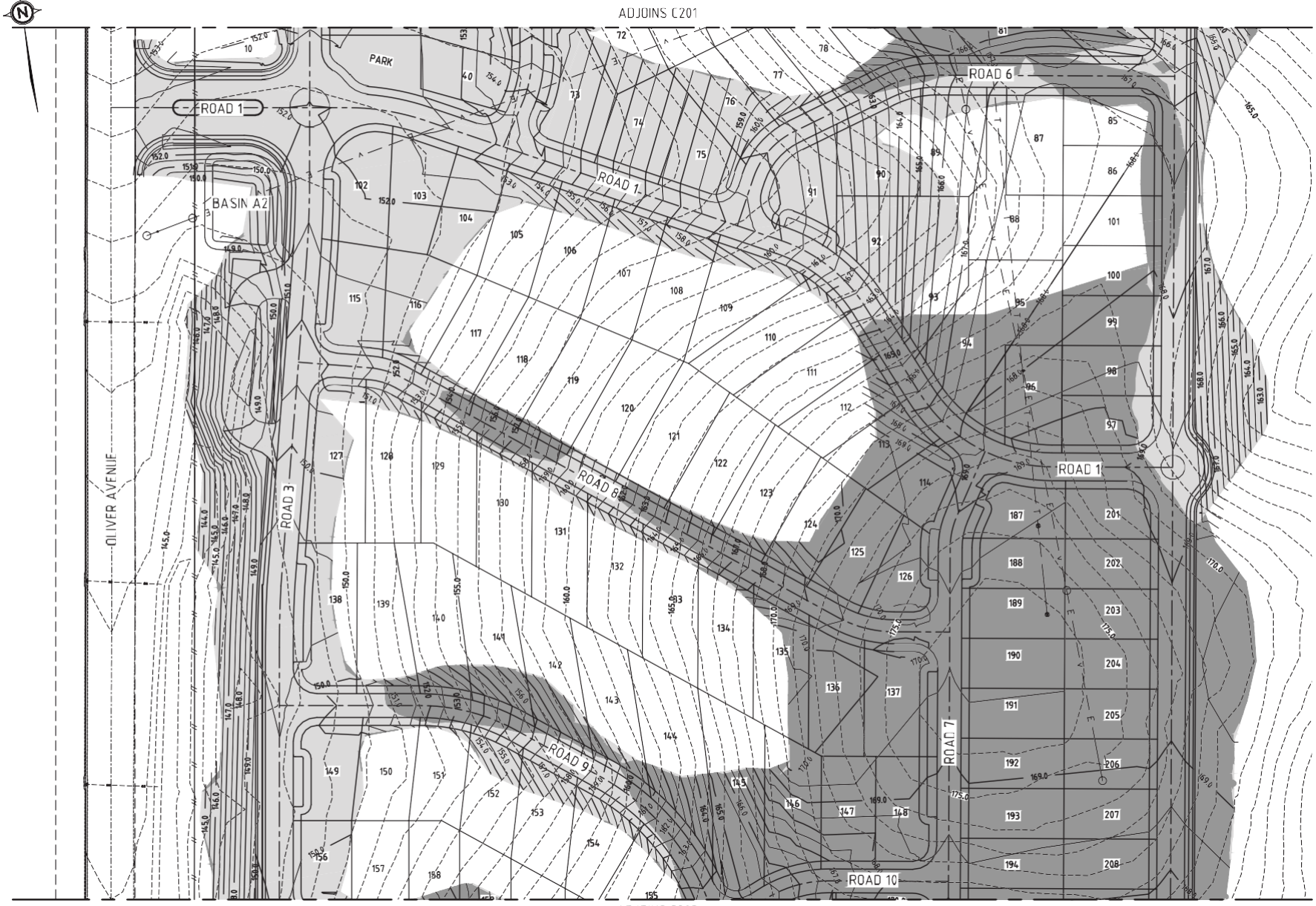

EARTHWORKS LAYOUT PLAN

SCALE 5 0 5 10 15 20 25 (metres)
1:500 AT A1

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Datum: A.H.D.

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DATE: .....
FULL SIZE A1

CLIENT: AARIAN PTY LTD ATF
PROJECT
AT: 1055 BRUXNER HIGHWAY, LISMORE, NSW
LOT 42 ON DP868366 AND LOT 1 ON DP957677
TITLE: EARTHWORKS LAYOUT PLAN - SHEET 2 OF 4

COUNCIL REFERENCE
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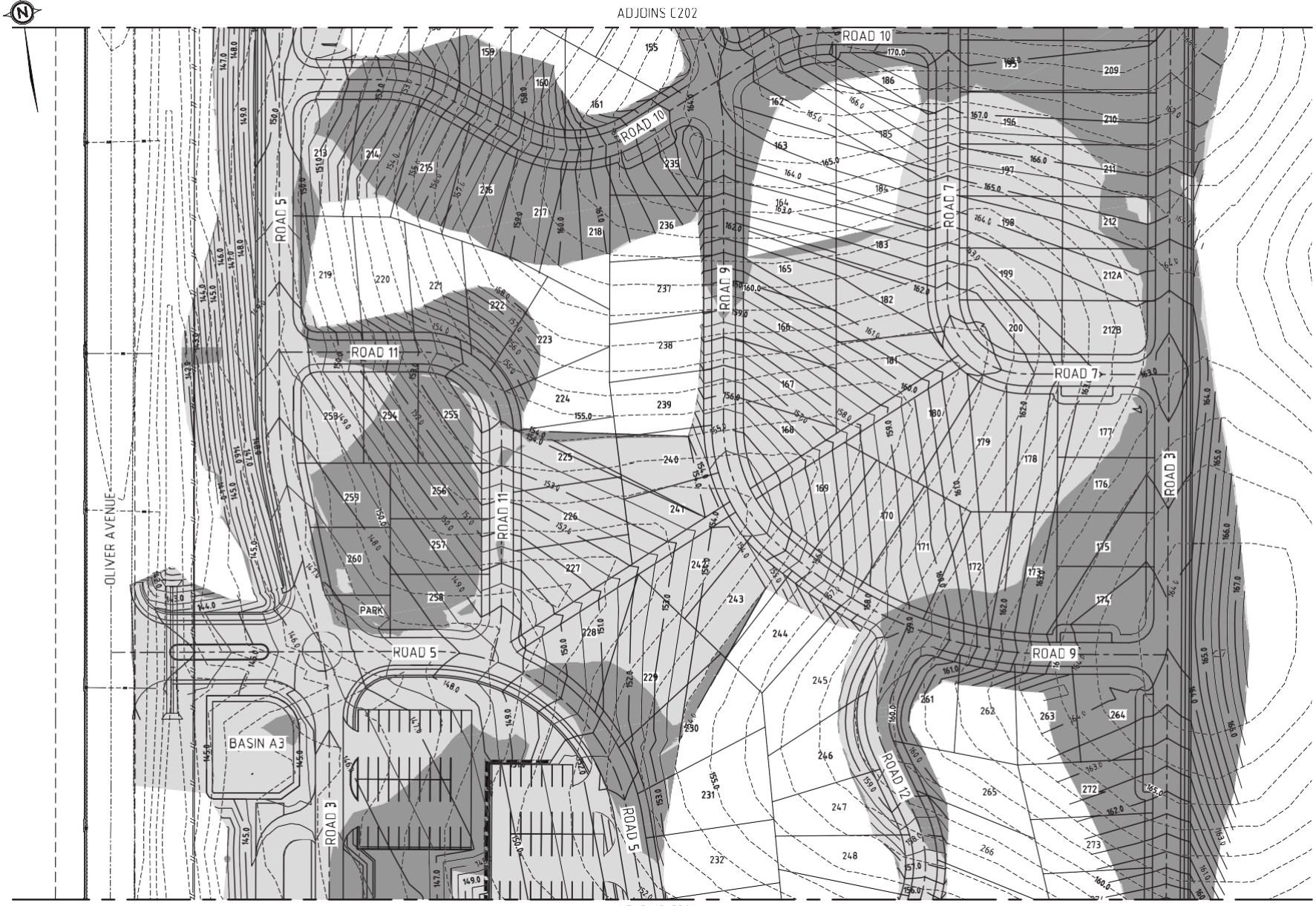

LEGEND

- EXISTING CONTOURS
- EXISTING FENCE
- EXISTING OVERHEAD ELECTRICITY
- EXISTING WATER MAIN
- EXISTING STORMWATER DRAINAGE
- EXISTING TELSTRA
- PROPOSED DESIGN CONTOURS
- PROPOSED BATTER
- AREA IN CUT
- AREA IN FILL

EARTHWORKS LAYOUT PLAN

5 0 5 10 15 20 25 (metres)

1 : 500 AT A1

AARIAN PTY LTD ATF

FILENAME: ARROA-15-C201-204-A.dwg - DATE : 11/11/15 | XREF's: x-base; x-Titleblock A1; x-survey

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DATE: .....

FULL SIZE A1

CLIENT: AARIAN PTY LTD ATF

PROJECT

AT: 1055 BRUXNER HIGHWAY, LISMORE, NSW
LOT 42 ON DP868366 AND LOT 1 ON DP957677

TITLE: EARTHWORKS LAYOUT PLAN - SHEET 3 OF 4

COUNCIL REFERENCE
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EARTHW'OlllKS LAYOUT PLAN

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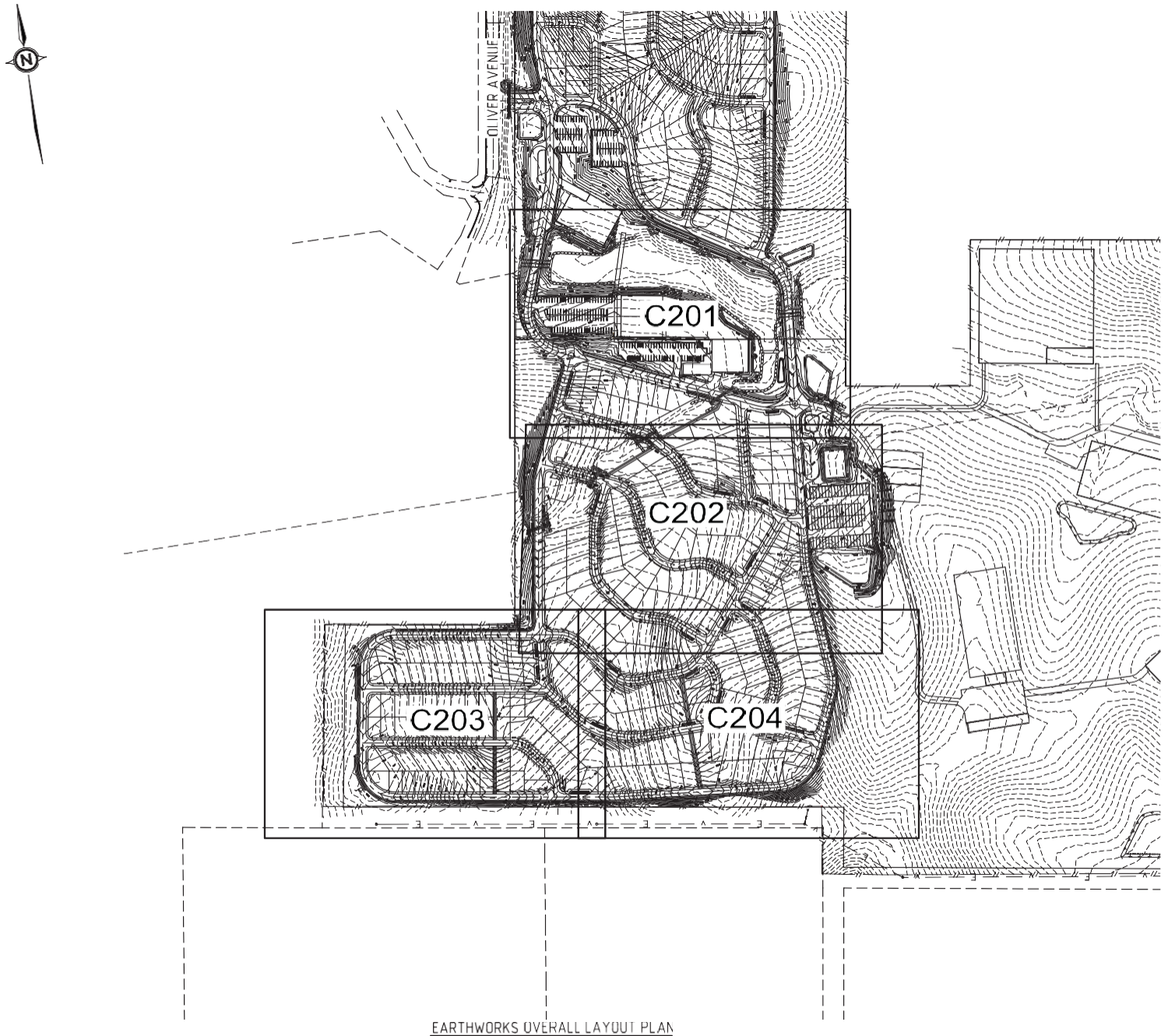
AARIAN PTY LTD ATF This plan is copyright protected	QT CONSULTING DESIGN MEMBER OF THE INSTITUTE OF MUNICIPAL ENGINEERING	No / Date	ORIGINAL ISSUE	Design: Drawn: Date: Checked:	APPROVED FUU..SCZE A1	"-'<HT AARIAN PTY LTD ATIF •OOJOCr VILLAGE BROOK BIOSPHERE •'" 1055BRUXNER HIGHWAY, LISMORE. NSW LOT 42ON OP868366 ANO LOT 1 *ON* DP9576n TITILE. EARTMWORKS I.AY·OUT *PI.AN* - SHEET 4 OF 4	QOUNCIIIREFIRENC[DRAWING NO: REV: ARROAl151C204 A



EARTHWORKS VOLUME

(SURFACE TO SURFACE ESTIMATE. NO ALLOWANCE FOR TOPSOIL, COMPACTION, PAVEMENT THICKNESSES)

CUT: 40,410m^3

FILL: 45,840m^3

EARTHWORKS OVERALL LAYOUT PLAN

SCALE 20 0 20 40 60 80 100 (metres)

1 : 2000 AT A1

AARIAN PTY LTD ATF

FILENAME: ARROB-15-C200-A.dwg - DATE : 11/11/15 | XREF's: x-base; x-Titleblock A1; x-survey

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DATE: .....

FULL SIZE A1

CLIENT: AARIAN PTY LTD ATF

PROJECT

AT: 1055 BRUXNER HIGHWAY, LISMORE, NSW
LOT 42 ON DP868366 AND LOT 1 ON DP957677

TITLE: EARTHWORKS OVERALL LAYOUT PLAN

COUNCIL REFERENCE
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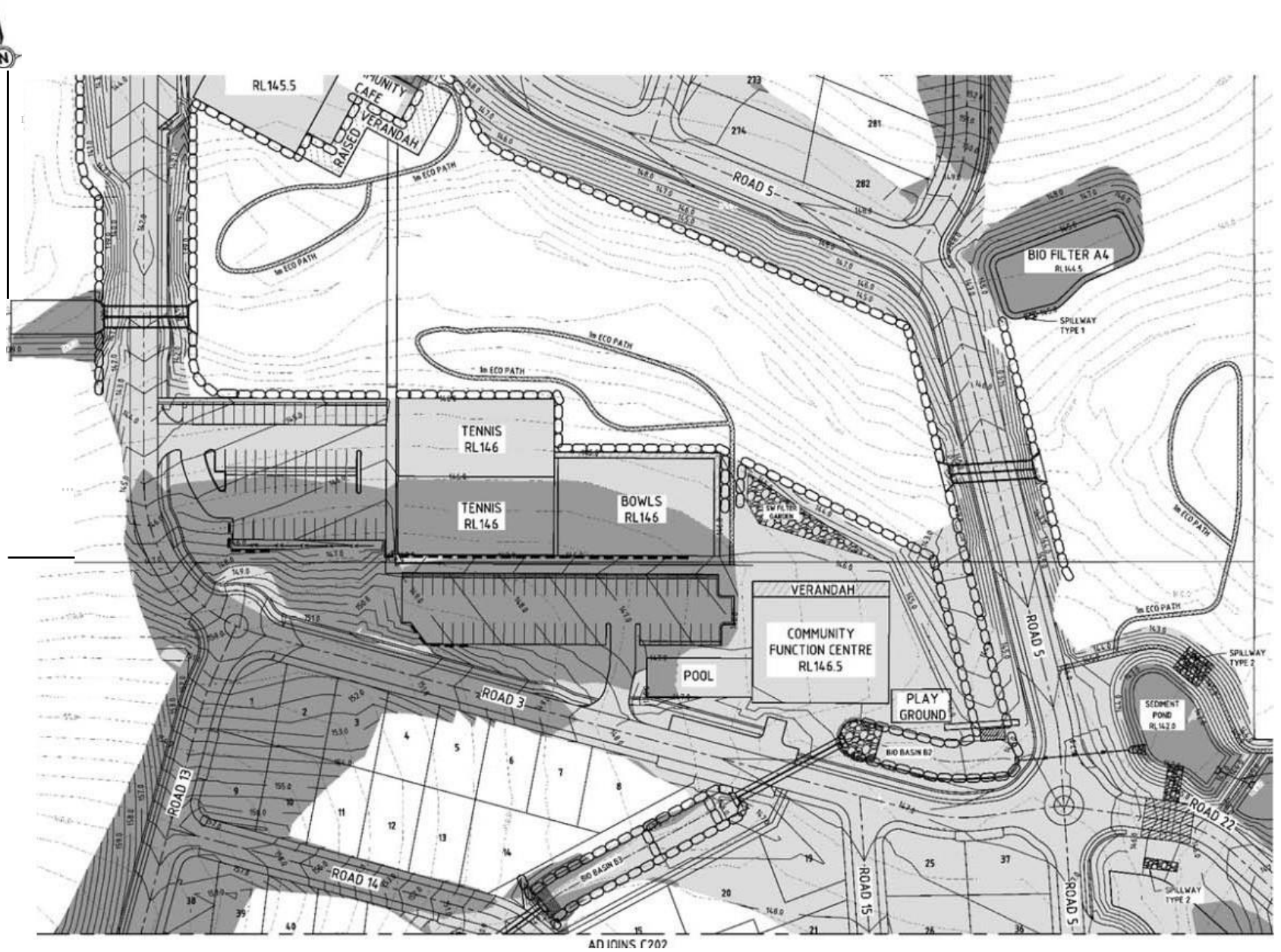

EARTHWORKS LAYOUT PLAN

SCALE 1:500 AT A1 (metres)

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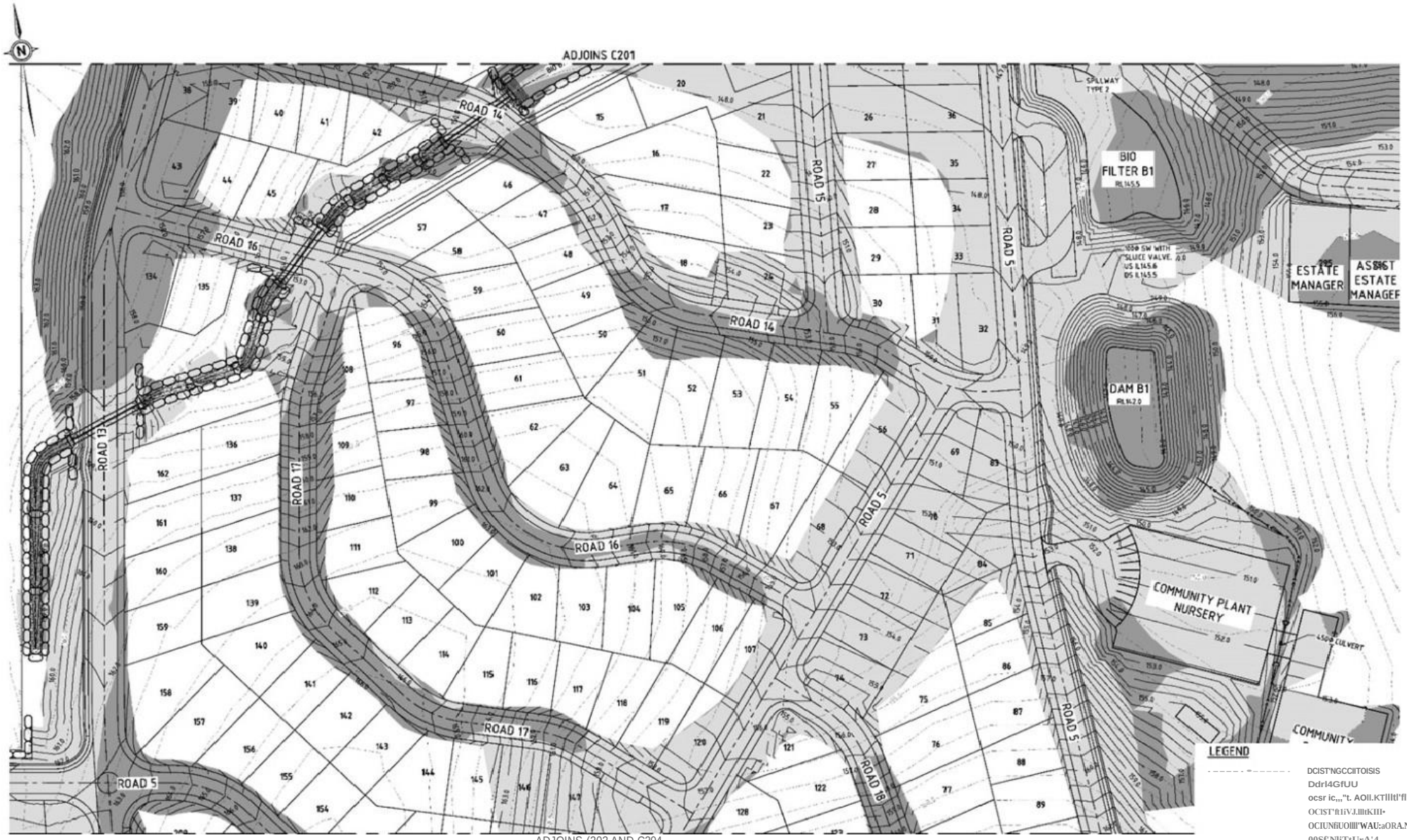

EARTHWORKS LAYOUT PLAN

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					VILLAGE BROOK BIOSPHERE	
					1055BRUXNER.HIGHWAY, LISMORE, NSW LOT 42 ON DP&68566 AND LOT 1 ONOP957677	DRAWING No: REV
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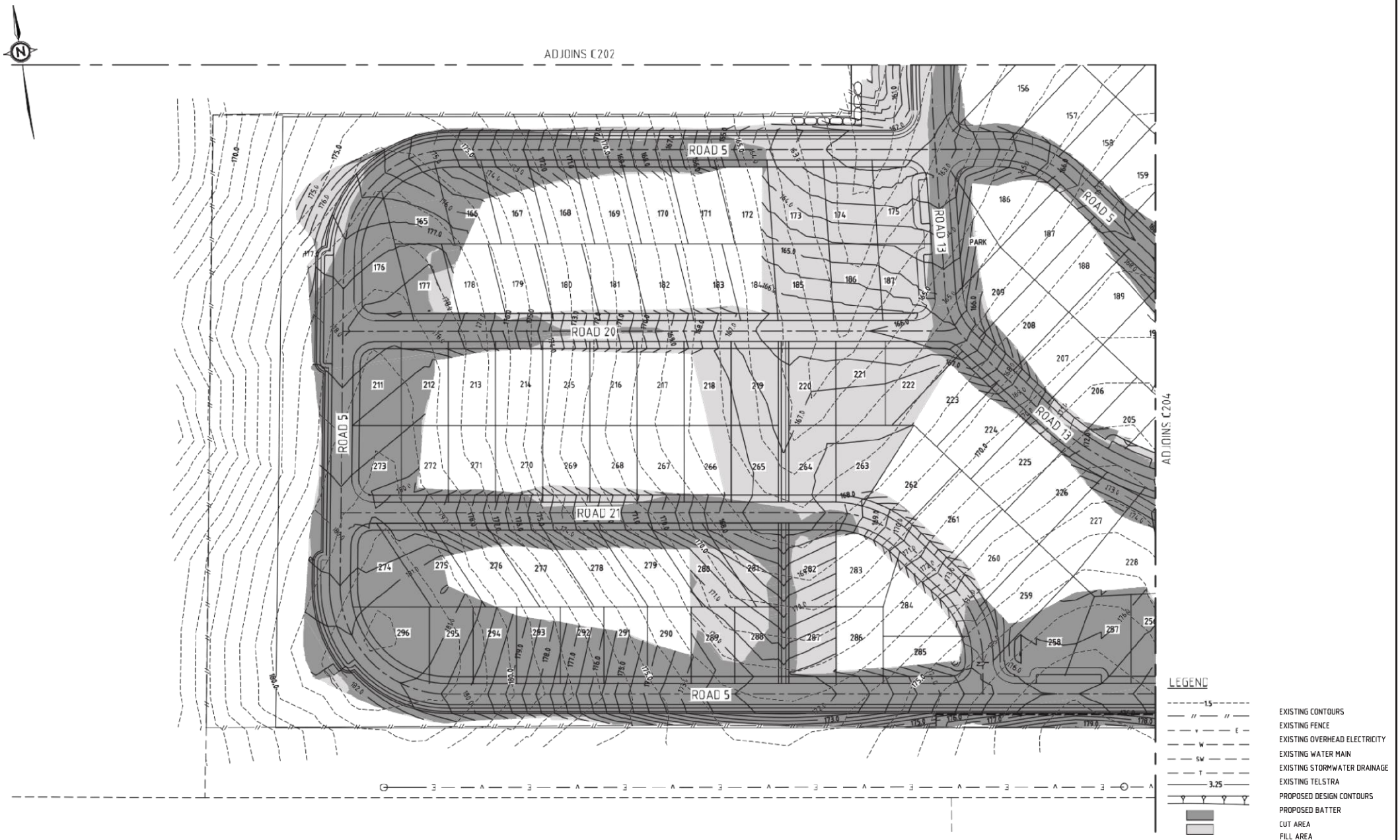

EARTHWORKS LAYOUT PLAN

SCALE 5 0 5 10 15 20 25 (metres)
1:500 AT A1

AARIAN PTY LTD ATF

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Datum: A.H.D.

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DATE: .....

FULL SIZE A1

CLIENT: AARIAN PTY LTD ATF

PROJECT

AT: 1055 BRUXNER HIGHWAY, LISMORE, NSW
LOT 42 ON DP868366 AND LOT 1 ON DP957677

TITLE: EARTHWORKS LAYOUT PLAN - SHEET 3 OF 4

COUNCIL REFERENCE
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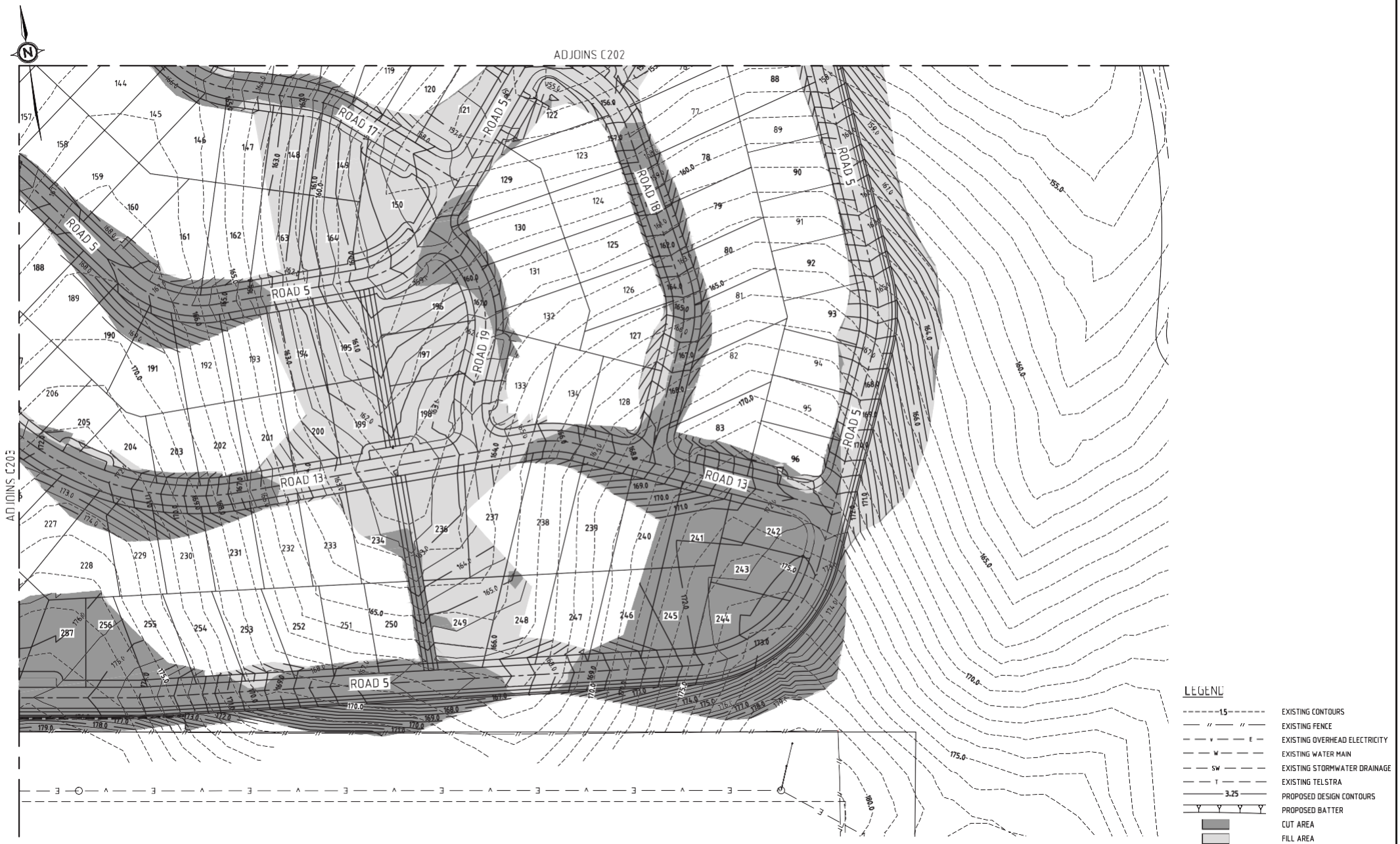

EARTHWORKS LAYOUT PLAN

SCALE 1:500 AT A1 (metres)

AARIAN PTY LTD ATF

FILENAME: ARROB-15-C201-204-A.dwg - DATE : 11/11/15 | XREF's: x-base; x-TitleblockA1; x-survey

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No	Date	Amendment
A	10-08	ORIGINAL ISSUE

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Datum: A.H.D.

APPROVED

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DATE: .....

FULL SIZE A1

CLIENT: AARIAN PTY LTD ATF

PROJECT

AT: 1055 BRUXNER HIGHWAY, LISMORE, NSW
LOT 42 ON DP868366 AND LOT 1 ON DP957677

TITLE: EARTHWORKS LAYOUT PLAN - SHEET 4 OF 4

COUNCIL REFERENCE
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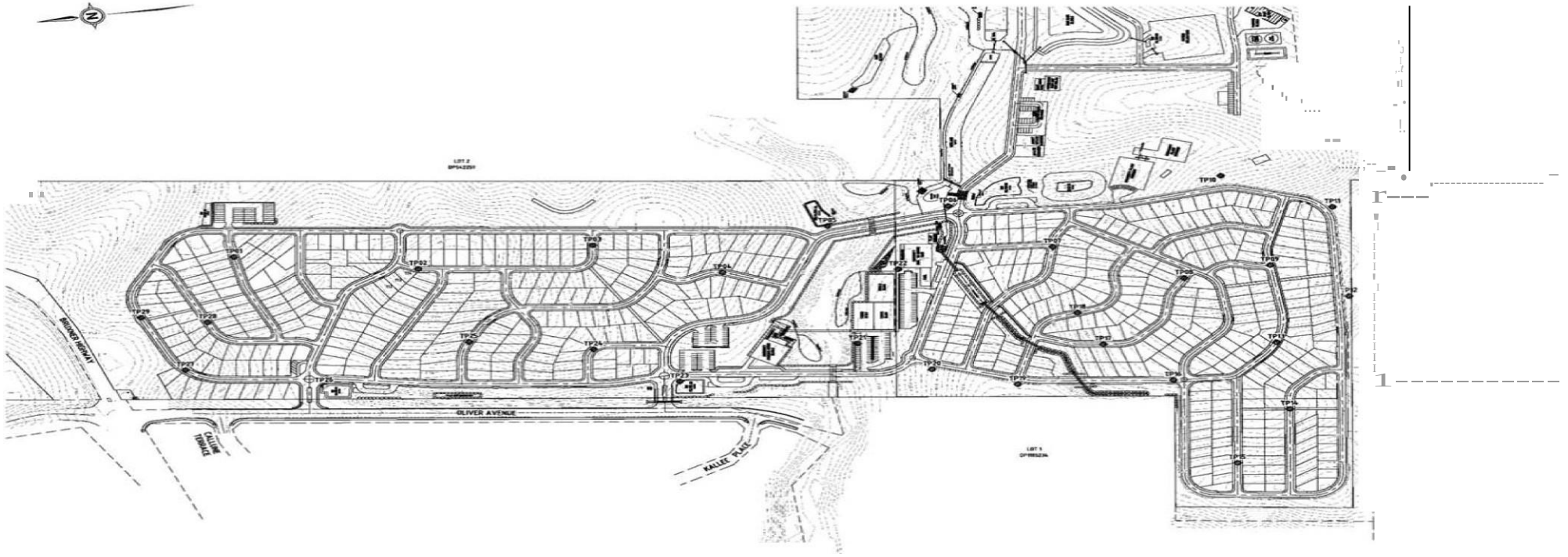
DRAWING No: ARROB\15\C204 REV: A

APPENDIX G



TEST PIT L A Y O UT PLAN

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					1055 BRUXNER HIGHWAY, LISMORE. NSW LOT 42 ON OP868366 ANO LOT 1 ON DP957677	
				A1	TEST PIT LAYOUT PLAN	ARR/15/C103 A

APPENDIX H

066 665 147 Pty Ltd T/A ABN 71 066 665 147

SES

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.ru0429674334 or AH 07 54 414228

l'.0. Box 1225. Nambour Qkl 4)60

For all Civil Tt$ting
Sen'icing South Ji.:astQ1,u.-cnS;land

Project: .1055 Hruxner Highw v
Goonellab2ith
Client: Aarian Ptv Ltd

Requested Ry:___;<,.>J"-N ----
l)atc Tested: 22-111-15
Report No.:_71..:4:;:4:._ ___ __

Drilling Method: 12 tonc excavator

Bore Hole No.:l

Com.mc11l

Oeptb Mm	l>escription
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Hole Tcnnioated

Pa_gc 1of 33
Mill l.anc Nambour

Form 4 March 2003

Authonsed :;1g,,:nory: C. Templeton
Uate: 16-11•15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOUTH RAST SOIL Tl::,S-UNG
PH 0429 674334 Or All 07 414128

1-'or all CMITesting
Servicing South East Queensland

Projec.t: 1055Bruxner lliahwav
c:oondlab-ah
Client: A;,arian Pt\' Ltd

R,-que,;lcd Hy:_( ) /N ----
Date Tested: 22-10-15
Report No.: 7 4 4

Drilling Method: 12 tone exca,,..ttor

Bore Hole No.:2

Depth Mm	UescriJ>tion	Comment
00	$illy CW\Y. bigfa plaslicily. red. moist Jinn to stiff(CH)	
1400	Sitt)•CLAY, hig,hplasticity, purplc/grc}'and *tcd* m o t t l e d O O'lc sand prc.c;cnt, moist, finn (CH)	
2200	Silly Cl.J\Y.high plasticity. purple with white moulfng,_somesand p scnt. moist. fum to stiff (CIJ)	
5000	Hole Tennin.ltcd	

l' e 2or}3
.MilJLane Nambour

Fo«m4 Match 2001

Authorised signa1ory: C. Templeton
Uate: 16 11•15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

SES

Y.0. t.wx. t22S. N:..i11100ur Qld'1560

SOUTH EAST SOIL TF.STINC
PH 04296743'34 or AU07 54 414:228

For allCivilTtsling
&rviciogSouth East Queensland

Project: 1055Bnn:ne.r Hi..,hwav Goonellnha.b

Client: Aarian Pt-v Ltd

Rcqu,.tcd lly:_("')f"'N._____

Date Te.o\tcd: 22-10-15

Report No.: 7"44"------

Dr-illing Method: 12 toneexcavator

Bore Hole No.:3

Depth Mm	Description	Comment
00	Silly<.:LAY. high plasticity. red. moisL ftnn to stiff(CH)	
150	SiltyCl.AY, hi h pl:'1.q_icity, l'<::d, moisi, firm (Cit)	
MOO	Silty CL/\ Y.highplaslicily. purple/grey and red mottled.somesand presenl. moist. finn tos.1iff(t:Jl)	
4000	llole Tmninated	

Autbo.Ucd :sigo.1tory·

C.·r-empltll)(l

16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOlJTH KAST SOIL TESTING
PH 0429 674334 or AH 07 54 414228

P.O. Box 122.'i, NamhoorQ)d,J:560

For all cn,il Tcstin_i
Servicing South F.a:;l Qut..-cnsl::tnd

Project: 1055Bruxner Highwav
<:oonclh1bah
Client A rian Ptv Ltd

Requ.,;ted By:..-'0,,/N""------ -
OateTested: 22-10-15
Report No.:_7 44 -----

Drilling Method: 12 tone excavator

Borc-.Jlofo No.:4

'Depth Mm	Ocscriptloo	Comment
00	Silly t:LAY, high pl city, red, moi t, firm to SJiff (Cl f)	
50	Silly CL/\Y. bi.gb plasaicity. reel, moist. finn (CH)	
1900	Silty Cl.AV, high r,lsr.ricity, *purple/grey* aiM,"l 111..,uled, wm,e s.1nd pn::: en1, 1nois1, firm1(i)ff{C:lt)	
00	Hole Tcm1inatcd	

P<tgc 4 of .,.,
Mill L.,nc Nambour

FQnn 4 Ma.rch 2003

Authoci ig.nsrory: C '0V.,...,C:S
C. Templeton
narc: 16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

P.O. Box 1225, NambourQkt4560

SOUTH EAST SOIL TF~ TING
PH 0429 (,74334 or AH 07 $4 414228

For 11111Ch·il Testing
ServicingSouth East Queensland

Proj, ct: 1055 Bruxner Hial,wav
G0-0nc Uah.ah
Clic:mt: Aarian Ph' J.td

Rcqu<,;tcd lJy:---'0"'/N"-'------ -
Date Tested: 22-10-15
Report No.:-'7"'44 ----

Drflling Method: J2 lont cx va1tor

Bore Hole No.:5

Depth l\fm	Description	Comment
00	Silly Cl.AY. highp cily. red. moisl firm to stiff'(CH)	
S.0	Silly CLAY. higJlpla!;ficit)\ red, moi.c:t, firm(CII)	
1900	SillyCLJ\Y.high pla:stfoily. purple/gre)'and mi moukd. some sand/gr.l\'el present moist. firm1os1iff(CTT)	
3000	Hot 'fenoiw.itt'don Kock	

P:igc 5 of :U
Mil11.:i..nc-Nambovr

Aulho,i,eu si::,,atory: C. ¥ "'
C. Templeton
L>ate: J6-l l•l5

Form 4 March 2001

06ri(16.i 147.-cyt.rd'I/A AHN 7HI(,<, (.t,\ 141 J'>.O. Rox 1225, Nambour Qld 4560

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S01.lfH EAST SOIL TFA<;TJN(;
PH 042 614334 or AH07 414228

ForallCh'ilTcstin::
Servicing S-Oulh Ea.11;t Queensland

Project: 10-55 Bruxner Highway
Goone-llabah
Client: Aaria.n Pty 1.td

Requested By:_(,,)/N=-------- -
Date Tested: 22-10-1S
Ro1>ort No.:_7:.;4:;:4,.___ _

Drilling Method: 12 tonecxeav:iltor

II-Ore Hole No.:6

Depth Mm	Description	Comment
0 0	.Silcy Cf.AY(ro il), hie)l rJa..(.;ticiry,htown, moi!i:t, fiml ttoitf(CH)	
300	Silty CLAY, medium to high plasticity. light brown.moist. finnlo sliff(<.:Jl}	
500	CLAY.high plaslic:ity. gi,:y wilb brown mottliny:. mo .:stiff(CJJ)	
4-000	Hole Terminated on decomposed Rock	

. I- C:-1-./ _
Page 6of n /\111|-ores , Slf;'IIU()ty: '-'
Mill Lime N:unbovr C. Templeton
Date: 16-11-15

F0tm4 March 2003

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOUTH "AST SOILTESTING
PH 04"29 6743.}4 or AH 07 54 414228

P.O. Box 1225, Namboor Qld 4560

for MU CivilTestiat
Servicing South East Queensland

Project: 1055Bruxncr Jjjuhwav GooneUabah

Client: Aarian 1•tv Ltd

Rcqucstc,1 By:-'0,,/N= ---
DateTested: 22-10-15
Report No.:_7:.;44:;,.._____

Drilling Method: 12 tone excavator

Bore. Hole No.:7

Depth Mm	Ocscriptioo	Cc,mmcnt
00	SiltyCl.AY(to il).hif'/1pla. .... ricity, brnwn/rcd, moi t, tinn to stitf{CH)	
50	Silly CL.AY. modium tohjgh plaslic.ity. redl'browo. moist Gnn to.stiff (CTI)	
100	Cl.I\V, high pl 1i¢ily, purple 3nd red m<>Uling, moist, Stiff(C:11)	
:1600	Ttole Tetmi1t<1ted-on de¢0'nposed Rock	

,c 7&3
MillLane Nambour

Authoris<dsig,,atory: C. ' °'\:;
<.:.Twtpl.:::wn
I.)ate: l6.11·15

Fom14 March2003

0(,(,M,$ lk? Pry(rdT/A AHN 71(){(,(,6(,,. 147 P.O. ll<>x 1225, l\'.:unhour ()Id 45-60

SOUTH EAST SOILTFA'iTTNG for all Ch•il TcstinJ,:
PH 0429614334 or AK 07 54 414228 Servicing S(luth Ea.'ol Queensland

Project: 1055Bruxner Highwa,• Goonellabah Requ.. ted By:,-'0"'1N"-' ---- -
Client: Aa.-iau Pty Ltd Date Tested: 22-I0-15
Report No.:_7:.;:4,a4c..... __

Drilling Method: 12 tone-.CXClh'l:tlOr Hore Hole No.:8

Depth Mrn	Description	Comment
0 0	Silt)' CLAY(topsoil),b.ig,h plasticity. b.rowtVned. rl'l◊ist. firm ti.i) ft·(Cll)	
250	Clayey GRAV L. comegrained,. rod, cobbles pres<.-nt, moist.dcnse(VP)	
1700	Hole Terminated on decomposed Rock	

P:ig.t S of 33
Mill1 1.o-e Namboor

Auth◊risedi::i2,1,:ir(W)t: C
Tcmpletoo
T>3rc: 1<>-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

P.O.!lox 1225. Nrunboor Qkl 4560

SOUTH EA!>'T SOIL TESTING
PH 04:29674334or AH 07 S4414228

For all CMITe,ting
Servicing South East Quecns1"nd

Pl-oject: 1055 Hruxncr lliuh.wa,·
Gooncllab::th
Clie-nt: Aarian Ph• Ltd

Requested By:-'0"'1N'-'-' -------
Date Tested: 22-10-15
Report No.:._7:..:44:::..

Drilling Method: 12 tone.excavator

8orc Hole No.:9

Depth Mm	Description	Comment
00	SiltyCl.AY(topMil), hi8)1 pl:tSli¢ity. bn>w1i/red, roomt. finulo s1iff (CU)	
100	SillyCLAY. high plasticity, rcdlbrown, moi$!:iff{CH)	
3700	Hole Tcmlinate<lofi d (,.m1pu1e(.I RQCk	

Authorised signato.y: C – —
<..Templet0l1
16-11-LS

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOUTH EASTSOIL TESTING
PH 0429 6i4334or AH07 54 4142!8

.P.O. Dox 1225, Nam rQJd•15(!0

F'or all CivilTt!>tiog
Scn·icing South Ea,:t Quccnshmd

.Projct-t: 1055Bn1xner Highway
\.oonellabah
Client: Aari::rn Ptv Ltd

Requested By:_,O"'/N,_,_ _
natcTested: 22-10-15
Report No.: 7 4 4

Drilling Method: 12 tone excavator

Bore lloh: No.:10

Depth Mm	Description	Comment
00	Silty Cl./1Y (h>psuil).high pl.1:stfoi1y. browufre<l.1ooisl. fmn le>stiff(Cln	
	SiltyCL.AY, high pla ticity, red, moiM,stiff(CH)	
1500	Silty CL.\Y. highplaslkily. grey wilh browo andn-d mottJing..moist stiff (CII)	
3800	Hole Terminated	

P11£,<: IOof 33
Mill ',MIC NamhC>IU'

AulhorisOOs.igri."ttory: C. Temple1M
16-11-15

Fo,m '1 March 2003

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOUTH EAST SOILTESTING

PH 0429 674334or AH 07 54 4142 28

P.O. Bo:,c 1225, Nambour Qld 4560

i:orall Civil Tcstin

Sen'lcingSouth t<:ast (.)uccn.sJand

Projcet: 1055 Bn1xner Hin-bwav Goonellabab

R«1ucstc,I By: O/N

DateTested:-'2"'2""-1'-:0-,-1"5:----

Client: Aarian l'tv Ltd

Report No.:._7,.,44,,,_____

Drilling Metbod: 12 tone excavator

Bore Hole No.:11

Depth Mm	Description	Comment
00	.Silcy Cl.AY(tc>psoi0. lugb pht:;tidly. brown/red. moist. finn to stiff(CH)	
150	Silly CLAY. highpla.c;ricity, red with*e1ey* tn◊llliug. moist :;liff (CJI)	
1100	SiltyC.1./\ V, hig.b pla.:sticity. purple\\ith brownand red mottling, moist,.s.titf{CH)	
1600	Cl . A Ɣ hie)l pl;mi.(;ity n-dlbrown. moist verystiff (CH)	
4000	Hole Te1rnin.i1.::d	

Authori.s.ignstol}':

C. TcmplctCln

l)azc: 16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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-P.O. R(,x 1225, N:l.lnbour Qld•1560

SOlJTII KAST SOIL TESTING
PR 0429674334or AU07544J4ns

for all Civil T tlnt
Stn·itingSouth Rast Qucemdv.nd

Project: 10558ruxncr llighway
Gooncll::tbah
Client: Aarian Ptv Ltd

Requested By:-'O"'/N"-·'-------
l)ateTested: 22-10-15
Report No.:_ 74 4 -----

Drillin Method: 12 tone e-.xcavator

llorc Ilolc No.:12

Depth Mm	Description	Comment
00	SiltyCL.\Y(top oil}, medium to high pla.<;.ticity, hrov.-"ll, 1nc:,il:i:tiff(Ci lf)	
100	Silty CLAY.highplasticity. rod/brown, moist, $tiff(CH)	
1100	SillyCLAY, high pl8$tidty,brownwithredmo,nling.. m,oisl, stiff (Cl I)	

Hok Tcm1inatcd

J'a,ge 12 or 33
Mill I.rm N.irnbout

Form •1 M r¢h 2003

A1,1tll()riseidg.1tatocy:
C. Tcmpktoo
Date: 16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOUTH RAST SOIL Tl· TING
PR 0429674334 Or All 0754 414:228

l'.O. Uox 1225. Nawbour Qld 4560

For allCMITesdng
ServicingSouth East Queensland

Project: 1055Bruxner Highway
c:ooncllabah
Client: Aarian PfyLtd

Rcqu«led Ky:._0=/N.,_ ___ _
Date Tests'(): 22-W-JS
Report No.:_,7c,4c:,4_____

Drilling Method: 12 tonecxc.1vator

Bore Hole No.:13

Oepth Mm	J)csc:ri1>tion	Comme.nt
00	Silly CLAY(topsoil), medium to high plasticity. brown, moisL stiff(Cl-t:H)	
200	Silty CLAY, high plasticity, red, moist, stiff (CIT)	
1300	SiltyCLAY.high plastidty, red/purple. moist, "Cl)' stiff(CH)	
2500	Silty Cl,AY, l1i11,b pla 1K:i1y, hn.>wn with N:,I rn11uling. moi:<t, iaiff{CIT)	
4000	lloleTcnninakd	

P e J:.iof u
Mill Lill Nawbow-

Authorised signatory: C)ffe-c:;
C.Temptc100
I>ltte: 16-11-15

Form4 M;.m;h 2003

066 665 147 Pty Ltd T/A ABN 71 066 665 147

f>.O. livx lll5,N;:..mboorQlt.14560

SOUTH RAST SOIL TESTING
PH 042t>674334or AH 07S4 41..128

For :111 CMITesting
ServicingSouth East Quc«.:nsland

Project: 1055Bruxne.r Hiahwa,· Goonellahah
Client: Aaria.n Ph· Ltd

Requested By:-'0"'1N"'-:,...,,,---
DateTested: 22-10-15
Report No.:._7'--44'-'------

Drilling Method: *12* toneexcavator

!loreHoleNo.:14

Depth Mm	Description	Comme,nt
00	SiltyCLA.Y(topsoil). tn1.-dium to high pla<;ticity, brown,moiM, Miff(C:T-C::11)	
250	SiltyCl.AV, 1 dium plasticity.*100.* moist. :stiff'(CH)	
2700	Sihy CLAY. bi_gbplasticity, browntrod mottlint, moi1;r, 11tiff(CJJ)	
3700	lloJe Tcnninatcd	

Pa. 14 of :l:l
Mill I,:me Namboor

Fonn*4* Msrch 2001

Authorised signatory:
C. Templeton
Date: 16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

P.O. .Lwx 1225. Narnbo1.1r Qld 4560

SOUTH EAST SOILTESTING
PH 0419674-334 or AH 01S4414228

f'or 311Civil Tcstin.z
ServicingSouth F.a t Qut-cns:land

Proj, t: 1055Brlllner Hi'"hwav
Goonellahah

Client: Aari*n Ply Ltd

Requested By:__O /N -,---
D•tc Tc<tcd: 22-10-15
Report No.:_7c:;44c,_ _

Drilling Mc.thod: t 2 tone C.XC",:Wato.r

Bore Hole No.:15

Ocptb Mm	Desc.ription	Comment
00	Silty CLAY(topsoil), medium to high plasticity, brown, moist, stiff (CI-CH)	
I50	Silty CLAY, medium plasticity, red,mQist, iff{CIl)	
1000	SiltyCT.AV, l1i.g:h pbsticily. brown/mJ Ulottliog,. utQi.sl. stiff(Cll)	
3800	Hole Terminated	

Au1h,o,·i cid.et:uo,cy: C.Tcmpktoo

Oare: 16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOUTH EAST SOIL TESTING

PH 0429 <•74334 or AH 07 S4 4f422S

?.O. Iwx t22S. Namboor Qld 4560

For all CMI Tesrin;:
Servicing, South Ea.. t Queensland

Project: 1.055 Brumer Highwa\'
Goonellabah

Client: Aarian Pty Ltd

Requested By:_,O,,fN.,_,__ _
l)ate Tested: 22-10-15
Rcporl No.:_7:.;44=-----

Urilling Method: 12 tone.excavator

ll-Ore HoleNo.:16

Depth Mm	Description	Comme.nt
00	Silty Cl.AY(tapSOil), medium10 hif,h pb$licity, br◊Wll, m<>Lc:t., 1(fiff(CI-CH)	
150	Silty Cl.AY.medium plaslicily. red. moisLsliO'(CH)	
1500	Claycy GRAVEL, coarse gravel, brown, moist, dense (GP)	
1000	Hole Tcrmit13tccl(>ll Rcxk	

/\luh('ld:-cd !.it,n:!tory: C.·0p 9b
C. Templeton
Date: 16-11-15

(,f,'if471-'tYl.tdT/A A N7l0666o}l47 P.O. lk>x 1225.ll>n>boor QI 45(,0

SOUTH EAST SOILTF.STING

PH *0419*674334 *M* Alf 07 54 414228

for all Civil Tcstin
Sca:vic.ing South F.ast Qu«ns:land

Project: 1055Bruxner Hi<Fhwav Goonellnhah

Client: Aariao Ph·Ltd

Requested By:.-'0,,/N"-' -----
llnteTesttd: 22-10-15
Report No.:_7 44 -----

DrillingMethod: 12 tone exc.avat.or Bore Hole No.:17

Depth Mm	Description	Comment
00	$illyCw\ Y(lop:soil). wc«Jimo tohigh p.bt$ltl.'.j1y. browu. m◊i!,1, s1iff(CT-C:ll)	
150	Sitt)• Cl.Av. medium pfa.uici-.y.rc,1, moist, miff(C:l-1}	
1 00	Ch!yey GRAVCL. *coaNe*gi-.tvd. brown. mofat. *de e*(OP)	
2600	Hole Tcnninatcd	

V.ige 17 of :n
MillL.1M N.t1l'lbl)t)r

A\1th0Nseide,nauwy:
C:.Tcmpk«>n
T>.uc: 16-11-15

form 4 March 2003

066 665 147 Pty Ltd T/A ABN 71 066 665 147

P.O.Box 1225. Jl-'umbour Qld 4560

SOUTH EASTSOil,TRSTTNC

PH 04296i4334 0r AH07 54 414228

l'or ull CiviJ1\-stin

Sen'icingSouth 1-:.ast Queen hmd

Proje\.-t: 1055Brumer Hi!rtlwav G-Oonellabah

Client: Aarian Pty Ltd

Rcqucsh.-d Ry:_-"O"-/N'-'---------

DatcTc,;tcd: 22-10-15

Report No.:._7'-'44=------

l>rimng Method: 12 toneexca,'ator

Bore Hole No.:18

Depth Mm	Description	Comment
0 0	Silty C.:LAY(topi;oil). medium pla k-ity, browni'rcd, moist, stitf(CI)	
150	SiltyCl.AY,medium lo high ph1;11jci1y,.n:dfbrown. moist stiff(<.:1-<.:.U)	
1200	Clayey GR.AVlil.coarse TU\'CI, brown/rcd, low plaqiciry clay pccs.cnt, moi t, dcn._-.c (GP)	
3(,,00	ffolc:Tmnioatc:d on Rock	

P .c 18of 33

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Fonn 4 March 200.3

Authorised sig:natCK)': C- -•-

C. Tcmpl<:ton

16-11-15

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P.O. Uox 1225. NamOOl.l-rQld 15(,0

SOUTH EASf SOIL TF.STINC
PH 041 614334 m·AH 07 414228

For all CivilTesting
Sen·icing South Eats-t Quccn land

Projec-.t: 1055Bruxner Higbwav
Goone-.llahah
CUcnt: Aariao Pty Ltd

Keque<ted l!y:_O=/N,._ _____ __
D»tc Tc.-sted: 22-10-15
Report No.:_7 4 4_____

n,;m.og Method: 12 toneexca,,ator

Bore Hok No.:19

Depth Mm	Description	<:omment
0 0	$il(y CLAY(lopsoil). mcd.iwn plasticity. browlll'roo. moist. stiff(Cl)	
150	Silty \.I.AY, medium t(I high J)L'!Stid1y, !'((I, m◊iSl, Stiff (Cl•C:l T)	
1200	Clayey GRAVEL. roarsc.gravel, brown'rcd, low plasticityday prescnL moist. dCllsc-(GP)	
JJOO	Hole Tt.'mlinated on rock	

It:, 19 of 3)
Mill e Nambour

Authoris«l ,i.,,.,1ory: C ."2)___
C, Tettlpl l0ll
U-,tle: 16·11·15

f.◊nO4 Marl;h 2003

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOUTH EAST SOIL T•:STINC
PH 0429674334 or AR 07 $1414218

P.O. 0ox 12?.5. NamhonrQld 15(,0

Forall CivilTesting
Scn·icing South .&ast Quccn hand

Project: 1055 Rruxncr Highway Goonellabah

Clie.nt: Aarian Pty l.td

Requested By:-'O"'/N"-·'- ---
OateTesled:_.2,_.2"-•l..,Occ•l..,5'---
Rcport No.:_ 7 4 4_____ __

llrill;ng Mcthod: 12 h,mc CXC)l'\'Jttor

Bore llolc No.:20

llepth Mm	l>e.tt'ri{Hion	Comment
0 0	Silty CLAY(topsoil), medium plasticity, brown/red, moist, stiff (CI)	
150	Silty CLAY, medium *to* hip,h pt:i tidty, red, moist,stitr(CI-CH)	
1300	Silty Cl,AY.medhn'fl lO bigb p foily. purple with red1brow11nlc>Uling.,mois:1, sriff(CI-CH)	
3400	lfoltTmllU'laled vu rvck	

Aud1◊ri$ sig.1L'lU)ty:

C. Tcmpl-c«>n
16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOUTH EAST SON, TESTING
PH 0429674:tl4 oir Alt (/7 54 41422$

r.o.&x 1225, NsmbourQld4560

ror allCivilTcstinf:,
Servicing South Ea,.t Queensland

Project: 1055Bruxner Highwa,·
c;ooncUabah
Client: Aarhm Pt\· Ltd

Requested By:_O /N ----
llatc Tested: 2:Z.10-15
Report No.:_7'-4'-'4,_ _ _

Ddlling Method: 12 tooccxca,·ator

!lore llole No.:21

Depth Mm	Ues.cription	Comment
00	Silty C.:LAY(lopsoil). m<diwn pfaslicity. browi:i/ d. 1m>i$1, s1iff(CT)	
150	SiltyCl.AY, medium oohi pla<;ticrt)\ red, moist, sriff(CI-CH)	
2700	Hole Trnninatcd on rock	

J\uth()ri"oid nnrory: C, 0v ..,
C. Tcmpk-coo
O::uc: 16-IJ-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

P.O.ilox1225. Nambour Qld 456()

SOUTII t<;AST SOIL TE 'TlNG
r•110429674334o.r All 07 S.J 414228

for au C.::iviJ T1. io:
Senrid1lg South 1-:.ast Queensland

Projcd: 1055Bn1xner Highway Gooncl1a.hah
Client: Aarhtn.Pty Ltd

Requested 8y:_O / N
DateTt-,;tcd: 22-10-15
Report No.:_7 44 -----

Drillinit Method: 12 toneexca,•atm·

8ore Hole. No.:22

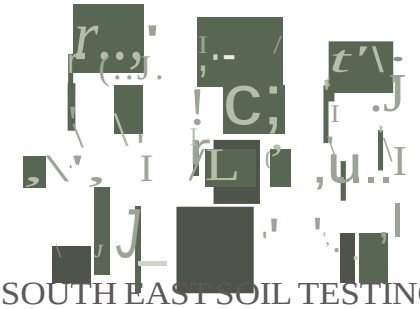
Depth Mm	l>t$Cripli(>n	Comment
00	SiltyCLAY(lopsoil). medium plastkity. brown/red. moist. stilf(Q)	
150	Silty CLAY. uaediuut tu high pfast.iclly. d. moisL stiff(Cl-CU)	
1700	Clayey GR.AY£L. well graded, brown & rod monling, low p!a.c;ticiryclay, moist,sriff(GW)	
2700	HoleTcnnioatcd on rock	

P.1g,: 22-of 3J
Mill Ulu.: Nambuur

fom14 M.v,;:h 2003

Audloriscd signatory: C ·0 *'1:f* <>cs
C.:.Trotpklon
L>ate: 16-ll-lS

P.O.IJ.ox l225. N3-m1)our Qld 4560



SOUTH EAST SOIL TESTING
PH 042t>674334 ar AH 07 414118

for ill CivilTt$tine;
Senicing South East Quccosla:nd

Project: 1055Brnxner Highway
(",oonellabah

R<.'tj_UCS(ed By.: _,0«lN,c. 'c... ___ _
DateTcstcd:._ 22.:-:.1"0-:.,IaaSc_ _

Client: Aa.rian Ply I.td

ReportNo..:_744 -----

Drillin Method: 12 tone excavator

Bore Hole No.:23

Depth Mni	Description	Comment
00	Silty CLAY(lopwil), rnedi ,mJ,bt..ticity, brown/red, moist, stiff(CI)	
150	Sift)• CLAY. medium lo high plastjcity. rcdfbrQwu. m()isl, fif,n *to* niff(CI-CH)	
1200	Silly Cl.AY, l1ig.h pl:t.uicity, red&.brown monlcd, moist. fmn (Cll)	
2000	Silty C:LAY, hi.tth pla ticity, red, bmun& grl.'3/ mottled. mo . fotre (CTT)	
2700	Silty <.:LAY. mc:diwn pki::;licily. brown &€,l'e>' 1Yl()nk:d, 1noin, tinn(Cl)	

Tlole Tcnnin:ucd

t,.{ill I.MIC Nsmbour

Authorised signatory:

C.-3/h-

C. Tempklon

Date: 1 Jl-15

P.O. Rox 122$, Namhotrr Qld 45(){)

SOUTll.EA 'T SOIL TESTING
PH 0429674.3.34 or AH 07 54 414228

For all Civil Tci;tini
Scn·icing South East Quccn!Shmd

Project: IOSS .lku:imcr Highway Goonellabah
Clie nt: Aarian Pty Ltd

Requested By:_,O.,,I.N,_
J>atcTcslcd: 22-Hl-lS
Report No.:_7 4 4

Drilling Method: 12 lonecxe.t,·ator

Bore Hole No.:24

l><ptb Mm	Description	Comment
00	Silry(1..AY(10pS()it), medium lo h.i.gb pla:sticily. brown/ml. t1XJj$1.$li!r(CJ)	
250	SiltyCl.AY, medium to hiSh pl:t,;,ticity, rcd/htown, moi!!t, timl (Cl.CH)	
(000	Silty Ct.AV, t1ig.h pl<11>tfoi1y. purpk withgrey & n,d moll.ling. moist. futo(CJI)	
3600	Hole Terminated	

c 24of 33
Mill I nc Nambour

Authorised signatory:

cO,L=
C.Templeton
Hi-11-15

Form-1 March 2003

SOUTH EAST SOIL Tl·$rlNG
Pll 0429674334Or All();54414228

For all Ch•il Testing
Servicing South East Queensland

Project.: 1055Bruxner Highwav
Goone.Jlabah
Clitot: Aarian Pt\- Ltd

Requested By:-'O"'/N"-.' ------
Dat< Tested: 22-10-15
Report No.:_7 4 4_____ __

Drilling Method: 12 toneexc:a"·ator Bore Hole No.:2S

Depth Mm	Description	(;omment
00	Sill)' CLAY(topsoil). medium to high plasticity. brown/n:d. a,oj$ll.iff (Cl)	
250	Silty C.I..AY, medium to hith pla.--ticily, red/hrov.-n, moist,finn (Cl-CH)	
2:lOO	Silly CW\Y. high phutjcity. brown. 1noi t. fum (Cln	
3600	Hok Tenninatcd	

Authorised :c:ig,rwoty:
Date: 16-11•15

U6<><>6 147l'lyLIJTIA ,\UN71066MSH7

P.O. Uox.1225. N.ai.nboor Qld 4560

SOUTl:I EASTSOILTJ,:STING

PU 0429674334ur AH07 54 414228

For auCiYil Testing

S.,rvicingSouth East Queensbnd

Project: 1055 Bnn.,1cl" llighwa.y Gooncllabah

Client: Aariau Pty Ltd

Rcqu ted lly:.....;(,.::lf"-N,_ _ _

DateTcsl<-d: 22-10-IS

Report No.:._7 44 -----

Drilling Mdhod: 12 toneexcavator

Bore Hole.No.:26

Depth Mm	Oc$criptioo	Connne.nt
00	Silty CLAY (fill),high pl:i. ticity, rcd/brovm, moist, finn(CH)	
1100	Silty Cl.AY, hi.r;,,hp1$1:iciry, bmwn,mait,t, fiml (CH)	
3-600	HoleTaminatcd	

Mill Lane Nambour

fonn4 March 2003

Authorised sign.::tory:

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C'.r!!mpletan

16 1t-15

P.O. U.0:-c 1225. Nambou.r Qkl 4$60

SOUTH EAST SOIi,Tl>:l;TING
PH 0429674334 ur AU 01 54 414218

Fnr all CivilTestinl,!
Sc-rvicing South Ea.,t Queensland

Projed: 1055Bruxner Hi"hwa\l Goonc\lahah
Client: Aarian Ptv Ltd

Rcqu,-.tcd lly:_(,,)""/N.,_ __ _
DateTested: 22-10-15
Report No.:_7:.;44:;;:..

DrillingMethod: 12 tone excavator

llore llole No.:27

Depth Mm	Dc:scri.ptfoo	Comment
00	Silty CLAY (topsoil), medium m hi#l plr.ticit)•, bcawn.,'rcd, moi tlml (Ci-CH)	
ISO	$illyCw\ Y. medium tobjgb plasticity. brown'rcd. moi . finn (Cl-CH)	
1900	Silty CLAY, high plo.'>Ocity, brown, mom_, very !>tiff (CH)	
3600	Hok: Tcnninatcd	

Authorisedsignatory:

C·o/6=
C. Tewpl tuu
16-JJ.Jl

066 665 147 Pty Ltd T/A ABN 71 066 665 147

P.O. Rox 1225, Namhour Qld 4560

SOUTJ I EASTSOILTESTING
PH 0429674334 or AH 07 414Z2R

For 211 C'iYil Tcstin
Scn'icing South East Qu«.--cr,,sland

P·rojcd: I055 llruxncr Highway Goonellabah
Client: Aarian l'tv Ltd

Requested By:_O /N=' --,-,,----
DateTcsted: 22-111-15
Report No.:_7,_44'-'------

Drilling Method: 12 toneexu,•ah>r

Bore llolc No.:28

Depth Mm	Desc.ription	Comment
00	Silty CLAY (topsoil). medium lohigh pbcitic ity. brown/ml moisL firm(CJ-CU)	
150	Silty CLAY,medium to high pb. city, red, moi$.t, firm (Cl-CH)	
1900	Silty CLAY, medium to hif,h pl:1. ticity, redlbn>wr1. mois1,·, el)•Sliff(Cf-CIT)	
3600	Hok Tcrmill3tod	

Authorised signatory:

O:uc:

C. Tcmplctofl
16-11-15

066MS IJ'7PWl.tdT/A ABN 71 066 665 147

P.O. Rox 122.'i, Naml)our Qkl4560

SOUTH EAST SOILT :STING
PH 0429674334 or AH 07 5441422$

f()rallCn'ilTesting
Sc-rviciog South El:!$t Qucc-m;hmd

Project: 1055Bruxner Hio-hwa,· Goonelln.hah
Client: Aari•n Pn·Ltd

Requested By:....:O-<:/N,.,_____ __
Dale TcSl«I: 22-10-15
Report No.: 7 4 4 ----

Drilling Method: *U* toneexcavator

Bon, Hole No.:29

Oeptb Mm	Description	Co1"ment
00	Silly CL:\Y (lopwiJ). mtdiwn lo highplaslicity. brown/red. moi.s1. firm (Cl.CJI)	
150	SiltyCT.AY, medium I◊hig.h pl $ticity. red,nl()i$1, *firm* (Cl·CII)	
1600	Silly Cw\ Y.m ium tohigh plasticity. n,dlbrown. moisl. \'Crysl itf (Cl-CH)	
3600	Hole Tenninaled	

P:l .c 29 of 33
Mill t.;1nc K ml>our

F'oml '1 March 2003

Authorised signatory:

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16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

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SOUTH EAST SOIi, TF.STING

PH 0429674334 r All 07 54 414:228

P.O. Box 1225, Nambour Qld•1560

For all CivilTcstint
ServicingS-Outh F.a"'t QuL-cni-htnd

Proj<:ct: 1055 Brumer Hi!!il'ff'av
Goonella:bah

Client: Aari n Ptv Ltd

Rcqu,-,;tcd 8y:._O=/N"'---------
Date r.. ted: 22-10-15
Report No.:_7c;44 -----

Drilling Method: 12 tone e-.xcavator

Bore.lloleNo.:30

Depth Mm	Descriptioo	Comment
00	Silly CLAY (lopsoil).highplamtity,brown/red, moi!>t, firm (Cl-CH)	
150	SiltyCLAY,hit,h pl:.l$li¢i1y. red.woi:::;t. fuw (Cl-CH)	
3300	SihyCLAY. higJI pla.<-ticrt)[1]. purple with brown and*e1cy* monline,..., inoi.$1[1] s.1iff(Cl-Ol)	
3900	Jlole Tc:nninau.-d	

f'* 30or J:;
Mi11T[1]N<1mbour

FMm 4 M3rch?.003

Authorised signatory:

C- b:
CTempleton

Date: 16-11-15

P.O. Rox 1225, N:unhour Qld 45(:,0

SOliTU EA!>'T SOIL TESTING

rH 0429674334or AH 07 54414228

fiorau Civil Tcr.:tin
St.rvking South r+:Jt. t Queensland

l'rojcct: I0 5 Bnu..ner Highwav
Goonellabah

Client: Aarinn Ph·1.td

R"1uested By:-'O=/N.,__ _
Date Tested: 22-10-15
Report No.:_7c:4c,4_____

Drilling Mc-.tbod: 12 toneeic-•.wator **!lore llole No.:31**

Depth Mm	Description	Comme-.nt
00	SiltyCt.AY (1opsui0. high plasticity, brown/red, moi!(ffirm (C.1-Cfl)	
150	Silty Cl.AY, high pl.t licily. n:d. moist. firm (Cl-CH)	
1500	Silty CT.AV, hi plasticity. purple with brown nndgrey monlin moi1>t, r.:tiff(Cl-01)	
3900	HC)k:Te""Ulated	

Authorised signatory: C--0,Pb=
C. Templeton

Oatc: 16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

P.O. Bo:-c 1225. Nambour ().kt 4560

SOUTIIEAST SOILTESTING

l'll0429 674334 or AH 07 54 414118

For all <.:Ml Tr:stinx
ServicingSouth ti:ast Quecn land

Proj«t: 1055 llruxncr Bighwav
(:ooncllabah

Client: Aarian Ptv Ltd

Rcquc:!'ilt..-d Ry:._.,O"-/N'-'.'--,..,,----
O•tcT.,;tcd: 22-10-15
Report No.:._7.:.;44:;;:..

Drilling Method: 12 tonc excavator

Bore Aole No.:32

l>cpth Mm	Description	Comment
0 0	Silty CJ,AY{f()(l6<)il). hjgh pl..!sli,city. brown/red. moist. fmn (Cl-CH)	
150	$illy CLAY.high pla c.ity,red,mni t,fiml{C':t-Ctl)	
Il00	Silty Cl.AY, high p13:5,1i¢ily, purpl wilh brownand grey mottling. moist, stiff(Cl-CH)	
3900	Hok Terminated	

Authorised signatorv:

C-J,:i)<i""--,""-E;;e::---
C.Te-mpkton
16-11-15

066 665 147 Pty Ltd T/A ABN 71 066 665 147

SES

SOUTH EAST SOIL·n:STING
PH 0429674334or AR 07 54 414:228

P.O. Box 1225, NamboorQld 45(,0

For all Ch'ilTestinj,!
ServicingSouth to:a.st Queensland

(>rojcct: 1055 Brumer Highway
Goonellabnh
Client: Aarian Plv Ltd

Requested lly:_ O /N '------
DatcT<.,,tcd: 22-10-1S
Report No.:._ 744-

Drilling Method: 12 toneexc.avator

Bore Hole No.:33

Depth Mm	Description	Comment
00	Silty Cl.AV (lop:.oil). high plasticity, hto\\on/tt<J, rnoi:.l. fum (C.:1-CH)	
150	Silty\.I.AV, hig.b pla:stfoily. red.moist, firm (\.f-CTT)	
2000	11¢1,eTmninated	

AutllClri dis.natory:

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C–O–
Ciempktc.»1
16·11·15

APPENDIX I

066 665 147 Pty Ltd T/A
SOUTHEAST SOIL TESTING
ABN 71 066 665 147

P.O. Box 1225, Nambour Qld 4560

For an Civil Testing
Senicing South East Queensland

TEST **REPORT**

Project: **1055 Bruxner Highway Goonellabah**
Client: **Aarian Pty Ltd**

Requested By: OIN
Date Tested: **22-10-15**
Report No. **-'-'78:;....4'-----**

Laboratory Test Procedure: AS 1289 3.9.Z,ASl289 3.4.1

Sample method: Excavation with 12t excavator

Sample Description: See Below

	784.1 TP2	784.2 TP8	784.3 TP13	784.4 TP21	784.5 TP28
Liquid Limit(%):-	53.4	56.7	49.6	44.4	46.l
Plasticity Index:-	36.7	41.0	34.4	28.2	29.7
Linear **Shrinkage(%):-**	16.7	**16.4**	16.2	**16.2**	**16.4**

Nata Lab No.: 10602

Signatory: C. Templeton

Date: 1-12-15

Form 35 March 2003

APPENDIX J

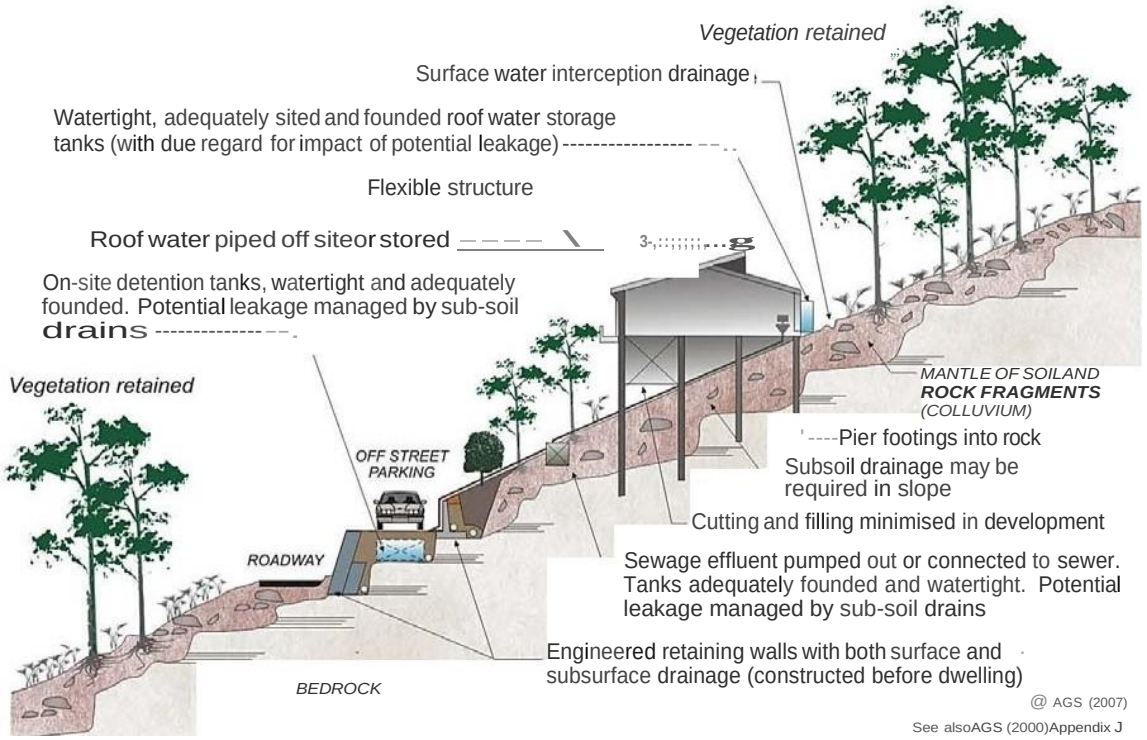
APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early sta e of plannin and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arisingfrom the identified hazards and conse uences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible stmctures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & **DRIVEWAYS**	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parkin.l! areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminato1v bulk eruthworks.
CUTS	Minimise depth. Suppo1t with engineered retaining walls or batter to appropriate slope. Provide draina,ge measures and erosion control.	Large scale cuts and benching. Unsuppo1ted cuts. I,gnore draina,ge requirements
FILLS	Minimise height. Strip vegetation and topsoil and key intonatural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide smface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCKOUTCROPS &BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope **above.** Construct wall as soon as possible afler cut/fill operation.	Construct a structurally inadequate wall such as sandstone **flagging,** brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footim1: excavations to exclude in2ress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIM\1ING POOLS	Engineer designed. Support on piers to rock where practicable. Provide **with** under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral suooort on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate ener,gy at chan,ges of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Providefilter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into abso1ption trenches.
SEPTIC& SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some ru·eas ifrisk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL& LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleru·ed area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Buildin A lication drawin s should be viewed b eotechnical consultant	
SITE VISITS	Site Visits by consultant may be ap ropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where stmctural distress is evident see advice. If seeoa2e obse1ved, determine causes or seek advice on conseauences.	

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.

EXAMPLES OF **GOOD** HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LRS).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down to1Nards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LRS).

Surface loads - are minimised. No fill embankments have been built. The house is a lightweight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

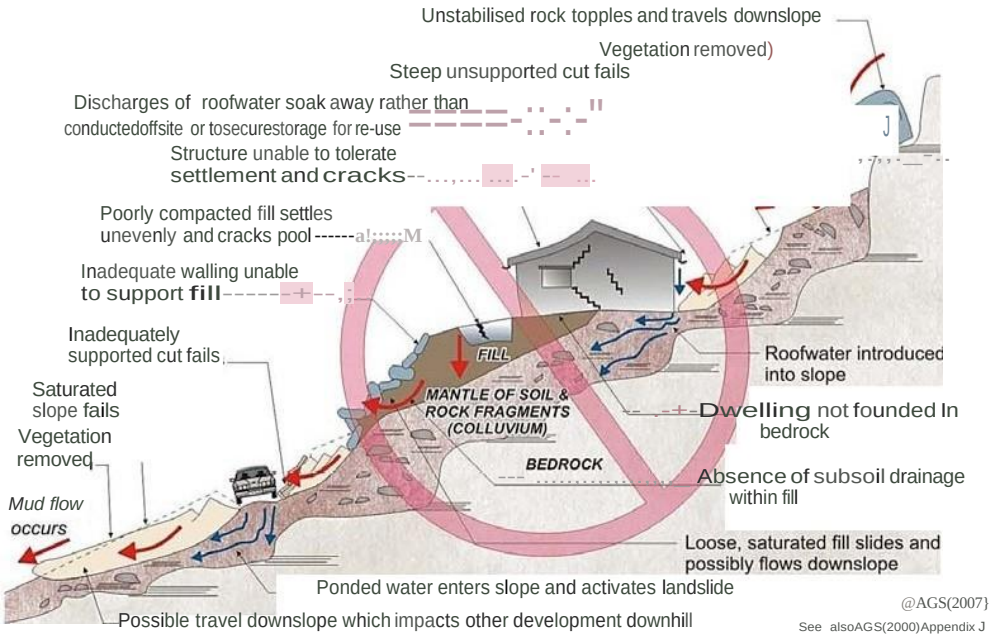
Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LRS). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION **PRACTICE)**

EXAMPLES OF **POOR** HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE **PRACTICES POOR?**

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flow paths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

More information relevant to your particular situation may be found in **other Australian GeoGuides:**

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LRS - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society. a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

RETAINING WALLS

Retaining walls are used to support cuts and fills. Some are built in the open and backfill is placed behind them (gravity walls). Others are inserted into the ground (cast *in situ* or driven piles) and the ground is subsequently excavated on one side. Retaining walls, like all man-made structures, have a finite life. Properly engineered walls should last 50 years, or more, without needing significant repairs. However, not all walls fit this category. Some, particularly those built by inexperienced tradesmen without engineering input, can deflect and even fail because they are unable to withstand the pressures that develop in the ground around them or because the materials from which they are built deteriorate with time. **Design of retaining walls more than 900mm high should be undertaken by a geotechnical practitioner or structural engineer and normally require local council approval.**

Retaining walls have to withstand the weight of the ground on the high side, any water pressure forces that develop, any additional load (surcharge) on the ground surface and sometimes swelling pressures from expansive clays. These forces are resisted by the wall itself and the ground on the low side. Engineers calculate the forces that the retained ground, the water, and the surcharge impose on a wall (the disturbing force) as well as the maximum force that the wall and ground on the low side can provide to resist them (the restoring force). The ratio of the restoring force to the disturbing force is called the "factor of safety" (GeoGuide LR1). Permanent retaining walls designed in accordance with accepted engineering standards will normally have a factor of safety in the range 1.5 to 2.

Never add surcharge to the high side of a wall (e.g. place fill, erect a structure, stockpile bulk materials, or park vehicles) unless you know the wall has been designed with that purpose in mind.

Never more than lightly water plants on the high side of a retaining wall.

Never excavate at the toe of a retaining wall.

Any of these actions will reduce the factor of safety of the wall and could lead to failure. If in doubt about any aspect of an existing retaining wall, or changes you would like to make near one, seek advice from a geotechnical practitioner, or a structural engineer. This GeoGuide sets out basic inspection requirements for retaining walls and identifies some common signs that might indicate all is not well. GeoGuide LR11 provides information about records that should be kept.

GRAVITY WALLS

Gravity walls are so called because they rely on their own weight (the force of gravity) to hold the ground behind in place.

Fonned concrete and reinforced blockwork walls (Figure 1) - should be built so the backfill can drain. They should be inspected at least once a year. Look for signs of tilting, bulging, cracking, or a drop in ground level on the high side, as any of these may indicate that the wall has started to fail. Look for rust staining, which may indicate that the steel reinforcement is deteriorating and the wall is losing structural strength ("concrete cancer"). Ensure that weep holes are clear and that water is able to drain at all times, as high water pressures behind the wall can lead to sudden and catastrophic failure.

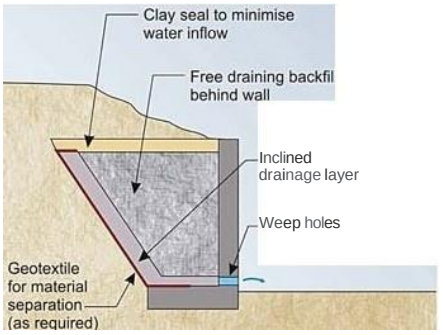


Figure 1- Typical formed concrete wall

Concrete "crib" walls (Figure 2) - should be filled with dean gravel, or "blue metal" with a nominated grading. Sometimes soil is used to reduce cost, but this is undesirable, from an engineering perspective, unless internal drainage is incorporated in the wall's construction. Without backfill drainage, a soil filled crib wall is likely to have a lower factor of safety than is required. Crib walls should be inspected as for formed concrete walls. In addition, you should check that material is not being lost through the structure of the wall, which has large gaps through it.

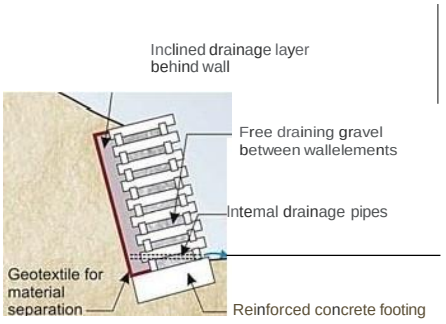


Figure 2 -Typical crib

Timber "crib" walls - should be checked as for concrete crib walls. In addition, check the condition of the timber. Once individual elements show signs of rotting, it is necessary to have the wall replaced. If you are uncertain seek advice from a geotechnical practitioner, or a structural engineer.

Masonry walls: natural stone, brick, or interlocking blocks (Figure 3) - more than about 1m high, should be wider at the bottom than at the top and include specific measures to permit drainage of the backfill. They should be checked as for formed concrete walls. Natural stone walls should be inspected for signs of deterioration of the individual blocks: strength loss, corners becoming rounded, cracks appearing, or debris from the blocks collecting at the foot of the wall.

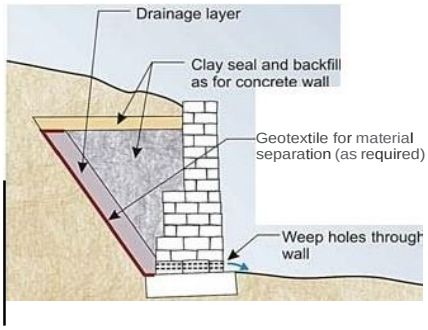


Figure 3 -Typical masonry wall

Old Masonry walls (Figure 4) - Many old masonry retaining walls have not been built in accordance with modern design standards and often have a low "factor of safety" (GeoGuide LR1). They may therefore be close to failure and a minor change in their condition, or loading, could initiate collapse. You need to take particular care with such structures and seek professional advice sooner rather than later. Although masonry walls sometimes deflect significantiy over long periods of time collapse, when it occurs, is usually sudden and can be catastrophic. Familiarity with a particular situation can instil a false sense of confidence.

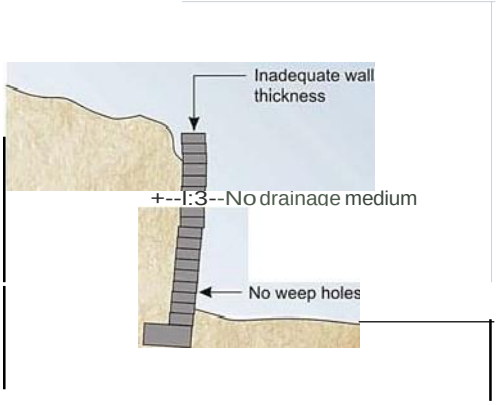


Figure 4 - Poor1y built masonry wall

Reinforced soil **walls** (Figure 5) - are made of compacted select fill in which layers of reinforcement are buried to form a "reinforced soil zone". The reinforcement is all important, because it holds the soil "wall" together. Reinforcement may be steel strip, or mesh, or a variety of geosynthetic ("plastic") products. The facing panels are there to protect the soil "wall" from erosion and give it a finished appearance.

Most reinforced soil walls are proprietary products. Construction should be carried out strictly in accordance with the manufacturer's instructions. Inspection and maintenance should be the same as for formed concrete and concrete block walls. If unusual materials such as timber, or used tyres, are used as a facing it should be checked to see that it is not rotting, or perishing.

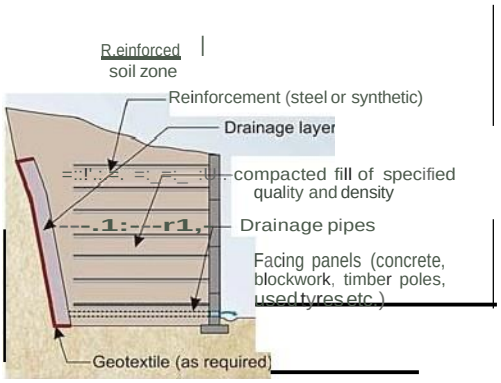


Figure 5 • Typical reinforced soil wall

OTHER WALLS

Cantilevered and anchored walls (Figure 6) - rely on earth pressure on the low side, rather than self-weight, to provided the restoring force and an adequate factor of safety. These walls may comprise:

- a line of touching bored piers (contiguous bored pile wall) or
- sprayed concrete panels between bored piers (shotcrete wall) or
- horizontal timber or concrete planks spanning between upright timber or steel soldier piles or
- steel sheet piles.

Depending on the form of construction and ground conditions, walls in excess of 3 m height normally require at least one row of permanent ground anchors.

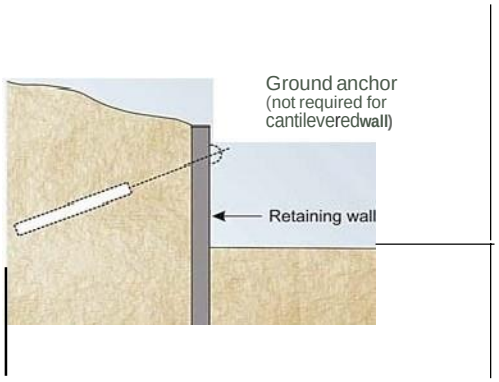


Figure 6 - Typical cantilevered or anchored wall

INSPECTION

All walls should be inspected at least once a year, looking for tilting and other signs of deterioration. Concrete walls should be inspected for cracking and rust stains as for formed concrete gravity walls. Contiguous bored pile walls can have gaps between the piles - look for loss of soil from behind which can become a major difficulty if it is not corrected. Timber walls should be inspected for rot, as for timber crib walls. Steel sheet piles should be inspected for signs of rusting. In addition, you should make sure that ground anchors are maintained as described in GeoGuide LR4 under the heading "Rock bolts and rock anchors".

One of the most important issues for walls is that their internal drainage systems are operational. Frequently verify that internal drainage pipes and surface interception drains around the wall are not blocked nor have become inoperative.

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides in Soil
- GeoGuide LR3 - Landslides
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR? - Landslide Risk
- GeoGuide LR8 - Hillside Construction
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

!LANDSLIDE RISK

Concept of Risk

Risk is a familiar term, but what does it really mean? It can be defined as "a *measure of the probability and severity of an adverse effect to health, property, or the environment."* This definition may seem a bit complicated. In relation to landslides, geotechnical practitioners (GeoGuide LR1) are required to assess risk in terms of the likelihood that a particular landslide will occur and the possible consequences. This is called landslide risk assessment. The consequences of a landslide are many and varied, but our concerns normally focus on loss of, or damage to, property and loss of life.

Landslide Risk Assessment

Some local councils in Australia are aware of the potential for landslides within their jurisdiction and have responded by designating specific "landslide hazard zones". Development in these areas is often covered by special regulations. If you are contemplating building, or buying an existing house, particularly in a hilly area, or near cliffs, go first for information to your local council.

Landslide risk assessment must be undertaken by a geotechnical practitioner. It may involve visual inspection, geological mapping, geotechnical investigation and monitoring to identify:

- potential landslides (there may be more than one that could impact on your site)
- the likelihood that they will occur
- the damage that could result
- the cost of disruption and repairs and
- the extent to which lives could be lost.

Risk assessment is a predictive exercise, but since the ground and the processes involved are complex, prediction tends to lack precision. If you commission a landslide risk assessment for a particular site you should expect to receive a report prepared in accordance with current professional guidelines and in a form that is acceptable to your local council, or planning authority.

Risk to Property

Table 1 indicates the terms used to describe risk to property. Each risk level depends on an assessment of how likely a landslide is to occur and its consequences in dollar terms. "Likelihood" is the chance of it happening in any one year, as indicated in Table 2. "Consequences" are related to the cost of repairs and temporary loss of use if a landslide occurs. These two factors are combined by the geotechnical practitioner to determine the Qualitative Risk.

TABLE 2: LIKELIHOOD

Likelihood	Annual Probability
Almost Certain	1:10
Likely	1:100
Possible	1:1,000
Unlikely	1:10,000
Rare	1:100,000
Barely credible	1:1,000,000

The terms "unacceptable", "may be tolerated", etc. in Table 1 indicate how most people react to an assessed risk level. However, some people will always be more prepared, or better able, to tolerate a higher risk level than others.

Some local councils and planning authorities stipulate a maximum tolerable level of risk to property for developments within their jurisdictions. In these situations the risk must be assessed by a geotechnical practitioner. If stabilisation works are needed to meet the stipulated requirements these will normally have to be carried out as part of the development, or consent will be withheld.

TABLE 1: RISK TO PROPERTY

Qualitative Risk		Significance -Geotechnical engineering requirements
Very high	VH	**Unacceptable** without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low. May be too expensive and not practical. Work likely to cost more than the value of the property.
High	H	**Unacceptable** without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable level. Work would cost a substantial sum in relation to the value of the property.
Moderate	M	**May be tolerated** in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as possible.
Low	L	**Usually acceptable** to regulators. Where treatment has been needed to reduce the risk to this level, ongoing maintenance is required.
Very Low	VL	**Acceptable**. Manage by normal slope maintenance procedures.

AUSTRALIAN GEOGUIDE LR7 (LANDSLIDE RISK)

Risk to Life

Most of us have some difficulty grappling with the concept of risk and deciding whether, or not, we are prepared to accept it. However, without doing any sort of analysis, or commissioning a report from an "expert", we all take risks every day. One of them is the risk of being killed in an accident. This is worth thinking about, because it tells us a lot about ourselves and can help to put an assessed risk into a meaningful context. By identifying activities that we either are, or are not, prepared to engage in we can get some indication of the maximum level of risk that we are prepared to take. This knowledge can help us to decide whether we really are able to accept a particular risk, or to tolerate a particular likelihood of loss, or damage, to our property (Table 2).

In Table 3, data from NSW for the years 1998 to 2002, and other sources, is presented. A risk of 1 in 100,000 means that, in any one year, 1 person is killed for every 100,000 people undertaking that particular activity. The NSW data assumes that the whole population undertakes the activity. That is, we are all at risk of being killed in a fire, or of choking on our food, but it is reasonable to assume that only people who go deep sea fishing run a risk of being killed while doing it.

It can be seen that the risks of dying as a result of falling, using a motor vehicle, or engaging in water-related activities (including bathing) are all greater than 1:100,000 and yet few people actively avoid situations where these risks are present. Some people are averse to flying and yet it represents a lower risk than choking to death on food. Importantly, the data also indicate that, even when the risk of dying as a consequence of a particular event is very small, it could still happen to any one of us any day. If this were not so, no one would ever be struck by lightning.

Most local councils and planning authorities that stipulate a tolerable risk to property also stipulate a tolerable risk to life. The AGS Practice Note Guideline recommends that 1:100,000 is tolerable in newly developed areas, where works can be carried out as part of the development to limit risk. The tolerable level is raised to 1:10,000 in established areas, where specific landslide hazards may have existed for many years. The distinction is deliberate and intended to prevent the concept of landslide risk management, for its own sake, becoming an unreasonable financial burden on existing communities. Acceptable risk is usually taken to be one tenth of the tolerable risk (1:1,000,000 for new developments and 1:100,000 for established areas) and efforts should be made to attain these where it is practicable and financially realistic to do so.

TABLE 3: RISK TO LIFE

Risk (deaths per participant per year)	**Activity/Event Leading to Death** (NSW data unless noted)
1:1,000	Deep sea fishing (UK)
1:1,000 to 1:10,000	Motor cycling, horse riding , ultra-light flying (Canada)
1:23,000	Motor vehicle use
1:30,000	Fall
1:70,000	Drowning
1:180,000	Fire/burn
1:660,000	Choking on food
1:1,000,000	Scheduled airlines (Canada)
1:2,300,000	Train travel
1 32,000,000	Lightning strike

More information relevant to your particular situation may be found in other **AUSTRALIAN** GEOGUIDES:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR8 - Hillside Construction
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

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APPENDIX K

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKEUHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	**Notional Boundary**					
10•!	5x10·2	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10·2		100 years		The event will probably occur under adverse conditions over the design life.	LIKELY	B
10·3	5xl0"3	1000 years	200 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10-4	5xI0⁴	I0,000 years	2000vears	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10·5	5x10·5	I00,000 years	20,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10-6	5xl0·6	1,000,000 years	200,000 years	The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa.*

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	**Notional Boundary**			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	**1%**	Limited damage to part of structure, and/or part of site requiriruz some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from leftto right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

APPENDIX C: - QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX -LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	1: CATASTROPHIC 200%	2: MAJOR 60%	3: MEDIUM 20%	4: MINOR 5%	5: INSIGNIFICANT 0.5%
A - ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	MorL(5)
B - LIKELY	10^{-2}	VH	VH	H	M	L
C - POSSIBLE	10^{-3}	VH	H	M	M	VL
D - UNLIKELY	10^{4}	H	M	L	L	VL
E - RARE	10-5	M	L	L	VL	VL
F - BARELY CREDIBLE	10-6	L	VL	VL	VL	VL

Notes: (5) For Cell *A5*, may be subdivided such that a consequence ofless than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

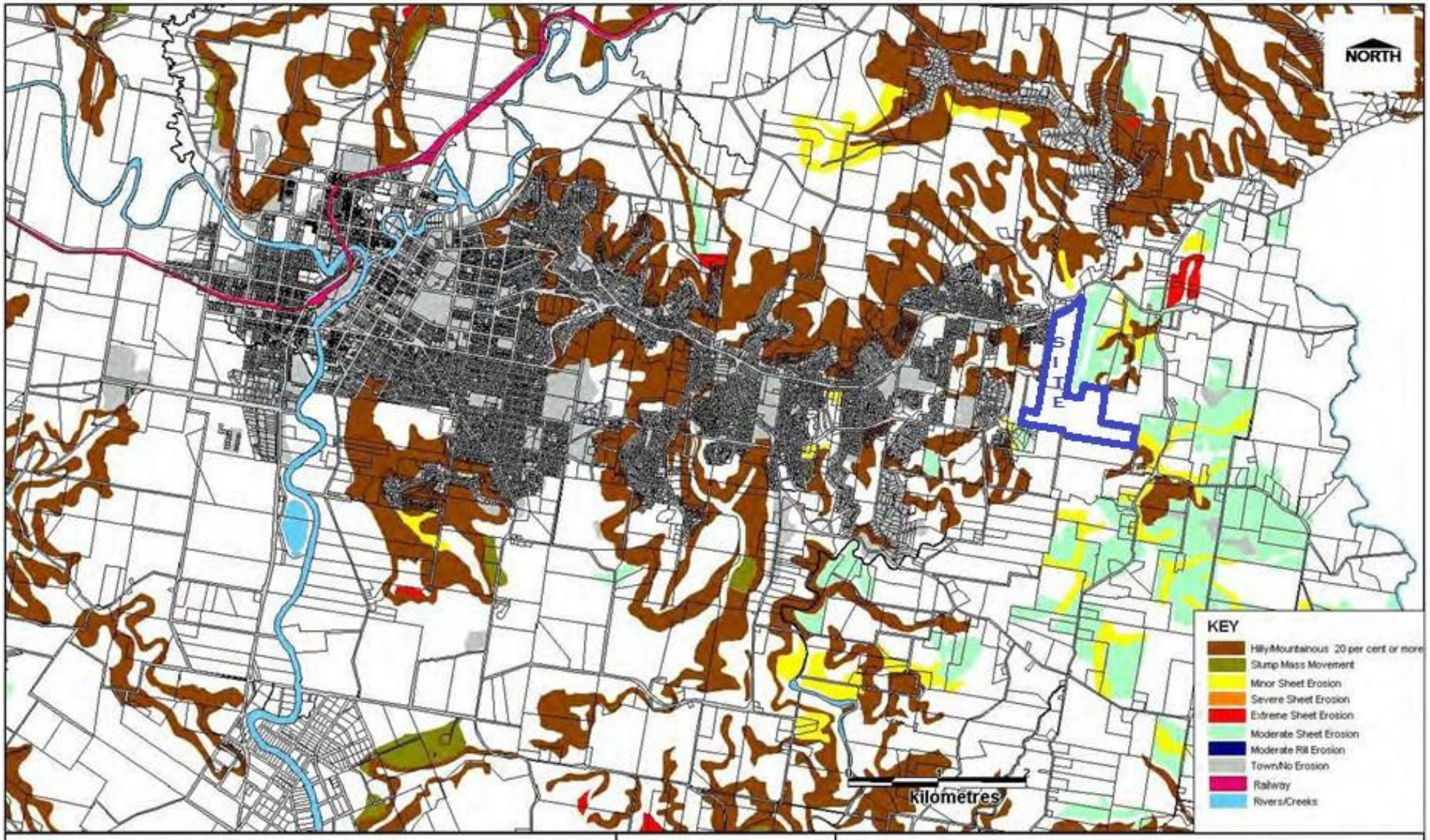
RISK LEVEL IMPLICATIONS

Risk Level		Example Implications (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the ro r
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is re uired.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

APPENDIX L

APPENDIX L :- Slip Prone Land. Source: 2004 Lismore Urban Strategy, Map 3.



LISMORE CITY COUNCIL

Printed: March 2004

Scale: 1 : 40,000

GDA

MAP 3

LAND WITH SLOPES OF 20% OR MORE AND SLIP AND EROSION PRONE LANDS

LISMORE URBAN STRATEGY

APPENDIX M

APPENDIX M:- Details of Qualitative Risk Assessment for Property at 1055 Bruxner Highway Lismore for Works on Site.

Hazard	Existing State			Works in Accordance with this Report			Comments
	Likelihood	Consequence	Assessed Risk	Likelihood	Consequence	Assessed Risk	
1.Shallow failure in the fill soil in and below the footing zone of the structure.	Possible	Major	High	Unlikely	Minor to Insignificant	Low to Very Low	The site is located on the eastern Lismore escarpment. It is moderate to steeply undulating and is underlain by basalt. No groundwater was observed during the investigation and the soil is medium to well drained. Prolonged rainfall events may saturate the soils and give rise to temporary perched water tables. The test holes revealed a homogenous soil matrix. Based on these factors the likelihood was assessed as **Possible**. The assessed consequences were **Major**. The assess risk for the proposed works without specific design considerations is **High**. Providing the recommendations of this report are adopted the likelihood is assessed as being **Unlikely.** The consequence would be **Minor to Insignificant**. Based on the assessed likelihood and consequences, the assessed risk is thus **Low to Very Low** in accordance with AGS 2007.
2. Shallow failure in the footing zone of the structures in residual soil and weathered rock	Unlikely	Major	Moderate	Rare	Medium	Low to Very Low	The likely hood of a shallow failure of the residual soil weathered rock is considered **Unlikely**. The likelihood is based on the fact that there is no evidence of such instability on site or surrounds including the adjacent Regatta Estate where steeper slopes have been developed. Furthermore, the land is not designated as slip prone on Map 3 Lismore Urban Strategy 2004. The consequences of such a failure is assessed as **Major**. The assessed risk without specific design is thus **Moderate**. As the structures are proposed to have deep footings the likelihood has been reassessed to **Rare**. Although rare a failure would still have **Medium** consequences as the damage would likely be limited to part of the structure in the vicinity of the failure. The assessed landslip risk associated with this mode of failure for works constructed in accordance with this report is **Low to Very Low** as per AGS 2007.
3. Deep failure below the footing zone of future structures in the residual soil and weathered rock	Rare	Major	Low	Rare	Major	Low	The likelihood of failure through the residual soil and deep basalt is assessed as **Rare**. The consequences are likely to be **Major** as severe damage to substantial parts of the structure are likely. The assessed risk on the site in its present state is **Low** as per AGS 2007. For works designed appropriately by a professional engineer to the recommendations in this report the likelihood was assessed as **Rare**. Consequences of such a failure would be **Major** The assessed risk is **Low** in accordance with AGS 2007.
4. Failure of engineered retaining structures or cut and fill batters on site	Likely	Medium	High	Unlikely	Minor	Low	Retaining walls and batters without adequate design for slope conditions are considered to have a likelihood of **Likely**. The consequences of such a failure are considered **Medium**. The assessment risk is thus **High** for walls or batters constructed without adequate design. For retaining structures and batters designed appropriately by a professional engineer to the recommendations in this report the likelihood was assessed to be **Unlikely**. Consequences of engineered retaining structures or batters failing would be **Minor** as the damage would likely be limited to landscaping or a localized part of the structure in the vicinity of the failure. The assessed risk is **Low** as per AGS2007, providing the retaining walls and batters ae designed by a suitable qualified engineer in accordance with AS 44678-2002 and founded appropriately as outlined in this report.
5. Slump failure on the slopes adjacent to or away from building envelopes	Possible	Medium to minor	Low	Unlikely	Minor to Insignificant	Low to Very Low	The likelihood of a significant slump on the slopes adjacent to the building envelopes has been assessed as **Possible.** This is due to the steepness of the natural slopes assessed against the possibility of saturated soil. Without the recommendations in this report, such slumps could disrupt service and result in damage to landscaping and structures. The consequences are thus assessed as **Medium to Minor**. The assessment risk is thus **Low.** Providing the recommendations of this report are adopted the likelihood is assessed as being **Unlikely.** With most services located in residual material and with granular material as services bedding, subsoil drainage is increased and the consequences are reduced to **Minor to Insignificant** and the assessed risk is assessed is reduced to **Low to Very Low** in accordance with AGS 2007.

Appendix B

Nata Registered Laboratory Number: 10602

SOUTH EAST SOIL TESTING
A.B.N. 71 066 665 147

PO Box 1225, Nambour QLD 4560
PH (07) 5442 2860 FAX (07) 5442 2840
Mob 0429 674 334

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Accredited for compliance with ISO/ IEC 17025

For All Civil Testing
Servicing South East Queensland

CALIFORNIA BEARING RATIO TEST CERTIFICATE

Project: **1055 Bruxner Highway**
Goonellabah

Requested By: **O/N**
Date Tested: **22-10-15**

Client: **Aarian Pty Ltd**

Report No. **_7;...;::8:..::4'--------**

Laboratory Test Procedure:- AS1289 6.1.1, 5.1.1,(2.7KG, 300MM, 3 LAYERS, 25 BLOWS/ LAYER,

Date Sampled	22-10-15	22-10-15	22-10-15	22-10-15	22-10-15
Location	BHll	BH14	BH19	BH24	BH27
	150-1100	250-2700	1200-3300	1000-3600	150-1900
	See	Attached	Bore	Hole	
Description of Sample	744.6	744.7	744.8	744.9	744.10
Max. Lab. Dry density t/m3	1.52	1.61	1.76	1.46	1.50
Optimum moisture content%	18.5	15.5	14.5	19.0	16.5
Material retained on 19mm	0.0	0.0	0.0	0.0	0.0
Was the 19mm mat. Replaced	no	no	no	no	no
Dry before soak	1.52	1.61	1.76	1.46	1.50
Density t/m3 after soak	1.52	1.61	1.76	1.46	1.50
Density Ratio before soak	100.0	100.0	100.0	100.0	100.0
Moisture Ratio before soak	100.0	100.0	100.0	100.0	100.0
No. of days soaked	4	4	4	4	4
Surcharge kg	4.5	4.5	4.5	4.5	4.5
Moisture Content after Test% top 30mm	19.5	16.0	16.0	19.5	17.5
remainder	18.5	15.5	14.5	19.0	16.5
Swell after soak%	0.5	0.5	0.5	0.5	0.5
C.B.R. value 2.5mm	3.5	5.0	7.5	4.0	4.0
C.B.R. value 5.0mm	3.5	5.0	8.0	4.5	4.5

Remarks: See location map for approximate test location
Soaked

Nata Laboratory Number: 10602
ABN 71066665147 Mill Lane Nambour

Signatory: C. Templeton

Date: **1-12-15**

Form 7A May 2005

Nata Registered Laboratory Number: 10602

SOUTH EAST SOIL TESTING
A.B.N. 71 066 665 147

PO Box 1225, Nambour QLD 4560
PH (07) 5442 2860 FAX (07) 5442 2840
Mob 0429 674 334

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Accredited for compliance with ISO/ IEC 17025

For All Civil Testing
Servicing South East Queensland

CALIFORNIA BEARING RATIO TEST CERTIFICATE

Project: **1055 Bruxner Highway Goonellabah**
Requested By: 0/..N
Date Tested: 22-10-15
Client: **Aarian Pty Ltd**
Report No. 7 84

Laboratory Test Procedure:- AS1289 6.1.1, 5.l.1,(2.7KG, 300MM, 3 LAYERS, 25 BLOWS/ LAYER,

Date Sampled	22-10-15	22-10-15	22-10-15	22-10-15	22-10-15
Location	BHl	BH3	BH5	BH8	BHlO
	150-2000	150-1400	50-1900	250-1700	1500-3800
	See	Attached	Bore	Hole	
Description of Sample	744.1	744.2	744.3	744.4	744.2
Max. Lab. Dry density t/m3	1.51	1.55	1.48	1.67	1.52
Optimum moisture content%	16.5	17.0	17.5	18.5	18.0
Material retained on 19mm	0.0	0.0	0.0	19.5	4.5
Was the 19mm mat. Replaced	no	no	no	no	no
Dry before soak	1.51	1.55	1.48	1.67	1.52
Density t/m3 after soak	1.51	1.55	1.48	1.67	1.52
Density Ratio before soak	100.0	100.0	100.0	100.0	100.0
Moisture Ratio before soak	100.0	100.0	100.0	100.0	100.0
No. of days soaked	4	4	4	4	4
Surcharge kg	4.5	4.5	4.5	4.5	4.5
Moisture Content after Test% top 30mm	17.5	17.5	18.0	19.0	19.0
remainder	16.5	17.0	17.5	18.5	18.0
Swell after soak%	0.5	0.5	0.5	0.5	0.5
C.B.R. value 2.5mm	4.0	4.0	4.0	6.5	4.5
C.B.R. value 5.0mm	4.0	4.0	4.0	6.0	4.5

Remarks: See location map for approximate test location
Soaked
Nata Laboratory Number: 10602
ABN 71066665 147 Mill Lane Nambour

Signatory: C. Templeton

Date: **1-12-15**

Form 7A May 2005

066 665 147 Pty Ltd *T/A* ABN 71066665 147

P.O. Box 1225, Nambour Qld 4560

SOUTH EAST SOIL TESTING

PH 0429 674334

For all Civil Testing

Servicing South East Queensland

Project: 1055 Bruxner Hiu;hway
Goonellabah

Client: Aarian Pty Ltd

Requested By: 0/N

Date Tested: 22-10-15

Report No.: 784

Lab test **procedure:** AS1289 3.9.2, 3.4.1, 3.6.1
Sample Method: 12t Excavator
Sample Description: See attached Bore hole
Location: See attached site plans. Approximate location only

Description	Depth (mm)	PP(KPa)	LL	Pl	LS	%passing 0.425mm
BHI	350	120				
BH2	1000	150	53.5	36.5	16.5	72
BH3	600	150				
BH4	900	90				
BH5	600	150	54.0	29.5	15.5	81
BH6	700	220				
BH7	900	200				
BH8	1100	160	56.5	41.0	16.5	47
BH9	900	150				
BHI0	900	110				
BHll	1200	180	48.5	32.0	15.0	76
BH12	1400	200				
BH13	1500	150	49.5	34.5	16.0	84
BH14	1000	180				
BH15	1200	200	55.0	30.5	15.0	82
BH16	1200	150				
BH17	1800	300	32.0	21.0	12.0	38
BH18	1400	350	30.5	16.0	10.5	40
BH19	900	150				
BH20	900	200				
BH21	1000	160	44.5	28.0	16.0	89
BH22	1300	250				
BH23	900	150	38.5	24.0	13.0	81
BH24	800	120				
BH25	1200	100				
BH26	1200	80	48.0	31.5	15.0	74
BH27	1100	150				
BH28	1500	250	46.0	29.5	16.5	91
BH29	1000	125				
BH30	1000	150	52.5	32.0	15.5	86
BH31	900	110				
BH32	1400	220	48.0	31.0	14.0	87
BH33	1000	120				

Authorised signatory:

C. Templeton

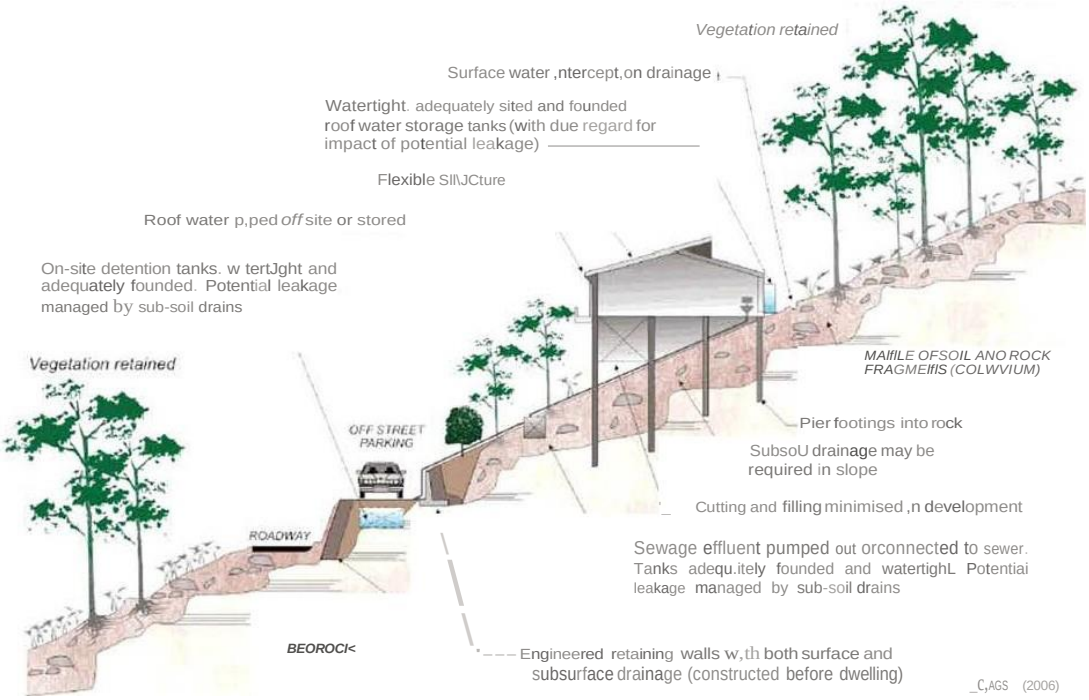
Date: 1-12-15

Mill Lane Nambour

Form 4 March 2003

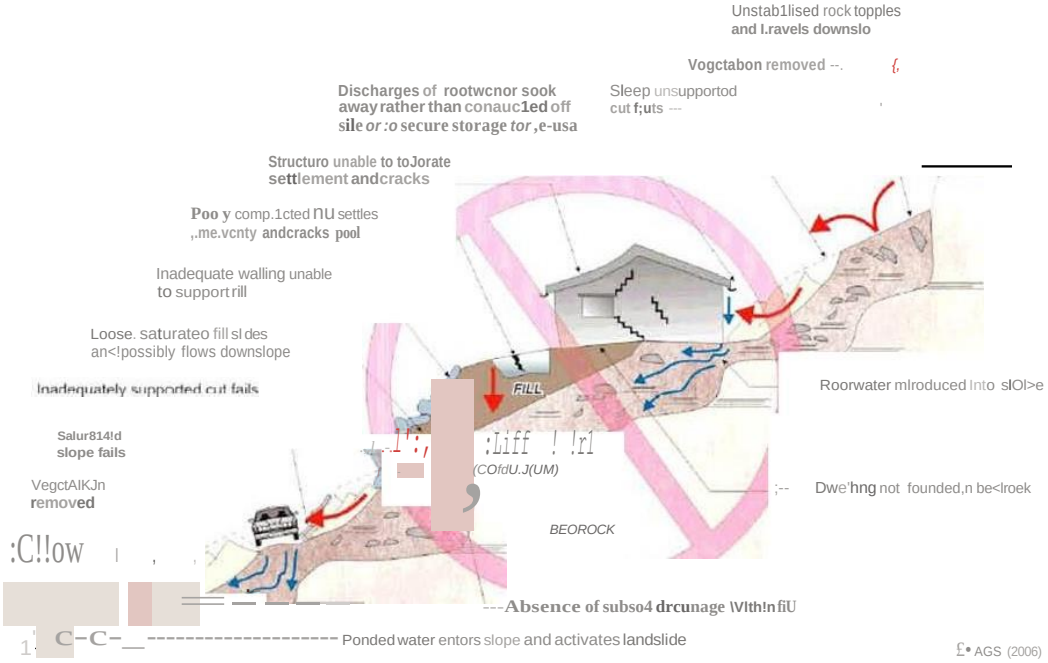
Appendix C

EXAMPLES OF GOOD HILLSIDE PRACTICE



_C,AGS (2006)

EXAMPLES OF POOR HILLSIDE PRACTICE



£• AGS (2006)

See alsoAGS (2000)Appendlx J

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPEJ\1DIX C: LA1\1DSLIDE RISK ASSESSlVIENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

*QUALITATIVE MEASURES OF **LIKELIHOOD***

Approximate Annual Probabilit;v		Implied l11dicati1•e Landslide Recurrence Intenal		Descri1>tion	Descriptor	Lenl
Indicative VaJue	NotlonaJ B01111da1-y					
JO-I	sx10-^{2}	10 years	20 years	TI1e event is expected to occur over the design life.	ALMOST CERTAIN	A
I0-2	5x10-^{3}	100 years	200 years	The evem will probably occm· tuider adverse conditions over the design life.	**LIKELY**	B
10-'	5xl0^{4}	1000 years	2000 vears	l11e evem could occur under adverse conditions m·er the desi_!lll !ife.	POSSIBLE	C
10-4	5xl0-S	10.000 years	20.000 years	The event might occtu· under ve1y adYerse circumstances O\'er the desi1m life.	UNLIKELY	D
10->	5xl0-0	100_000 years	200.000 years	l11e ewnt is conceiYable but only under exceptional circllllStances over the desiw life.	RARE	E
10·0		1.000_000 years		The event is inconceivable or fanciful over the design life.	**BARELY** CREDIBLE	F

Note: (l) TI1e table should be used from left to right: use Approximate Annual Probability or Description to assign Descriptor. not *rice rersa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approxi.nrnte Cost of Damage		Description	Descriptor	Levpl
Indicative Value	Notional Boundary			
200%	100%	Stmcnu·e(s) completely destroyed and/or large scale damage requiting major engineering works for	CATASTROPHIC	1
60%	40%	Extensive damage to most of strucrure. and/or extending:beyond site bom1daries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage_	MAJOR	2
20%	10%	Could cause al least one adjacent property minor consequence damae:e.	**MEDTI.JM**	3
5%	1%	Limited damage to pa11 of structme. and/or pait of site requiring some reinstatement stabilisation works.	lv!INOR	4
0,5%		Little damage. (Note for high probabiliiy event (Almost Ce1iai11). this catego1y may be subdivided at a notional bounda1y of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market Yalue. being the cost of the in1proved rnlue of the llilllffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direcr cost of the damage. such as the cost ofreinstatement of the da1naged po1tion oftbe prope1fy (land plus structures), stabilisation works required to rende.r the site to tolerable risk leYel for the landslide which has occun-ed and professional design fees. and consequential costs such as leg:al fees. tempora1y accommodation, It does not include additional stabilisation works to adch-ess other landslides which may affect the property.

(4) The table should be used from left to right: use Approximate Cost of Damage or Description to assign Descriptor. not vice versa

APPEl\TJ)IX C: - QUALITATIVE TERMIJ'\[1]OLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX - LEVEL OF RISK TO PROPERTY

LIKELIHOOD	Iudirative Value of Approximate Annual Probabilitv	CONSEQUEl\"CES TO PROPERTY (W'ith Iuclic:itin Approximate Cost ofDmnage)				
		1: CATASTROPHIC 200%	2: .\1AJOR 60%	3: MEDn'l),f 20%	4: MCNOR 5%	5: 11\"SlG:'TFICM1 0.5%
A - ALMOST CERTAI:'i	10·1				H	MbrL(5)
B - LIKELY	10·2				iv(	L
C - POSSIBLE	10-J			M	M	VL
D - Ul\"LIKELY	10-l	H	M	L	L	VL
E - RARE	10·'	M	L	L	VL	VL
F - BARELY CREDIBLE	10-6	L	VL	VL	VL	VL

l'iotes: (5) For Cell A5. may be subdivided such that a consequence ofless than 0.1% is Low Risk.
(6) When considering a 1isk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the cuuent time.

RISK LEVEL IMPLICATIONS

Risk Level		Example Implications (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research. planning aud implementation of treatment options essential to reduce risk to Low: may be too expensive and not practical. Work likely to cost more than mine of the rope1ty.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation. planning and implementation **of** treatment options required to reduce risk to Low. Work would cost a substantial smn in relation to tl1e value of the property.
1-f	MODERATE RISK	May be tolerated in ce1tai11cimunstances (subjecl to regularor's approval) but requires investigation. planning and implementation oftreanuent options to reduce !he risk to Low. Treatment options to reduce to Low 1isk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the lisk to this level. ongoing maintenance is re_guired.
	VERY LOW RISK	Acceptable. Manage by nonnal slope maintenance procedures.

l'iote: (7) The implications for a patticular situation are to be detennined by all pa11ies to the risk assessment and may depend on the namre of the prope1ty at risk: these are only given as a general guide.