SLOPE STABILITY ASSESSMENT AND REPORT

P957B

Prepared for: Wayne Wong

Project: Slope Stability Assessment,
Lot 3 on RP837881,
318 Thirkettle Avenue
Frenchville, QLD 4701

Job Reference: 2128E.P.957B

Date: 4th March 2017

Construction Sciences

Contact Information

Construction Sciences Pty Ltd
ABN 74 128 806 735

101 High Street,
North Rockhampton Qld 4701

Telephone: 07 4928 0044
Facsimile: 07 4926 1286

constructionsciences_cq@cardno.com.au
www.constructionsciences.net

Document Information

Prepared for	Wayne Wong
Project Name	Slope Stability Assessment & Report, Lot 3 on RP837881, 318 Thirkettle Avenue, Frenchville
Commission	Slope Stability Assessment
File Reference	2128E.P.957
Job Reference	P957B
Date	4/03/2019

Document Control

Version	Date	Description of Revision	Prepared By	Prepared (Signature)	Reviewed By	Reviewed (Signature)
A	19/02/2019	FINAL REPORT	P.Kilaverave		S.Kwok	
B	4/03/2019	FINAL REPORT	P.Kilaverave		S.Kwok	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
A	FOR ISSUE	P.Kilaverave		19/02/2019
B	RPEQ Sign Off	P.Kilaverave		4/03/2019

TABLE OF CONTENTS

TABLES

APPENDICES

1.0 INTRODUCTION

A slope stability investigation was carried out for the proposed residential development at Lot 3 on RP837881, Thirkettle Avenue, Frenchville at the request of Mr Wayne Wong.

The primary objective of this investigation was to satisfy the general requirements of Council which requires a slope stability assessment of the site in order to determine whether the site is suitable and feasible for development based on the existing geotechnical conditions. This includes ensuring long term stability for the development works associated with earthwork batters, retaining structures, access driveways and house pads.

The following methodology was undertaken by our Geotechnical Engineer in order to achieve the objective above.

- Carry out literature research of known areas of landslip and assessed whether this site was located within an area of instability.
- Carried out a general site walk over and general mapping of existing soil/rock conditions as part of the fieldwork investigation.
- Provided recommendations on the building type considered suitable for this site.
- Commented on material encountered in relation to its use as structural fill.

At the completion of the investigation work an engineering report was prepared which included all the data gathered. The information was analysed and discussed, and conclusions and recommendations presented to satisfy the objectives of the investigation.

Authorisation to proceed with the investigation was received by this office on the 22nd January 2019 from Mr Wayne Wong.

This report must be read in conjunction with our attached *'General Notes'*, and *'Guidelines for Hillside Construction'*, Australian Geomechanics Society Journal, Volume 37, No. 2, May 2002.

2.0 SITE DESCRIPTION

The site, with real property address described as Lot 3 on RP 837881, was located on the southern side of Thirkettle Avenue with the proposed development set back approximately 10m from the existing street frontages.

The site was bound by existing residential buildings to the west and east and with the proposed residential building positioned to occupy approximately the top half of the block. Vegetation onsite comprised of maintained lawn with some trees located towards the downslope and towards the southern boundary of the block.

The sloping surface was generally planar in shape and descended uniformly in a southerly direction with slope measured onsite to range between 25-28% (1V:4H to 1V:3.6H).

Refer to plates 1 and 2 for typical site conditions encountered during our investigation.

Plate 1: View of the site from the southern property boundary.

Plate 2: View of the site from north east corner of the property boundary.

3.0 INVESTIGATION WORK

3.1 Background Search

As part of the slope stability assessment for the site, a literature research investigation was carried out to determine whether the site had any known published historical landslips within its boundaries.

Aerial photographic interpretation, using stereographic projection, was also carried out to assess if any physical evidence of previous landslips on the site could be observed.

3.2 Fieldwork

Fieldwork for the investigation was carried out on the 8th February 2019 and included the excavation of two (2) test pits at the locations shown on the Site Investigation Location Plan included in Appendix B. The material encountered at each location is described on the test pit logs included in Appendix C. In addition, borehole locations from previous drilling works at this site have also been included with the respective logs at the end of Appendix B and C respectively.

The subsurface profile was logged in general accordance with AS1726 *"Geotechnical Site Investigations".* Strata identification was based on inspection of materials recovered from the excavated material. The descriptions of the material encountered are further detailed on the test pit logs (and boreholes) in Appendix C.

3.3 Laboratory Testing

No laboratory testing was undertaken as part of this investigation, however field and laboratory test data provided in Construction Sciences' Site Classification (Ref No. 2128E/P/957A dated 21/12/2018) Report have been reviewed as part of the assessment undertaken in this report.

4.0 SUBSURFACE CONDITIONS

4.1 Subsurface Strata

The fieldwork indicated that the subsurface conditions consisted of varying thickness of overburden soil at TP1 and TP2.

A topsoil layer was observed to be common at both test pit locations with thickness ranging from 0.2-0.25m. Only colluvium and suspected fill material was encountered at TP2 location to approximately 0.5m depth.

The basal layer(s) encountered at both test pit locations comprised residual soils of dense clayey sandy gravels, underlain by distinctively weathered rock, resulting in bucket refusal at 0.6m and 0.8m at TP1 and TP2 respectively.

In the absence of documentations regarding the nature of the fill material, the existing fill material must be deemed to be uncontrolled.

The logs in Appendix C should be referred to for the detailed description of material encountered at each investigation location. A summary of the conditions encountered at each investigation location is detailed in Table 1 below.

Table 1: Summary of Subsurface Strata

Location	TOPSOIL	COLLUVIUM*	RESIDUAL	BEDROCK	RD (m)	Termination Condition
	Silty Gravelly SAND (SP)	Sandy Clayey GRAVEL (GC)	Clayey Sandy GRAVEL (GC)	DW Rock		
TP1	0.0-0.25	-	0.25-0.5	0.5-RD	0.6	Bucket Refusal DW Rock
TP2	0.0-0.2	0.2-0.45	0.45-RD	-	0.8	Bucket Refusal DW Rock

NOTES:

1. RD - Refusal Depth
2. All depths were measured from the existing surface level at the time of the investigation.
3. DW – Distinctly Weathered
4. Colluvium* - possible fill layer resulting from previous cut/fill earthworks operations.

No groundwater was encountered in any of the test pits during the investigation. However, it is possible that seepage could occur along the soil/rock during and after periods of wet weather.

5.0 GEOTECHNICAL ASSESSMENT

5.1 Earthworks

5.1.1 Site Preparation

All site preparation work should be carried out in accordance with AS3798-2007 *'Guidelines on Earthworks for Commercial and Residential Developments'*.

No proposed cut/fill levels were provided at the time of preparation of this report for building platforms and or access driveways. Only topographical survey data with relevant sections were provided and reviewed as part of this assessment.

All soil containing grass and root material should be stripped from the building sites and access areas prior to construction. This material is not considered suitable for use as structural fill but may be stockpiled for possible future landscaping purposes, if required. Stripping depths will generally be in the order of around 0.2m. However, isolated areas may require a deeper stripping depth. Furthermore, fill and/or colluvium material was encountered between 0.2m to 0.45m depth at TP2. It is recommended that all colluvium and fill material be excavated and recompacted where required subject to the final configuration of the proposed building. However, if left in place, the colluvium layer may creep and therefore, it is recommended that no loading is to be placed on any colluvium.

Where any existing fill is encountered during construction stage, it is expected that this fill was not placed in accordance with recognised standards and as such must be deemed to be *'uncontrolled'*. As such, removal of this fill and recompaction of the fill to the standards discussed below is recommended.

Prior to the placement of any structural fill, it is recommended that all underlying colluvium must be removed and the site should be proof rolled using a minimum 10 tonne vibrating padfoot roller. Should isolated soft/loose areas be encountered during this process, this material should be removed and replaced with select fill. It is likely that the removal of fill and colluvium where encountered, will alleviate potential handling, settlement or creep issues during and after construction.

Depressions formed by the removal of vegetation should have all disturbed soil cleaned out and be backfilled with compacted select fill material.

Construction Sciences should be engaged to confirm the suitability of the stripping depth and confirm the adequacy of the newly exposed soil for fill placement.

5.1.2 Structural Fill Placement

With the exception of the topsoil stratum, all materials encountered during the investigation are considered acceptable for use as structural fill provided that any pre-treatment (moisture conditioning, removal of oversize), is carried out prior to fill placement.

To minimise the potential for post compaction volume change due to moisture content variations, any structural clay bearing fill should be placed in loose layers not greater than 200mm thick at a moisture content in the range -2% to +3% of the standard optimum moisture content, and be compacted to a minimum dry density ratio of 98% standard compaction as per AS1289 5.1.1.

Measures should be adopted to ensure that this clay fill material is not allowed to dry out prior to the placement of succeeding layers of fill and final covering with building slabs and road pavements.

Filling should not be undertaken over colluvium strata. Filling should only be undertaken above insitu weathered rock.

It is recommended that the placement of all structural fill be inspected, tested and certified by Construction Sciences to Level 1 requirements, during the earthworks operations to ensure that all fill is placed in a *'controlled manner'*, in accordance with AS3798-2007.

Where filling is to be carried out over sloping land (slope > 8H:1V), the surface of the natural material should be benched so that the fill can be *'keyed'* into the slope, allowing for a good bonding interface between structural fill and the natural. The maximum height of the step must not exceed 0.5m, and the benching must be sloped to ensure free drainage.

5.1.3 Excavatability

Soils above excavator refusal depth should be able to be excavated using a small dozer (e.g. Cat D6 or similar) in bulk excavations and a medium size backhoe in trench excavations. Below excavator refusal depths, larger plant, including pneumatic/hydraulic equipment, may be required in order to achieve cut depths below those achieved during our investigation.

5.2 Batter Slopes

For initial design purposes, previous experience in the area has indicated that the following maximum unprotected batter slopes may be adopted for the cut and fill batters on the site as per Table 3. All final batter slopes must be reviewed by Construction Sciences to determine the stability of the final slope profile.

Table 2: Maximum Unprotected Batter Slopes

Material Type	Short Term (Maximum)	Long Term (Maximum)
Residual Soils (cut)	1V:1H	1V:2H
Colluvium	1:2H	1:3H
Controlled Fill Batters(1)	1V:1H	1V:2H
Weathered Rock	1V:1H	*

Notes:

(1) All fill batters should be overfilled, compacted and cut back at the maximum angles recommended above and with some form of erosion protection to minimise any potential unnecessary scour effects due to weathering. This is for fill placed in a controlled manner and in accordance with AS3798-2007.

* Denotes requirement for detailed stability assessment.

5.3 Building Footings

5.3.1 Footing Design Parameters

Based on the nature of the proposed dwelling and the subsurface conditions encountered, it is recommended that structural load bearing footings of the proposed dwelling be founded into the underlying **weathered bedrock** profile. Any cut/fill areas on site will have the potential for differential settlement across the floor slab and shall be taken into consideration in the design stage.

The maximum allowable bearing capacities shown in Table 4 below are suggested for the design of high level pad or strip footings.

Table 3: Maximum Allowable Bearing Capacities for Shallow Footings

Founding Material	Maximum Allowable Bearing Capacity (kPa)
Dense Clayey Sandy GRAVEL (GC) (RESIDUAL)	NR
Distinctively Weathered Rock – LOW TO MEDIUM STRENGTH	400*

NOTES:

NR = Not Recommended

*A footing inspection shall be carried out by this office to ensure bearing capacity and cleanliness at the base of the footing.

6 SLOPE STABILITY ASSESSMENT

Fieldwork for this component of the investigation was carried out by a Geotechnical Engineer on 8th February 2019.

The fieldwork exercise included an inspection of the site to assess the following;

- Determine slope angle
- Observe vegetation
- Note any evidence of tension cracking
- Note any evidence of seepage
- Note any evidence of soil creep
- Note any evidence of previous slips
- Geological features
- Subsurface conditions
- Drainage issues

Reference to the Queensland Department of Mines' 1:100,000 geological series Rockhampton sheet indicates that the site is underlain by the Lakes Creek Formation comprising siltstone and lithic sandstone.

Slope angles across the site varied from approximately 15° (25%) to about 18° (28%) and was observed to be sloping down in a southerly direction.

All footings of the building must be founded into the underlying weathered rock profile and proper drainage provision be in place to ensure that the materials around the building area will not become saturated and become unstable. It is anticipated that material won from cutting during construction may be used as fill material. The use of this material as fill will be dependent upon its material properties satisfying the required specifications. No fill should be placed over the colluvium. There is a risk that movement within the colluvium may occur and therefore it is not recommended that the material will support any loads.

Where earthworks involve some cutting of the site, engineered retaining walls should be adopted to provide stability. For any retaining structures that form part of the main building structure with top and bottom restraints, the conditions for material retained should be considered 'at rest' given that the retaining wall will have little tolerance for movement. All retaining walls will need to be founded into the underlying weathered bedrock strata.

Further to these parameters, in consideration for retaining structures, it is important to enable good drainage behind the structure itself to prevent excessive hydrostatic pressure. It is recommended to utilise clean granular backfill behind the wall itself and drain pipes at the base of the structure to release any water. The design should also allow for water pressure acting on the retaining structure to at-least one third the wall height in order to ensure stability in an elevated water level situation.

In addition, material directly behind the structure should not be heavily compacted, otherwise adverse effects from increased earth pressures may affect the in service use of the structure. Compaction by hand-held equipment is recommended when placing these layers.

Any retaining wall design for the building should take into consideration the loads that may apply from adjacent sites (buildings, driveways, etc.).

It is recommended that all cut batter slopes associated with the construction of these allotments be vegetated to control erosion potential and any potential surficial slipping.

The stability of an area under construction will largely be a function of adequate drainage control. Therefore, it is assumed that stormwater management will be designed and constructed in accordance with recognised building practices/standards to control all drainage issues. It is strongly recommended that adequate drainage paths are installed at the top and base of the cut batters in order to control and direct runoff away from the area.

It is recommended that removal of vegetation (with the exception of topsoil stripping) be kept to a minimum and that any vegetation removal only be undertaken where it is necessary in order to construct building platforms. Furthermore, where stripping is undertaken across the building and earthworks area, re-vegetation and/or batter protection should be a requirement in order to reduce the effects of erosion.

Based on the background search and the mapping exercise, the presence of colluvium indicates that there would be risk of potential future creep movement across the site. This must be considered in the design of the structural footings.

Further to the above, a quantitative risk assessment has been assigned to the site based on the required format provided by the *AGS 'Guidelines for Landslide Risk Management 2007'*. The results of this risk assessment indicated that the lot has a risk level of 'low to very low'. For details of this analysis, refer to Appendix E.

A slope stability analysis was carried out using Slope/W modelling software and results indicate that the current factor of safety at the site without any developments is greater than 1.5, which is above the acceptable limit. The slope analysis can be viewed in Appendix F. The final building configuration should be reviewed bv CS to confirm the slope stability analysis for the developed site.

Some surficial creep may be expected to occur in the colluvium over the long term. Provided that the building is founded into the underlying weathered rock, the building should have a sufficient factor of safety against slip failure for the long-term, subject to further stability analysis to confirm. Furthermore, it is recommended that the building foundations be embedded into the weathered rock profile to resist any lateral forces that may be applied from this surficial creep. There will still remain the potential for surface creep or slippage of the colluvium across the site.

The construction of the proposed dwelling and the driveway access road on this site is not expected to adversely affect the stability of the lot provided the recommendations above are adhered to and adequate civil/hydraulic and structural issues are addressed. Given the results of our assessment, provided the above recommendations are adhered to, the site is considered acceptable for its proposed usage with regards to stability. Effective subsurface and surface drainage will be critical in the maintenance of stability of the site.

7 CONSTRUCTION INSPECTIONS

It is recommended that placement of all structural fill and cut/fill batters be inspected, tested and certified where necessary, by Construction Sciences Pty Ltd to ensure recommendations made in this report have been adhered to.

Should subsurface conditions other than those described in this report be encountered, Construction Sciences Pty Ltd should be consulted immediately and appropriate modifications developed and implemented if necessary.

We trust that this information is helpful. Please contact our office with any queries or if further information is required.

Poka Kilaverave

Geotechnical Engineer

For Construction Sciences Pty Ltd

Sammy Kwok

Senior Geotechnical Engineer (RPEQ 18752)

APPENDIX A

GENERAL NOTES

Construction Sciences

GENERAL NOTES

GENERAL

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the introduction section(s) of the document. The report should not be used by other parties or for other purposes as it may not contain adequate or appropriate information.

BOREHOLE/TEST PIT LOGGING

The information on the borehole/test pit logs has been based on a visual and tactile assessment except at the discrete locations where test information is available (field and/or laboratory results).

Reference should be made to our standard sheets for the definition of our logging procedures (Soil and Rock Descriptions).

GROUNDWATER

Unless otherwise indicated the water levels noted on the borehole/test pit logs are the levels of free water or seepage recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeabilities. Further variations of this level could occur with time due to such effects as seasonal and tidal fluctuations or construction activities. Final confirmation of levels can be only made by appropriate instrumentation techniques and programmes.

INTERPRETATION OF RESULTS

The discussion and recommendations contained within this report are normally based on a site evaluation from discrete borehole/test pit data. Generalised or idealized subsurface conditions (including any cross-sections contained in the report have been assumed or prepared by interpolation/extrapolation of this data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions used for this report can occur, particularly between discrete borehole/test pit locations. Furthermore, certain design or construction procedures may have been assumed in assessing the soil structure interaction behaviour of the site.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed in this report should be referred to this firm for appropriate assessment and comment.

FOUNDATION DEPTH

Where referred to in the report, the recommended depth of any foundation (piles, caissons, footings, etc.) is an engineering estimate of the depth to which they should be constructed. The estimate is influenced and perhaps limited by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The depth remains, however, an estimate and therefore liable to variation. Footing drawings, designs and specifications based upon this report should provide for variations in the final depth depending upon the ground conditions at each point of support.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in this report for the inclusion in the contract documents or engineering specification of the subject development, such reproduction should include at least all the relevant borehole/test pit logs and test data, together with the appropriate standard description sheets and remarks made in the written report of a factual or descriptive nature.

APPENDIX

B

SITE INVESTIGATION LOCATION PLAN


TP2
BH1
BH2
TP1
© 2018 Google
feet
300
meters
90

APPENDIX

C

TEST PIT LOGS WITH EXPLANATORY NOTES

TEST PIT NUMBER TP1

Construction Sciences

CLIENT Wayne Wong
PROJECT NAME Slope Stability Analysis
PROJECT NUMBER 2128E.P.957
PROJECT LOCATION 318 Thirkettle Avenue

DATE STARTED 7/2/19 **COMPLETED** 7/2/19
R.L. SURFACE
DATUM
EXCAVATION CONTRACTOR Jeef Thompson Excavator Hire
SLOPE ---
BEARING ---
EQUIPMENT 5T Excavator
TEST PIT LOCATION Refer to Site Plan in Appendix B
TEST PIT SIZE 0.5X1.2m
LOGGED BY M.Walters
CHECKED BY P.Kilaverave
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
Bucket					SP	Silty Gravelly SAND (TOPSOIL) fine to coarse sand, dark brown, dry, dense, fine to coarse gravel, subangular and angular, negligible plastic fine, roots and rootlets.		
					GC	Clayey Sandy GRAVEL (RESIDUAL) fine to coarse gravel, angular and subangular, cobbles and boulders, fine to coarse sand, low plastic fines.		
			0.5		DW/SW	DISTINCTLY TO SLIGHTLY WEATHERED ROCK (SILTSTONE) high to very high strength, brown with occasional grey/blue, fine to medium grained, granular.		
						Test Pit Terminated at 0.6m (Bucket Refusal - DW/SW Rock)		
			1.0					
			1.5					
			2.0					

BOREHOLE / TEST PIT TP LOG 5.5M.GPJ GINT AUSTRALIA.GDT 7/2/19

Test Pit 1 (TP1) - Exposed weathered rock at approximately 0.5m

TEST PIT NUMBER TP2

Construction Sciences

CLIENT Wayne Wong
PROJECT NAME Slope Stability Analysis
PROJECT NUMBER 2128E.P.957
PROJECT LOCATION 318 Thirkettle Avenue

DATE STARTED 7/2/19 **COMPLETED** 7/2/19
R.L. SURFACE
DATUM
EXCAVATION CONTRACTOR Jeef Thompson Excavator Hire
SLOPE ---
BEARING ---
EQUIPMENT 5T Excavator
TEST PIT LOCATION Refer to Site Plan in Appendix B
TEST PIT SIZE 0.5X1.2m
LOGGED BY M.Walters
CHECKED BY P.Kilaverave
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
Bucket					SP	Silty Gravelly SAND (TOPSOIL) fine to coarse sand, dark brown, dry, dense, fine to coarse gravel, subangular and angular, negligible plastic fine, roots and rootlets.		
					GC	Sandy Clayey GRAVEL (COLLUVIUM/FILL?) fine to coarse gravel, subangular, brown, dry, dense, fine to coarse sand, medium plastic fines.		
			0.5		GC	Clayey Sandy GRAVEL (RESIDUAL) fine to coarse gravel, angular and subangular, cobbles and boulders, fine to coarse sand, low plastic fines.		
						Test Pit Terminated at 0.8m (Bucket Refusal - DW/SW Rock)		
			1.0					
			1.5					
			2.0					


Test Pit 2 (TP2) - Exposed weathered rock at approximately 0.8m

LOG SECTION

kPa IS ALLOWABLE BEARING PRESSURE CALCULATED IN ACCORDANCE WITH A PAPER BY M.J. STOCKWELL (JUNE 1977.)

TEST SITE NO. 1 LOCATION:REFER TO SKETCH

DEPTH (mm)	DESCRIPTION	SAMPLE	FILL	kPa	D.C.P.
100	TOPSOIL				
200					
300	SANDY GRAVELLY CLAY (Orange Brown) Fine to Coarse Sand Fine to Medium Angular Gravel Medium Plasticity Moist / Stiff				3
400					2
500				100	3
600					4
700					4
800				160	6
900					8
1000					9
1100				300+	>20
1200	SANDY CLAYEY GRAVEL (Orange Brown) Fine to Coarse Sand Fine Angular Gravel Medium Plasticity Moist / Very Stiff				
1300					
1400					
1500					
1600					
1700					
1800					
1900					
2000	END OF HOLE				
2100					
2200					
2300					
2400					
2500					
2600					
2700					
2800					
2900					
3000					

TEST SITE NO. 2 LOCATION:REFER TO SKETCH

DEPTH (mm)	DESCRIPTION	SAMPLE	FILL	kPa	D.C.P.
100	TOPSOIL				3
200	SANDY CLAYEY GRAVEL (Brown / Orange Brown) Fine to Coarse Sand Fine to Coarse Gravel Low Plasticity Moist / Medium Dense				5
300				120	4
400					3
500					9
600				250	>20
700	UTP - MODERATELY WEATHERED ROCK				
800					
900					
1000					
1100					
1200					
1300					
1400					
1500					
1600					
1700					
1800					
1900					
2000					
2100					
2200					
2300					
2400					
2500					
2600					
2700					
2800					
2900					
3000					

The methods of description and classification of soils used in this report are generally based on Australian Standard AS1726-1993 *Geotechnical Site Investigations*.

Soil description is based on an assessment of disturbed samples, as recovered from bores and excavations, or from undisturbed materials as seen in excavations and exposures or in undisturbed samples. Descriptions given on report sheets are an interpretation of the conditions encountered at the time of investigation.

In the case of cone or piezocone penetrometer tests, actual soil samples are not recovered and soil description is inferred based on published correlations, past experience and comparison with bore and/or test pit data (if available).

Soil classification is based on the particle size distribution of the soil and the plasticity of the portion of the material finer than 0.425mm. The description of particle size distribution and plasticity is based on the results of visual field estimation, laboratory testing or both. When assessed in the field, the properties of the soil are estimated; precise description will always require laboratory testing to define soil properties.

Where soil can be clearly identified as FILL this will be noted as the main soil type followed by a description of the composition of the fill (e.g. FILL – yellow-brown, fine to coarse grained gravelly clay fill with concrete rubble). If the soil is assessed as possibly being fill this will be noted as an additional observation.

Soils are generally described using the following sequence of terms. In certain instances, not all of the terms will be included in the soil description.

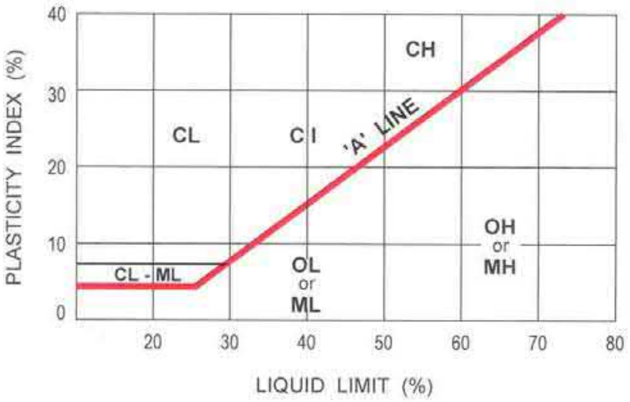
MAIN SOIL TYPE (CLASSIFICATION GROUP SYMBOL)
- strength/density, colour, structure/grain size, secondary and minor components, additional observations

Information on the definition of descriptive and classification terms follows.

<u>SOIL TYPE and CLASSIFICATION GROUP SYMBOLS</u>

	Major Divisions	Particle Size	Classification Group Symbol	Typical Names
COARSE GRAINED SOILS (more than half of material is larger than 0.075 mm)	BOULDERS	> 200mm		
	COBBLES	63 – 200mm		
	GRAVELS (more than half of coarse fraction is larger than 2.36mm)	Coarse: 20 – 63mm Medium: 6 – 20mm Fine: 2.36 – 6mm	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels.
			GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than 2.36mm)	Coarse: 0.6 – 2.36mm Medium: 0.2 – 0.6mm Fine: 0.075 – 0.2mm	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
			SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (more than half of material is smaller than 0.075 mm)	SILTS & CLAYS (liquid limit <50%)		ML	Inorganic silts and very fine sands, silty/clayey fine sands or clayey silts with low plasticity.
			CL and CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS & CLAYS (liquid limit >50%)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils.
			CH	Inorganic clays of high plasticity.
			OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

PLASTICITY CHART FOR CLASSIFICATION OF FINE GRAINED SOILS



(Reference: Australian Standard AS1726-1993 *Geotechnical site investigations*)

DESCRIPTIVE TERMS FOR MATERIAL PROPORTIONS

Coarse Grained Soils		Fine Grained Soils	
% Fines	Modifier	% Coarse	Modifier
< 5	Omit, or use 'trace'	< 15	Omit, or use trace.
5 – 12	Describe as 'with clay/silt' as applicable.	15 – 30	Describe as 'with sand/gravel' as applicable.
> 12	Prefix soil as 'silty/clayey' as applicable	> 30	Prefix soil as 'sandy/gravelly' as applicable.

STRENGTH TERMS – COHESIVE SOILS

Strength Term	Undrained Shear Strength	Field Guide to Strength
Very soft	< 12kPa	Exudes between the fingers when squeezed in hand.
Soft	12 – 25kPa	Can be moulded by light finger pressure.
Firm	25 – 50kPa	Can be moulded by strong finger pressure.
Stiff	50 – 100kPa	Cannot be moulded by fingers, can be indented by thumb.
Very stiff	100 – 200kPa	Can be indented by thumb nail.
Hard	> 200kPa	Can be indented with difficulty by thumb nail.

DENSITY TERMS – NON COHESIVE SOILS

Density Term	Density Index	SPT "N"	CPT Cone Resistance
Very loose	< 15%	0 – 5	0 – 2MPa
Loose	15 – 35%	5 – 10	2 – 5MPa
Medium dense	35 – 65%	10 – 30	5 – 15MPa
Dense	65 – 85%	30 – 50	15 – 25MPa
Very dense	> 85%	> 50	> 25MPa

COLOUR

The colour of a soil will generally be described in a 'moist' condition using simple colour terms (eg. black, grey, red, brown etc.) modified as necessary by "pale", "dark", "light" or "mottled". Borderline colours will be described as a combination of colours (eg. grey-brown).

EXAMPLE

e.g. CLAYEY SAND (SC) – medium dense, grey-brown, fine to medium grained with silt.
Indicates a medium dense, grey-brown, fine to medium grained clayey sand with silt.

The methods of description and classification of rock used in this report are generally based on Australian Standard AS1726-1993 *Geotechnical Site Investigations*.

Rock description is based on an assessment of disturbed samples, as recovered from bores and excavations, or from undisturbed materials as seen in excavations and exposures, or in core samples. Descriptions given on report sheets are an interpretation of the conditions encountered at the time of investigation.

Notes outlining the method and terminology adopted for the description of rock defects are given below, however, detailed information on defects can generally only be determined where rock core is taken, or excavations or exposures allow detailed observation and measurement.

Rocks are generally described using the following sequence of terms. In certain instances not all of the terms will be included in the rock description.

ROCK TYPE (WEATHERING SYMBOL), strength, colour, grain size, defect frequency

Information on the definition of descriptive and classification terms follows.

ROCK TYPE

In general, simple rock names are used rather than precise geological classifications.

ROCK MATERIALS WEATHERING CLASSIFICATION

Term	Weathering Symbol	Definition
Residual soil	RS	Soil developed from extremely weathered rock; the mass structure and substance fabrics are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely weathered	XW	Rock is weathered to such an extent that it has 'soil' properties, ie. it either disintegrates or can be remoulded in water.
Distinctly weathered *	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.
Highly weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decreased compared to the fresh rock, usually as a result of iron leaching or deposition. The colour and strength of the original fresh rock substance is no longer recognisable.
Moderately weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock may be no longer recognisable.
Slightly weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition or staining.

** Subdivision of this weathering grade into highly and moderately may be used where applicable.*

STRENGTH OF ROCK MATERIAL

Term	Symbol	Point Load Index I_s (50)	Field guide to strength
Extremely low	EL	< 0.03MPa	Easily remoulded by hand to a material with soil properties.
Very low	VL	0.03 – 0.1MPa	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low	L	0.1 – 0.3MPa	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	0.3 – 1.0MPa	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	H	1.0 – 3.0MPa	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very high	VH	3.0 – 10.0MPa	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely high	EH	> 10MPa	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Notes:

1. *These terms refer to the strength of the rock material and not to the strength of the rock mass which may be considerably weaker due to the effect of rock defects.*
2. *The field guide visual assessment for rock strength may be used for preliminary assessment or when point load testing is not available.*
3. *Anisotropy of rock may affect the field assessment of strength.*

COLOUR

The colour of a rock will generally be described in a 'moist' condition using simple colour terms (eg. black, grey, red, brown, etc) modified as necessary by 'pale', 'dark', 'light' or 'mottled'. Borderline colours will be described as a combination of colours (eg. grey-brown).

GRAIN SIZE

Descriptive Term	Particle Size Range
Coarse grained	0.6 – 2.0mm
Medium grained	0.2 – 0.6mm
Fine grained	0.06 – 0.2mm

DEFECT FREQUENCY

Where appropriate, a defect frequency may be recorded as part of the rock description and will be expressed as the number of natural (or interpreted natural) defects present in an equivalent one metre length of core.

EXAMPLE

e.g. SANDSTONE (XW) – low strength, pale brown, fine to coarse grained, 3 defects per metre.

ROCK DEFECTS

Defects are discontinuities in the rock mass and include joints, sheared zones, cleavages and bedding partings. The ability to observe and log defects will depend on the investigation methodology. Defects logged in core are described using the abbreviations noted in the following tables.

The *depth* noted in the description is measured in metres from the ground surface, the *defect angle* is measured in degrees from horizontal, and the defect *thickness* is measured normal to the plane of the defect and is in millimetres (unless otherwise noted).

Defects are generally described using the following sequence of terms:

Depth, Defect Type, Defect Angle (dip), Surface Roughness, Infill, Thickness

DEFECT TYPE

B Bedding
J Joint
S Shear Zone
C Crushed Zone

SURFACE ROUGHNESS

i. rough or irregular, stepped
ii. smooth, stepped
iii. slickensided, stepped
iv. rough or irregular, undulating
v. smooth, undulating
vi. slickensided, undulating
vii. rough or irregular, planar
viii. smooth planar
ix. slickensided, planar

INFILL

Infill refers to secondary minerals or other materials formed on the surface of the defect and some common descriptions are given in the following table together with their abbreviations.

Ls limonite staining
Fe iron staining
Cl clay
Mn manganese staining
Qtz quartz
Ca calcite
Clean no visible infill

EXAMPLE

3.59m, J, 90, vii, Ls, 0.1mm

Indicates a joint at 3.59m depth that is at 90° to horizontal (i.e. vertical), is rough or irregular and planar, limonite stained and 0.1mm thick.

APPENDIX

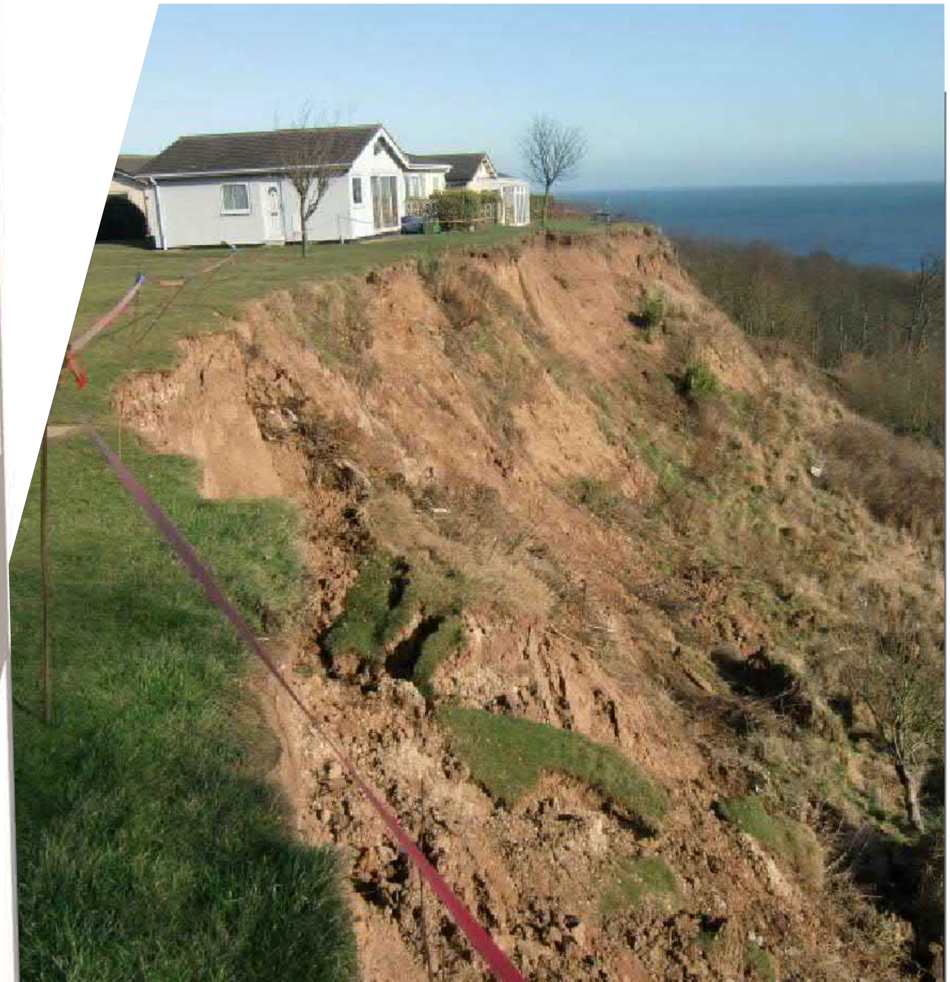
D

LABORATORY TEST REPORTS

APPENDIX

E

LANDSLIP RISK
ASSESSMENT



Landslide Risk Assessment

This report has used the landslide risk assessment methodology detailed in the Australian Geomechanics Society Landslide Risk Management Document (2007).

1. Definitions

The terminology used in this assessment is the same as that used by AGS,2007.

- **Acceptable Risk** – A risk which, for the purposes of life or work, society is prepared to accept as it is with no regard to its management. Society does not generally consider expenditure in further reducing such risks justifiable.

- **Annual Exceedance Probability (AEP)** – The estimated probability that an event of specified magnitude will be exceeded in any year.

- **Consequence** – The outcomes or potential outcomes arising from the occurrence of a landslide expressed qualitatively or quantitatively, in terms of loss, disadvantage or gain, damage, injury or loss of life.

- **Danger** – The natural phenomenon that could lead to damage, described in terms of its geometry, mechanical and other characteristics. The danger can be an existing one (such as a creeping slope) or a potential one (such as a rock fall). The characterisation of a danger does not include any forecasting.

- **Elements at Risk** – The population, buildings and engineering works, economic activities, public services utilities, infrastructure and environmental features in the area potentially affected by landslides.

- **Frequency** – A measure of likelihood expressed as the number of occurrences of an event in a given time. See also Likelihood and Probability.

- **Hazard** – A condition with the potential for causing an undesirable consequence. The description of landslide hazard should include the location, volume (or area), classification and velocity of the potential landslides and any resultant detached material, and the probability of their occurrence within a given period of time.

- **Landslide** – The movement of a mass of rock, debris, or earth (soil) down a slope.

- **Individual Risk to Life** – The risk of fatality or injury to any identifiable (named) individual who lives within the zone impacted by the landslide or who follows a particular pattern of life that might subject him or her to the consequences of the landslide.

- **Landslide inventory** – An inventory of the location, classification, volume, activity and date of occurrence of landsliding.

- **Landslide activity** –The stage of development of a landslide; pre-failure when the slope is strained throughout but is essentially intact; failure characterized by the formation of a continuous surface of rupture; postfailure which includes movement from just after failure to when it essentially stops and reactivation when the slope slides along one or several preexisting surfaces of rupture. Reactivation may be occasional (e.g. seasonal) or continuous (in which case the slide is "active").

- **Landslide Intensity** – A set of spatially distributed parameters related to the destructive power of a landslide. The parameters may be described quantitatively or qualitatively and may include maximum movement velocity, total displacement, differential displacement, depth of the moving mass, peak discharge per unit width, kinetic energy per unit area. - Landslide Susceptibility – A quantitative or qualitative assessment of the classification, volume (or area) and spatial distribution of landslides which exist or potentially may occur in an area. Susceptibility may also include a description of the velocity and intensity of the existing or potential landsliding.

- **Landslide Susceptibility** – A quantitative or qualitative assessment of the classification, volume (or area) and spatial distribution of landslides which exist or potentially may occur in an area. Susceptibility may also include a description of the velocity and intensity of the existing or potential landsliding.

- **Likelihood** – Used as a qualitative description of probability or frequency.

- **Probability** – A measure of the degree of certainty. This measure has a value between zero (impossibility) and 1.0 (certainty). It is an estimate of the likelihood of the magnitude of the uncertain quantity or the likelihood of the occurrence of the uncertain future event.

There are two main interpretations:

(i) ***Statistical – frequency or fraction*** – The outcome of a repetitive experiment of some kind like flipping coins. It includes also the idea of population variability. Such a number is called an "objective" or relative frequents probability because it exists in the real world and is in principle measurable by doing the experiment.

(ii) ***Subjective probability (degree of belief)*** – Quantified measure of belief, judgement, or confidence in the likelihood of an outcome, obtained by considering all available information honestly, fairly and with a minimum of bias. Subjective probability is affected by the state of understanding of a process, judgement regarding an evaluation or the quality and quantity of information. It may change over time as the state of knowledge changes.

- **Qualitative Risk Analysis** – An analysis which uses word form, descriptive or numeric rating scales to describe the magnitude of potential consequences and the likelihood that those consequences will occur.

- **Quantitative Risk Analysis** – an analysis based on numerical values of the probability, vulnerability and consequences, and resulting in a numerical value of the risk.

- **Risk** – A measure of the probability and severity of an adverse effect to health, property or the environment. Risk is often estimated by the product of probability and consequences. However, a more general interpretation of risk involves a comparison of the probability and consequences in a non-product form. For these guidelines risk is further defined as:

  (a) For life loss, the annual probability that the person most at risk will lose his or her life taking account of the landslide hazard and the temporal spatial probability and vulnerability of the person.

(b) For property loss, the annual probability of the consequence or the annualised loss taking account of the elements at risk, their temporal spatial probability and vulnerability.

- **Risk Analysis** – The use of available information to estimate the risk to individuals, population, property or the environment from hazards. Risk analyses generally contain the following steps: scope definition, hazard identification and risk estimation.
- **Risk Assessment** – The process of risk analysis and risk evaluation.
- **Risk Control or Risk Treatment** – The process of decision making for managing risk and the implementation or enforcement of risk mitigation measures and the re-evaluation of its effectiveness from time to time, using the results of risk assessment as one input.
- **Risk Estimation** – The process used to produce a measure of the level of health, property or environmental risks being analysed. Risk estimation contains the following steps: frequency analysis, consequence analysis and their integration.
- **Risk Evaluation** – The stage at which values and judgments enter the decision process, explicitly or implicitly, by including consideration of the importance of the estimated risks and the associated social, environmental and economic consequences, in order to identify a range of alternatives for managing the risks.
- **Risk Management** – The complete process of risk assessment and risk control (or risk treatment).
- **Tolerable Risk** – A risk within a range that society can live with so as to secure certain net benefits. It is a range of risk regarded as non-negligible and needing to be kept under review and reduced further if possible.
- **Vulnerability** – The degree of loss to a given element or set of elements within the area affected by the landslide hazard. It is expressed on a scale of 0 (no loss) to 1 (total loss). For property, the loss will be the value of the damage relative to the value of the property; for persons, it will be the probability that a particular life (the element at risk) will be lost, given the person(s) is affected by the landslide.

2. Landslide Risk Management

The processes followed for the risk analysis component of this site included:

- Assessment of landslide hazard,
- Assessment of landslide consequence, and
- Assessment of landslide risk for the identified study areas.

The methodology of these processes is described in more detail in the following sections. This landslide assessment take into consideration of all the recommendations provided in our slope stability report (building and site drainage properly designed and constructed with the proposed dwelling found into weathered rock) with good hillside construction practice across the lot.

3. Landslide Consequence Assessment

The elements at risk need to be considered when assessing the landslide risk. Persons are very vulnerable in the event of complete or substantial burial be debris, or the collapse of a building.

For loss of life quantitative risk estimation has been carried out considering the integration of the frequency analysis and the consequences.

3.1 Landslide Consequence Assessment

For loss of life, the individual risk can be calculated from:

$$R_{(LoL)} = P_{(H)} \times P_{(S:H)} \times P_{(T:S)} \times V_{(D:T)}$$

Where:

$R_{(LoL)}$: is the risk (annual probability of loss of life (death) of an individual)

$P_{(H)}$: is the annual probability of landslide

$P_{(S:H)}$: is the probability of spatial impact of the landslide impacting a building (location)taking into account the travel distance and travel direction given the event

$P_{(T:S)}$: is the temporal spatial probability (e.g. of the building or location being occupied by the individual) given the spatial impact and allowing for the possibility of evacuation given there is warning of landslide occurrence.

$V_{(D:T)}$: is the vulnerability of the individual (probability of loss of life of the individual given the impact).

3.1.1 Annual Probability of Landslide

Formulation of a Landslide Inventory would include compiling evidence for previous landslides using:

- Aerial photograph interpretation,
- Historic records and discussions with local residents/road maintenance personnel, and
- Field mapping.

Due to the limited historical records of landslide events in the subject area this assessment was qualitative only, based on AGS (2007, Appendix C, Page 91" Qualitative Measures of Likelihood, Table 2"). The collated data during site inspection and desktop study was then used to make an assessment of landslide frequency in the study area.

The proposed allotment was located along the down-slope of a hill, moderately sloping to the south. Relatively shallow weathered rock was encountered at the test locations. AGS (2007) recommends some published relationship between verbal descriptor and probabilities (Commentary on Practice Note Guidelines for Landslide Risk Management, Page127). According to the above information the estimation of Annual Probability of landslide for the subject site would be:

$P_{(H)}$ - *Annual Probability of Landslide:* 10^{-4}

3.1.2 Probability of Spatial Impact of the Landslide ($P_{(S:H)}$)

Based on the information gathered during inspection, it is highly likely that fill material would be exposed along the proposed cut faces of the batters.

For loss of life the Probability of spatial impact of the landslide impacting a building (location) taking into account the travel distance and travel direction given the event would be estimated as:

- Landslide impact a building on the subject site 0.5

- Landslide to impact a vehicle or area downslope 0.2

3.1.3 Probability of Occupancy ($P_{(T:S)}$)

For the temporal spatial probability of the building or location being occupied by the individual the estimation would be as follows:

The probability for a person occupies the house during a day is estimated less than 8 hours a day per year. The probability for the presence of a person within the area affected by landslide would be estimated conservatively 6 hours a day per year.
$\mathbf{P}_{\mathbf{(T:S)}}$ for person occupy the building : 0.33

$\mathbf{P}_{\mathbf{(T:S)}}$ for person attending the area or vehicle affected by landslide: 0.25

3.1.4 Probability of Loss of Life of the Individual ($V_{(D:T)}$)

According to "*Practice Notes Guidelines for Landslide Risk Management, 2007, AGS*", the following factors influence the likelihood of deaths and injuries or vulnerability ($\mathbf{V}_{\mathbf{(D:T)}}$) of a person who are impacted by a landslide:

- Volume of Landslide.
- Type of slide, mechanism of slide initiation and velocity of sliding.
- Depth of Slide.
- Whether the landslide debris buries the person(s).
- Whether the person(s) are in the open or enclosed in a vehicle or building.
- Whether the vehicle or building collapses when impacted by debris.
- The type of collapse if the vehicle or building collapses.

Persons are very vulnerable in the event of a substantial debris or collapse of a building. However, the site falls in an area of gentle slope. According to the examples of vulnerability values (*AGS2007, Appendix F, Page121) the* following conservative estimations are adopted for this assessment.

$\mathbf{V}_{\mathbf{(D:T)}}$ for a person in the building if the debris strikes the building only: 0.5

$\mathbf{V}_{\mathbf{(D:T)}}$ for a person in open space if stuck by slide/ rockfall : 0.7

3.1.5 Annual Probability of loos of life (death) of an individual $R_{(LoL)}$

For loss of life, the individual risk can be calculated from:

$\mathbf{R}_{\mathbf{(LoL)}} = \mathbf{P}_{\mathbf{(H)}} \times \mathbf{P}_{\mathbf{(S:H)}} \times \mathbf{P}_{\mathbf{(T:S)}} \times \mathbf{V}_{\mathbf{(D:T)}}$

- ***The risk for loss of life for person inside the proposed building:***

$\mathbf{R}_{\mathbf{(LoL)}} = \mathbf{10^{-4} \times 0.5 \times 0.33 \times 0.5 = 8.25 \times 10^{-6}}$

- ***The risk for loss of life for person within the affected area by Landslide:***

$\mathbf{R}_{\mathbf{(LoL)}} = \mathbf{10^{-4} \times 0.2 \times 0.25 \times 0.\ 7 = 3.5 \times 10^{-6}}$

Hence the proposed site shall be considered as low risk for loss of life of individual with an **acceptable risk criteria.**

The tolerable loss of life risk for individual criteria is suggested by AGS2007 (Practice Note Guidelines for Landslide Risk Management, Table1, Page77) as summarized in the following table.

Table 1: AGS Suggested Tolerable Loss of Life Individual Risk

Situation	Suggested Tolerable Loss of Life risk for the person most at Risk
Existing Slopes/Existing Development	10^{-4}/annum
New Construction/New Development/Existing Landslide	10^{-5}/annum

AGS suggested a tolerable risk for loss of life of 10^{-5} per annum for new developments and hence the proposed site shall be considered as acceptable for the loss of life assessment..

3.2 Risk to Property

A qualitative risk assessment for property was undertaken using the following tables according to AGS (2007). Table 2, suggests a descriptive term of likelihood of a landslide for an approximate annual landslide probability.

A qualitative risk assessment for property loss risks then shall be carried out in accordance with the risk matrix and terms in AGS 2007(Appendix C), as outlined in Table 3.

Table 2: Qualitative Measures of Likelihood

Indicative Value Approx. Annual Probability	Implied Indicative Landslide Recurrence Interval	Descriptor
10^{-1}	10 years	ALMOST CERTAIN
10^{-2}	100 years	LIKELY
10^{-3}	1,000 years	POSSIBLE
10^{-4}	10,000 years	INLIKELY
10-5	100,000 years	RARE
10^{-6}	1,000,000 years	BARELY CREDIBLE

Table 3: Qualitative Risk Analysis Matrix – Level of Risk Property

LIKELIHOOD		Consequence to Property				
Descriptor	**Indicative value of Approx. Annual Probability**	**1: CATASTROPHIC 200%**	**2: MAJOR 60%**	**3: MEDIUM 20%**	**4: MINOR 5%**	**5: INSIGNIFICANT 0.5%**
ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or L (5)
LIKELY	10^{-2}	VH	VH	H	M	L
POSSIBLE	10^{-3}	VH	H	M	M	VL
UNLIKELY	10^{-4}	H	M	L	L	VL
RARE	10-5	M	L	L	VL	VL
BARELY CREDIBLE	10^{-6}	L	VL	VL	VL	VL

Notes:
(1) As a percentage of the value of the property.
(2) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
(3) L low, M medium, H high, VL very low, VH very high.

Following the above assessment, Indicative values of Approximate Annual Probability were delineated as $10^{-4}$for the proposed dwelling adopting the recommended descriptors of ***Unlikely*** for the subject site.

An indicative approximate cost of damage in the order of 0.5% (insignificant) to 5% (minor) of the market value was assessed for the subject site based on *AGS (2007)* provided all the recommendations of this report are adhered to and adequate civil/hydraulic and structural issues are addressed.

According to above table *(Qualitative Risk Matrix, AGS, 2007, Appendix C)* the level of risk for damage to property ranges between ***Very Low to Low****.*

The proposed development would be a low-rise residential construction and shall be categorized as ***"Importance Level of Structure" of 2*** *(AGS, 2007, Appendix A, Page 86)*

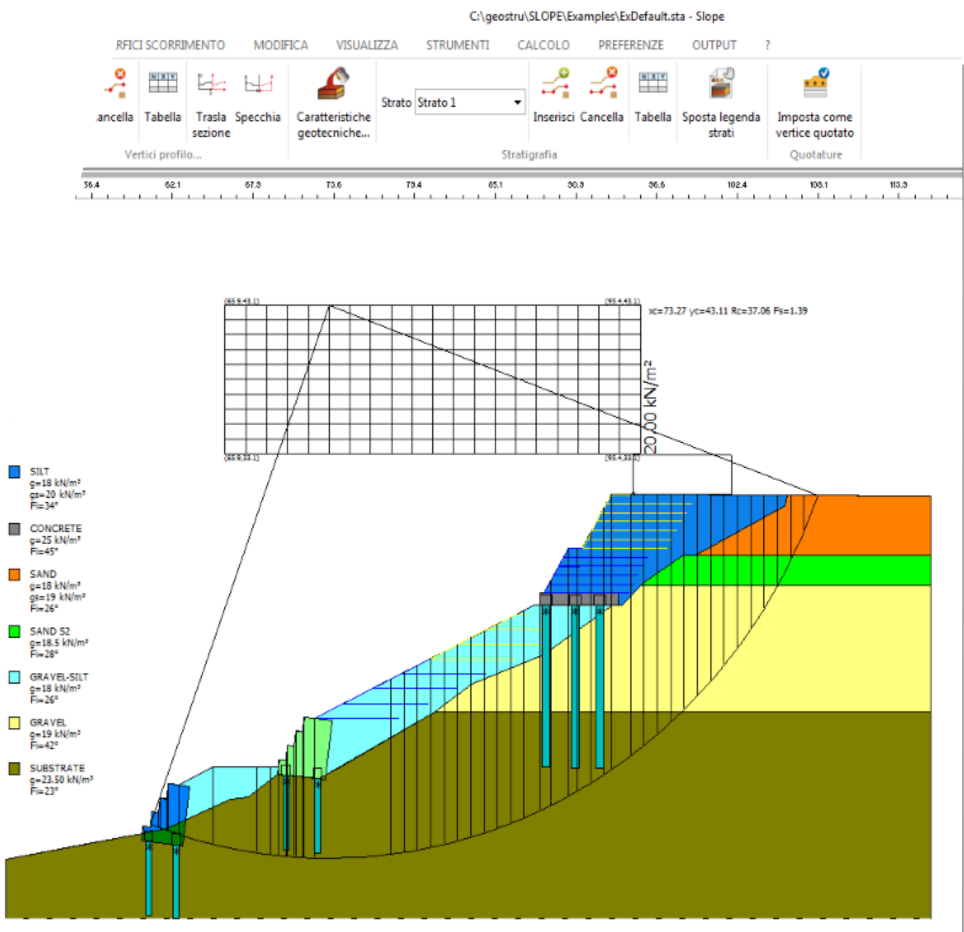
AGS (2007) suggests acceptable qualitative risk to property criteria as outlined in following *table (Table C10, Appendix C, Page 135)*. The risk to the proposed property is estimated as Acceptable.

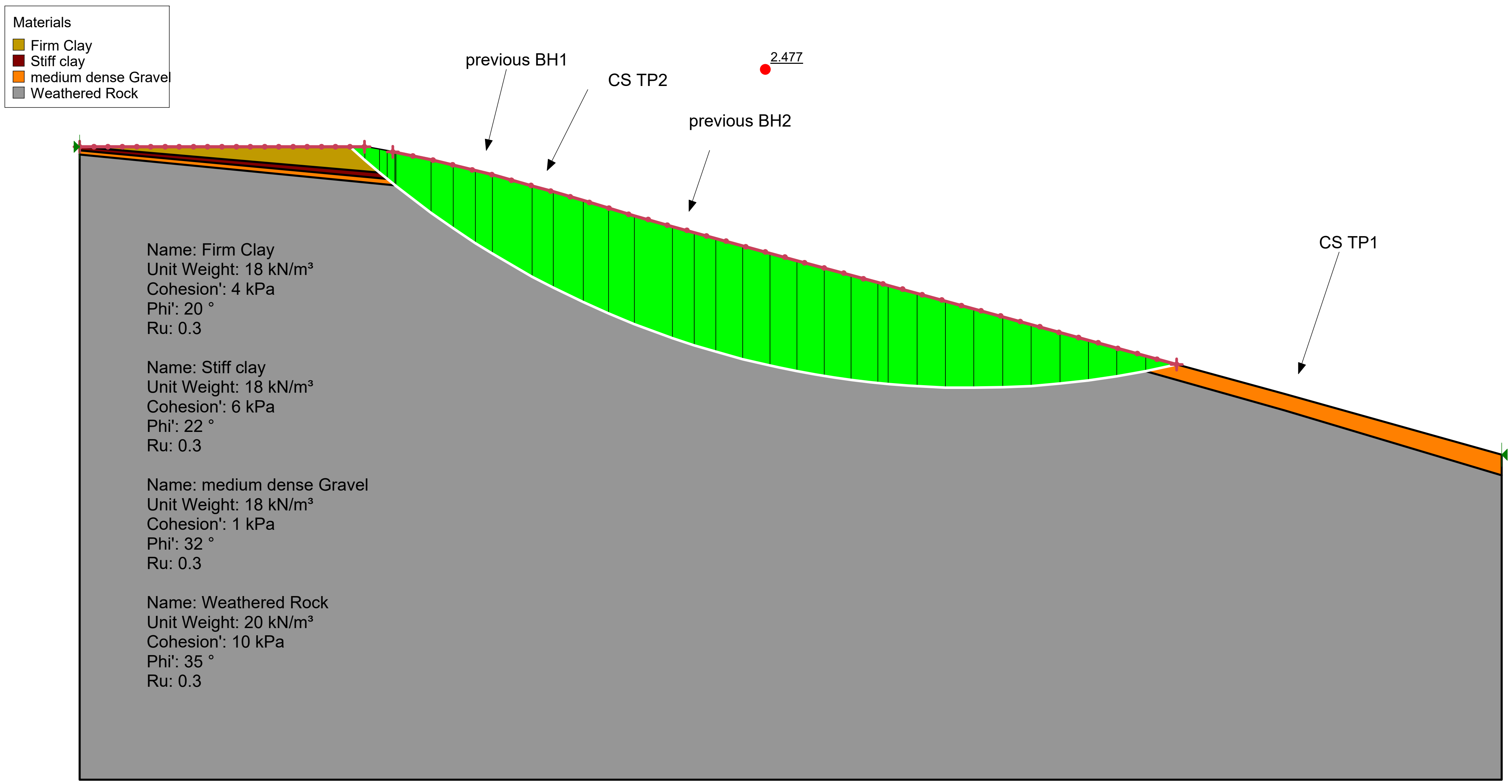
Table 4: Suggested Acceptable Qualitative Risk to Property

Importance Level of Structure	**Suggested Upper Limit of Qualitative Risk Property**	
	Existing Slope/Existing Development	**New Constructed Slope/New Development/Existing Development**
1	Moderate	Moderate
2	Low	Low
3	Low	Low
4	Very Low	Very Low

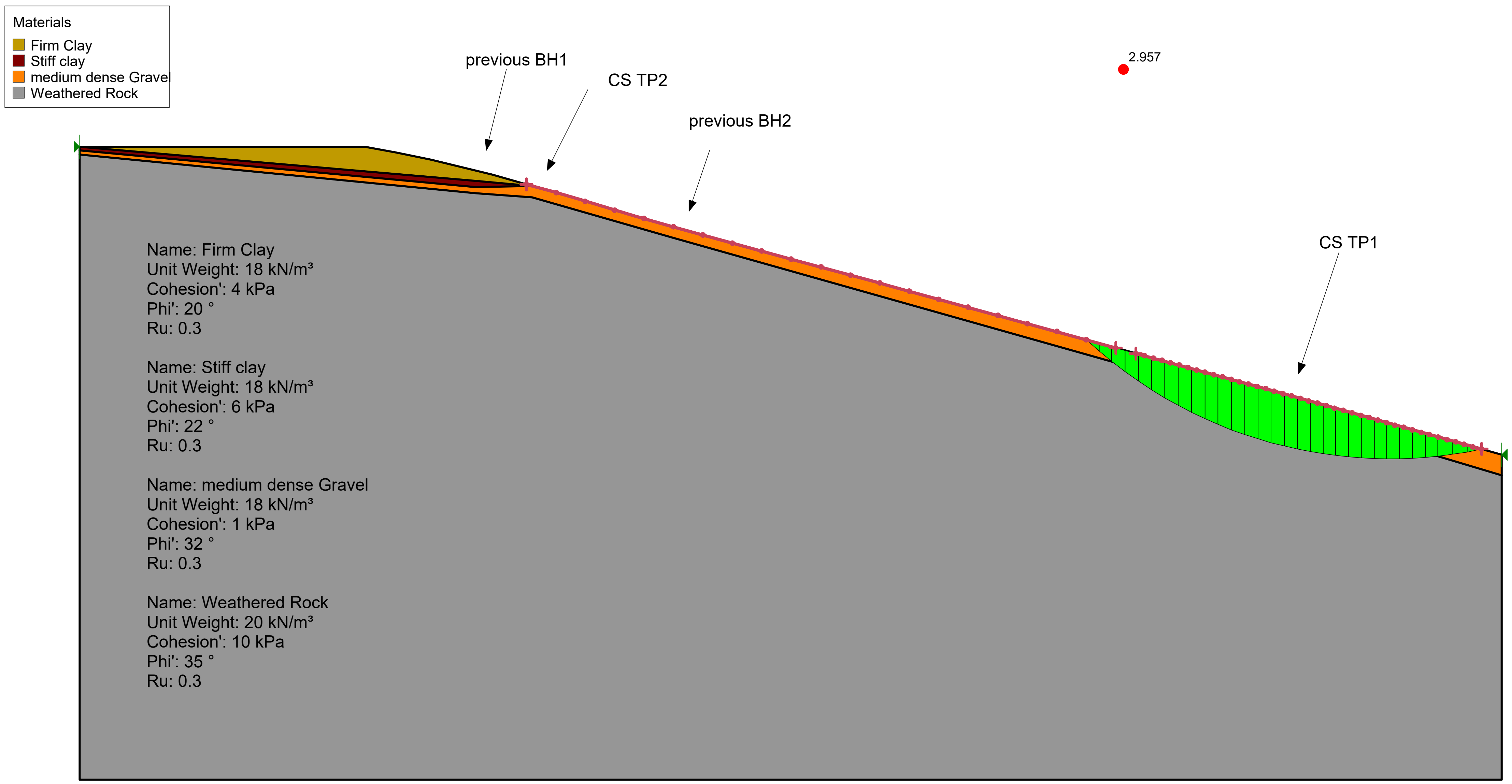
APPENDIX F

SLOPE MODEL ANALYSIS





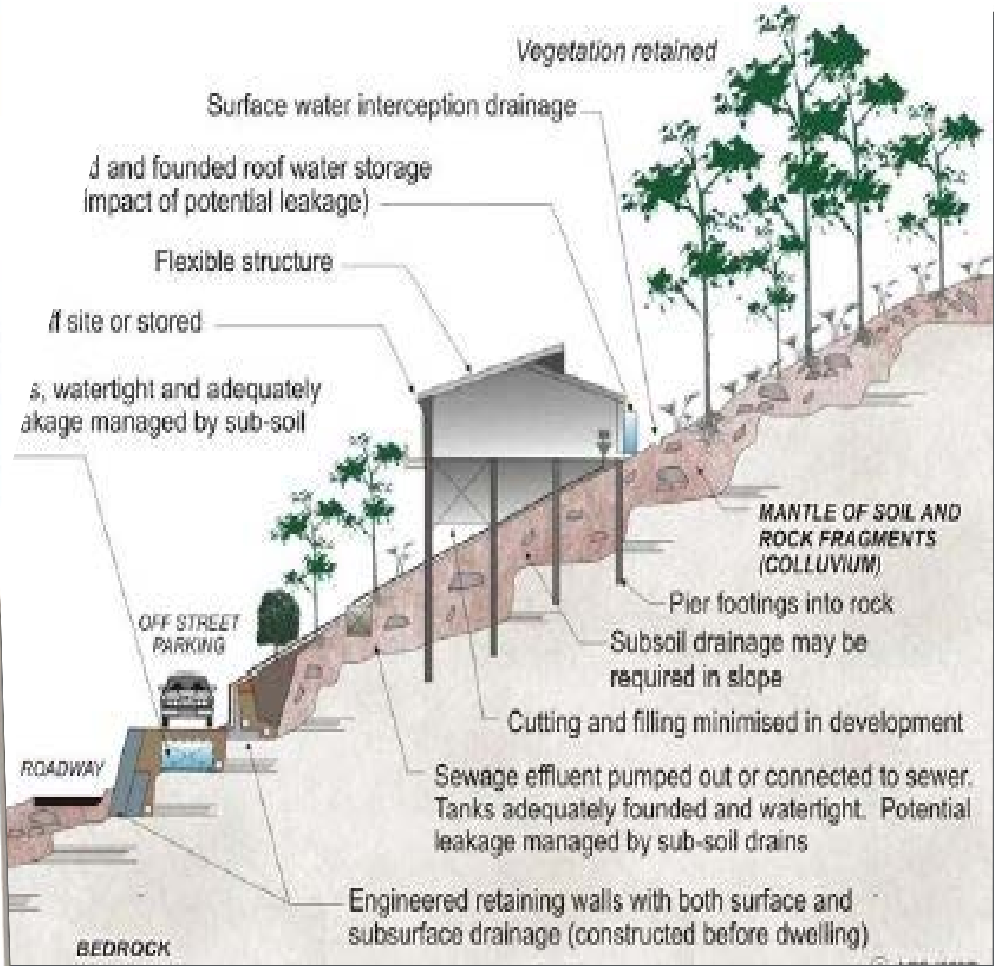
Global Stability Analysis



Local Stability Analysis

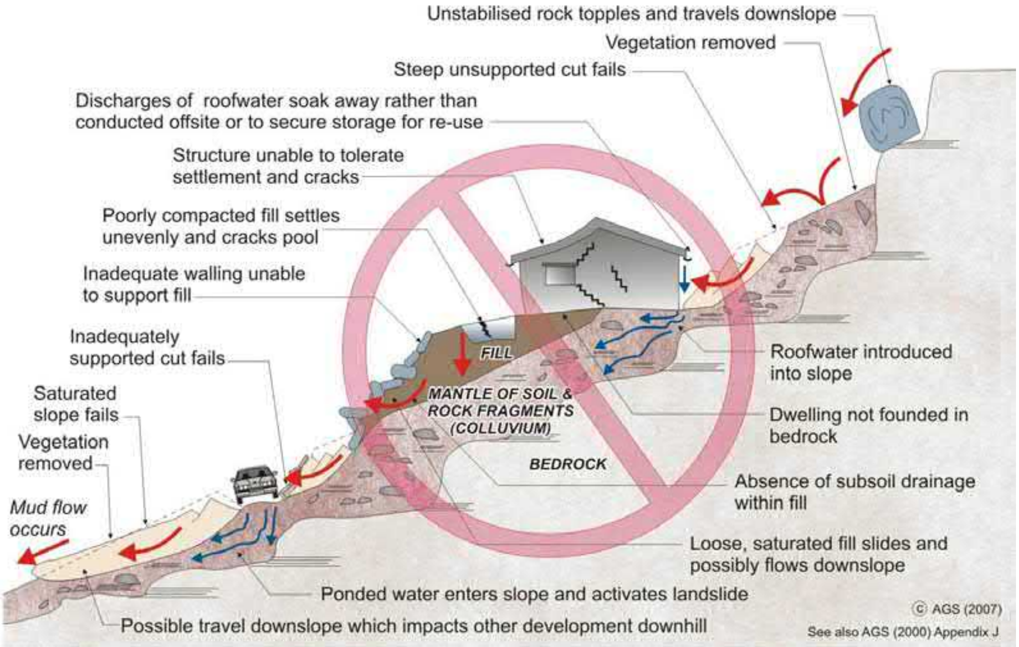
APPENDIX G

GUIDELINES FOR HILLSIDE CONSTRUCTION



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:

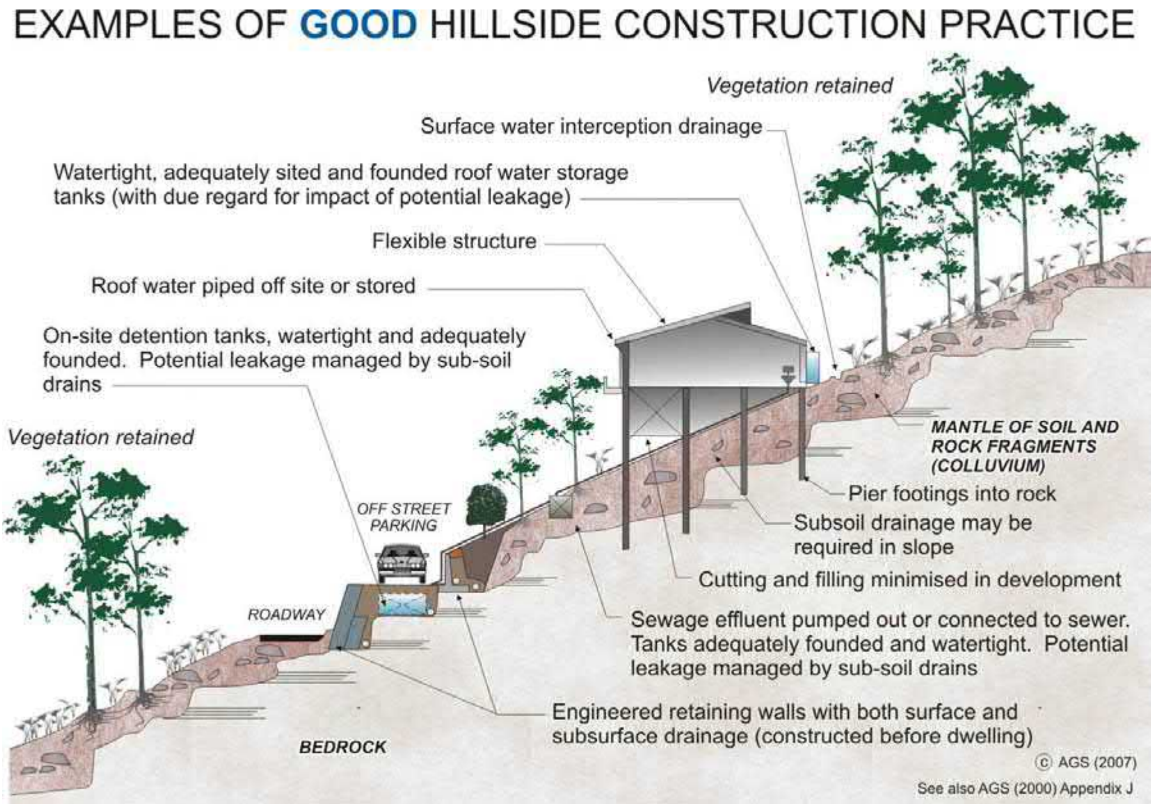
- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal 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.

AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

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.



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

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 towards 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 LR5).

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 LR5). 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.

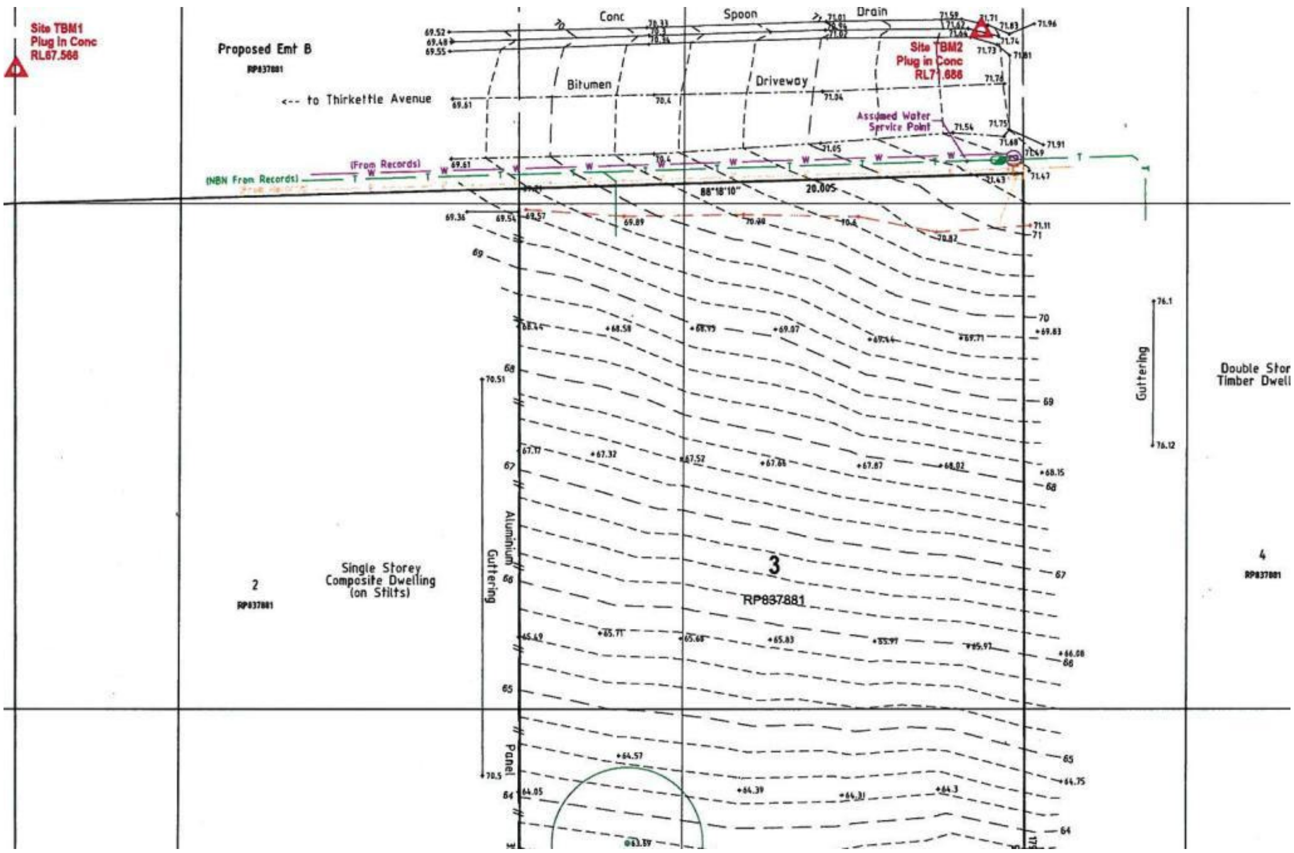
Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact 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

Attachment B – RPEQ signed Stormwater Plan (Stormwater Drainage Strategy)

Austin Grillmeier
Engineer - RPEQ 2048
314 Blanchfield St
North Rockhampton 4701

Stormwater Plan
New Dwelling
318 Thirkettle Ave, Frenchville 4701



Undeveloped Lot – Part Plan

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/10-2019

Dated: 10 May 2019

Contents

1. Introduction

There is a new dwelling to be constructed on this allotment which fronts Thirkettle Avenue and reaches to the adjoining street to the south which is Bloxsom Street.

An engineer was commissioned to inspect the site and the building plans for the proposed building and report on the stormwater management for this site.

2. Structure

The building plans for this dwelling were examined and indicate a column and beam structure contoured to the slope of the ground with the structure supported on piers and retaining walls.

The site slopes towards the south from Thirkettle Ave at grades of approx 1 in 4. The intent is to do as little bulk earthworks as possible and found the structure on isolated bored or excavated piers taken down to the rocky subgrade.

The Driveway is short and is designed to touch the existing Roadway Asphalt edge and connect to the carport slab. The driveway slopes slightly upwards from the road edge and a percentage of the runoff may fall to the open channel on the northern side of Thirkettle Ave, while the remainder will track to the west and run down the driveway towards the rear of the allotment.

3. Stormwater Considerations

The following observations of the building and site were made during the planning and are listed in summary dot point form :-

- The rear of the allotment touching Bloxsom Street with its natural gully is deemed to be the Legal Point of Discharge
- The Main Roof is designed to fall from the rear of the building towards the front and be collected in a box gutter.
- The Carport Roof will also fall to this box gutter.
- The Box gutter is to be designed to empty via its Rain Head to a sized downpipe draining to a 9000 litre poly tank situated under the Carport Slab. There two outlets to this tank :1.the overflow which will flow to a second 9000 litre tank and 2. the bottom outlet for domestic and garden use.
- The second 9000 litre tank is primarily for detention. It receives the overflow from the first tank and from its bottom outlet it drains via a sized outlet pipe to the Distribution area on the slope below the house. The overflow pipe from this second tank also drains to the Distribution area.
- The Distribution device is a ten metre long rock-filled trench with a level concrete weir to allow the runoff water to re-spread into sheet flow as it continues its runoff down the existing slope to the natural gully in Bloxsom Street
- The Driveway down the allotment on the western side of the house will run stormwater down the slope and this flow will also be directed towards the Distribution Weir to slow down the flow from the driveway. The driveway runoff will be diverted using a grassed earth bund.
- The layout of the allotment showing the dwelling and the features described above is attached at Appendix A. Also included is a skeleton sectional side view showing the house on the slope.

.

4. Calculations

The calculation sheet is included below.

318 THIRKETTLE AVE. FRENCHVILLE.

STORMWATER PLAN. FOR WAYNE WONG.

PRE-DEVELOPMENT:

THIRKETTLE AVE. DIRECTS FLOWS FROM THE NORTHERN SLOPE TO THE WEST BY ITS OPEN CHANNEL

∴ THE CATCHMENT IS THE ALLOTMENT = 1084 m^2.

LENGTH of FLOW (-NATURAL) = 56m. "AVERAGE GRASSED."

FROM HORTON'S GRAPH t_c = 9mins. ${}^{9}I_{10}$ = 160 mm/hr ${}^{9}I_{100}$ = 260.

FRACTION IMPERVIOUS f_i = 0.0 C_{10} = 0.59 C_{100} = 0.708

$Q_{i_{100}} = F.C.I.A = 0.00278 \times 0.708 \times 260 \times \frac{1084}{10000} = 0.055\ m^3/sec.$

POST-DEVELOPMENT:

FRACTION IMP. $f_i = \frac{390.3}{1084} = 0.36$

IMPERVIOUS: HOUSE 192
GARAGE 48
EAVES 63.5
FR. DRIVEWY 22
SIDE DRIVEWY 64.8
390.3 m^2.

from QUDM. C_{10} = 0.706 C_{100} = 0.847.

t_c - ROOF TO GUTTER TO TANK ~ 5mins
PIPE FLOW ~
DISTRIBUTION WEIR TO DISCHARGE 7mins (FROM HORTON)
12 mins

${}^{12}I_{10}$ = 145mm/hr ${}^{12}I_{100}$ = 225mm/hr.

$Q_{o_{100}} = 0.00278 \times 0.847 \times 225 \times \frac{1084}{10000} = 0.057\ m^3/sec$

PRELIMINARY ESTIMATE OF DETENTION VOLUME from QUDM.

$\frac{Q_i - Q_o}{Q_i} = \frac{0.002}{0.055} = r = 0.036 = \frac{V_s}{V_i}$ $V_i = 4 t_c Q_i / 3$

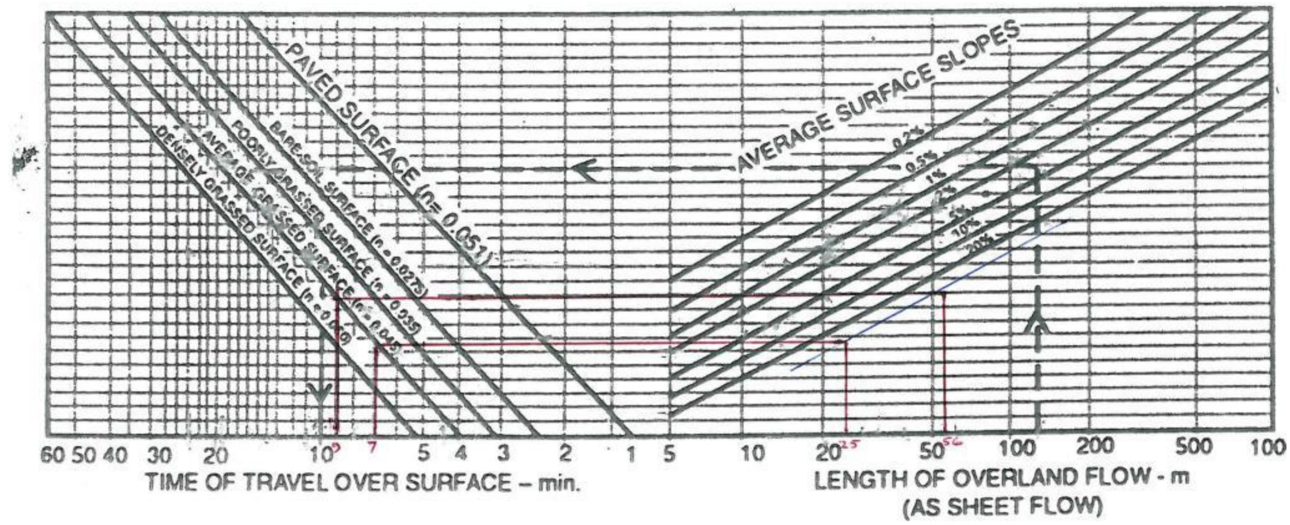
$V_s = \frac{4 \times 9 \times 60 \times 0.055}{3} \times 0.036$

$= 1.43\ m^3$. (FROM THE HYDROGRAPH CALCULATIONS THIS IS APPROX 20% OF THE ACTUAL VOL. REQUIRED.)

Q_{100} RUNOFF FROM ROOF = $2.78 \times 1 \times 320 \times \frac{303.5}{10000}$ = 27 litres/sec.

OVERFLOW PIPE IS 150 Dia AT NOT LESS THAN 1 IN 60 SLOPE.

Note Values for Horton's '*n*' are similar to those for Manning's '*n*' for similar surfaces.



The impervious areas include the driveways while the detention is achieved by the roof water runoff.

The diversion of the driveway runoff to the Diversion Weir will also have a retarding effect though this is ignored in the calculations.

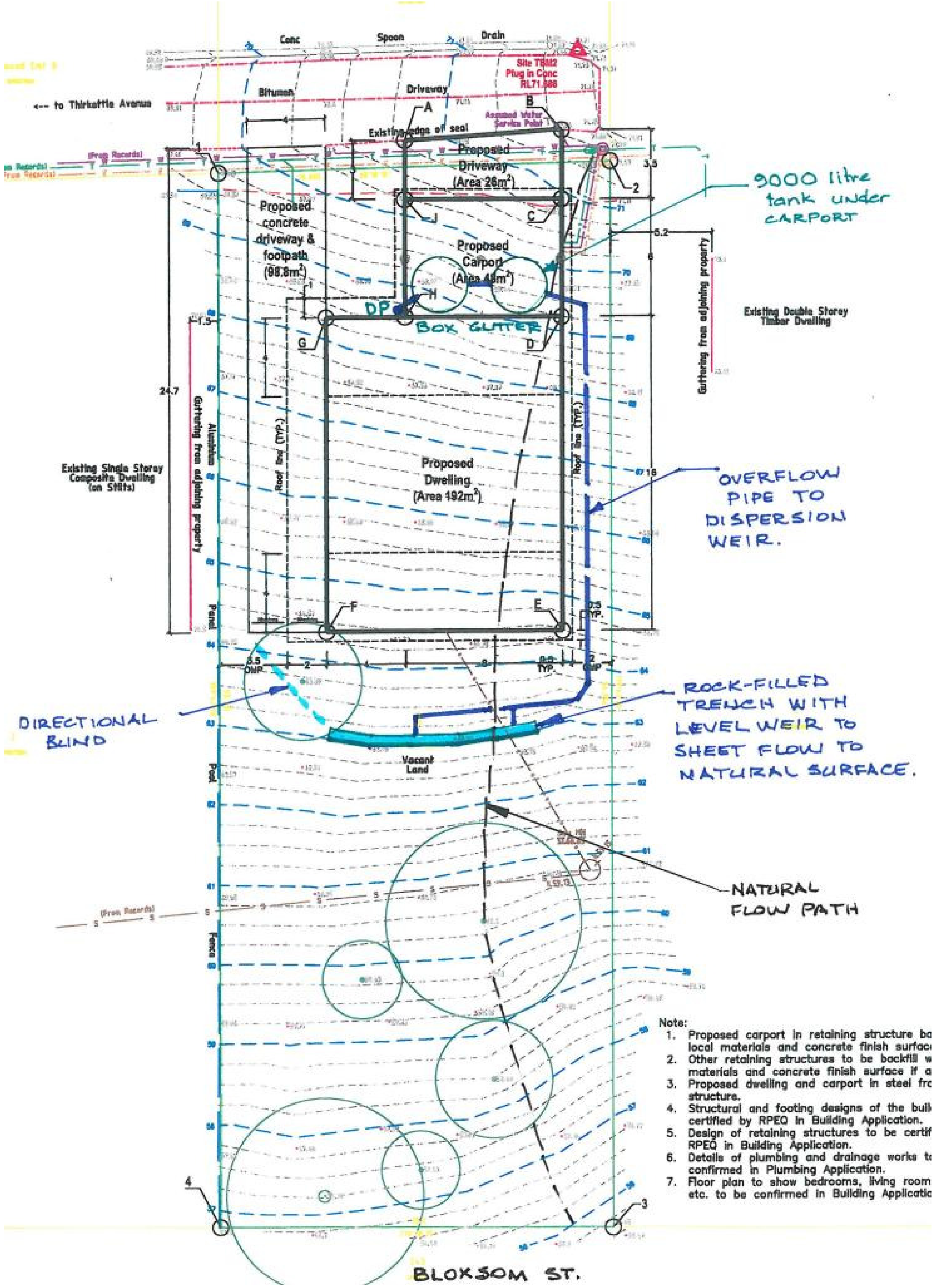
The Detention Tank sized outlet and the associated hydrograph calculations are attached at Appendix B.

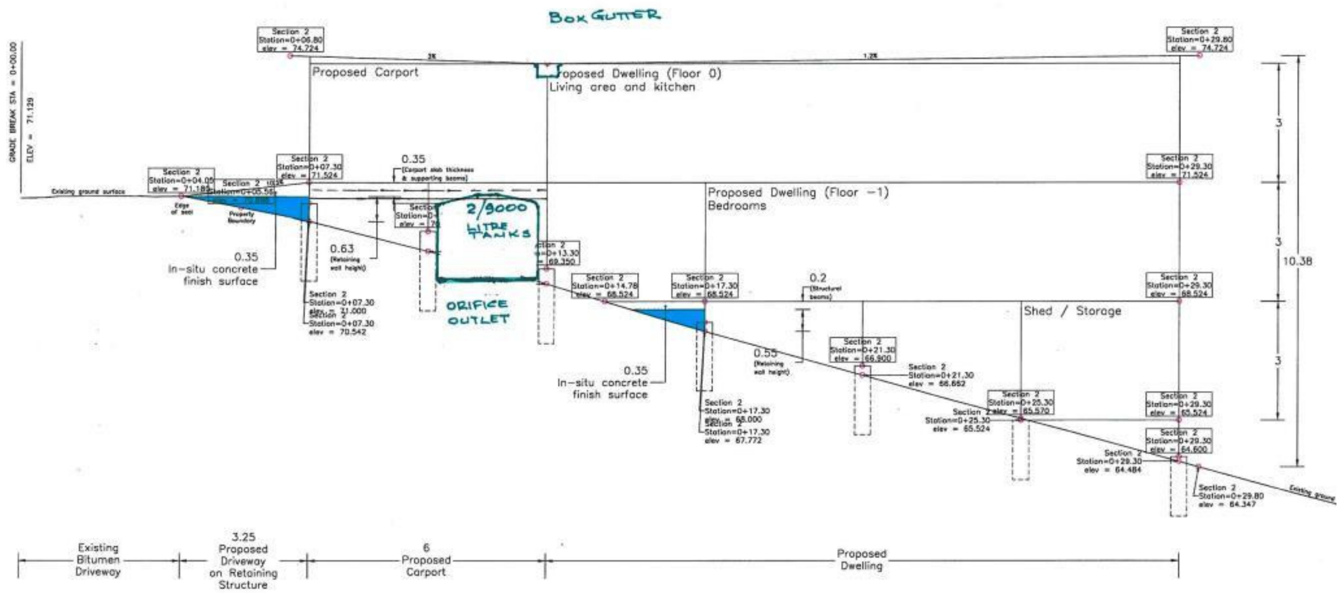
5. Conclusion

The stormwater management actions listed above would limit the runoff flows from the development of this allotment of the dwelling and driveway to better than pre-development flows.

Austin Grillmeier RPEQ 2048

6. Appendix A – Plan & Section



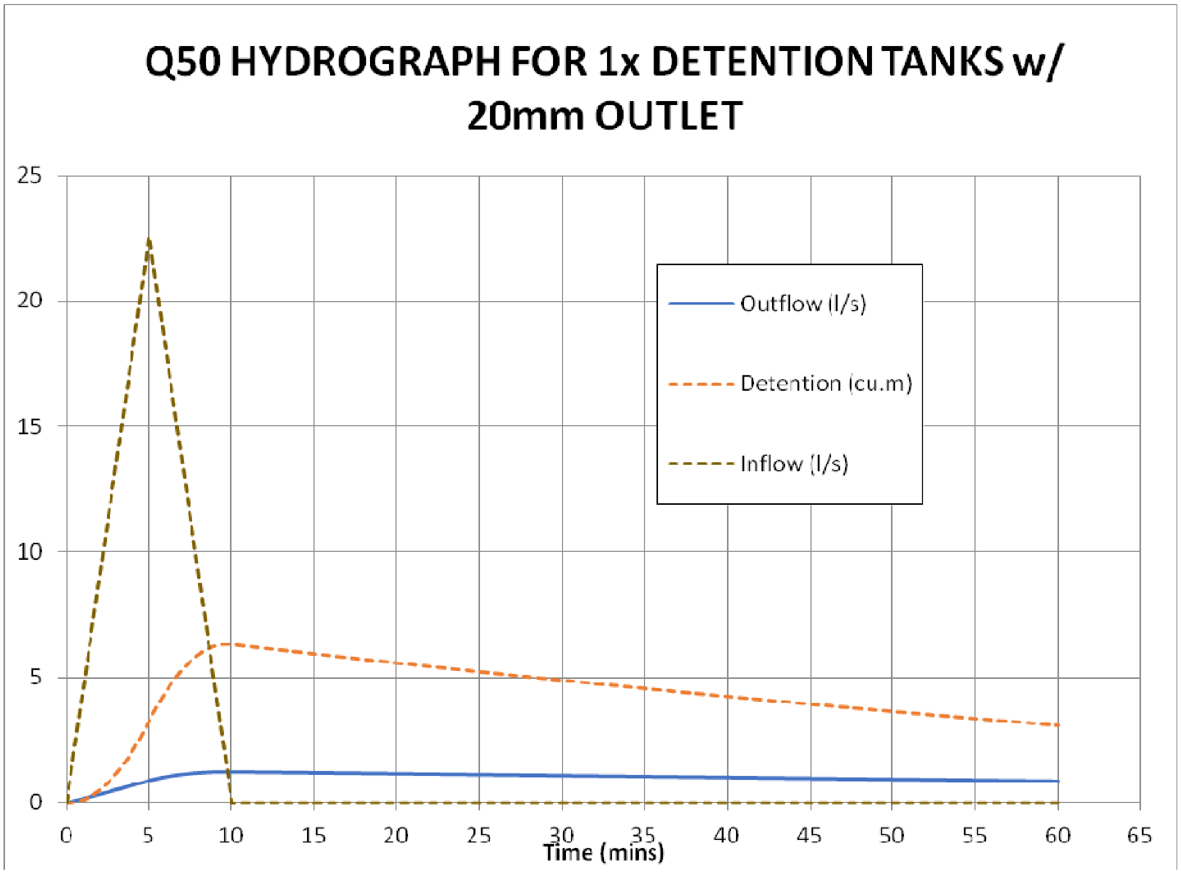

BOX GUTTER
Proposed Carport
Proposed Dwelling (Floor 0)
Living area and kitchen
Proposed Dwelling (Floor -1)
Bedrooms
Shed / Storage
2/9000 LITRE TANKS
ORIFICE OUTLET
0.35
0.63
In-situ concrete finish surface
0.2
0.55
10.38
3
Existing Bitumen Driveway
3.25
Proposed Driveway on Retaining Structure
6
Proposed Carport
Proposed Dwelling

7. Appendix B – Hydrograph Sheets

Q100 Detention

Q50 HYDROGRAPH FOR DETENTION TANKS

TIME (sec)	INFLOW (Cu.mecs)	OUTFLOW (Cu.Mecs)	Detention (l)
120	0.009	0.000	524.6
240	0.018	0.001	2089.5
360	0.018	0.001	4419.8
480	0.009	0.001	5903.1
600	0.000	**0.001**	**6290.8**
720	0.000	0.001	6141.0
840	0.000	0.001	5992.9
960	0.000	0.00121	5846.6
1080	0.000	0.001	5702.1
1200	0.000	0.001	5559.5
1320	0.000	0.001	5418.6
1440	0.000	0.001	5279.6
1560	0.000	0.001	5142.4
1680	0.000	0.001	5006.9
1800	0.000	0.001	4873.3
1920	0.000	0.001	4741.5
2040	0.000	0.001	4611.5
2160	0.000	0.001	4483.3
2280	0.000	0.001	4356.9
2400	0.000	0.001	4232.3
2520	0.000	0.001	4109.5
2640	0.000	0.001	3988.5
2760	0.000	0.001	3869.4
2880	0.000	0.001	3752.0
3000	0.000	0.001	3636.5
3120	0.000	0.001	3522.7
3240	0.000	0.001	3410.8
3360	0.000	0.001	3300.7
3480	0.000	0.001	3192.3
3600	0.000	0.001	3085.8



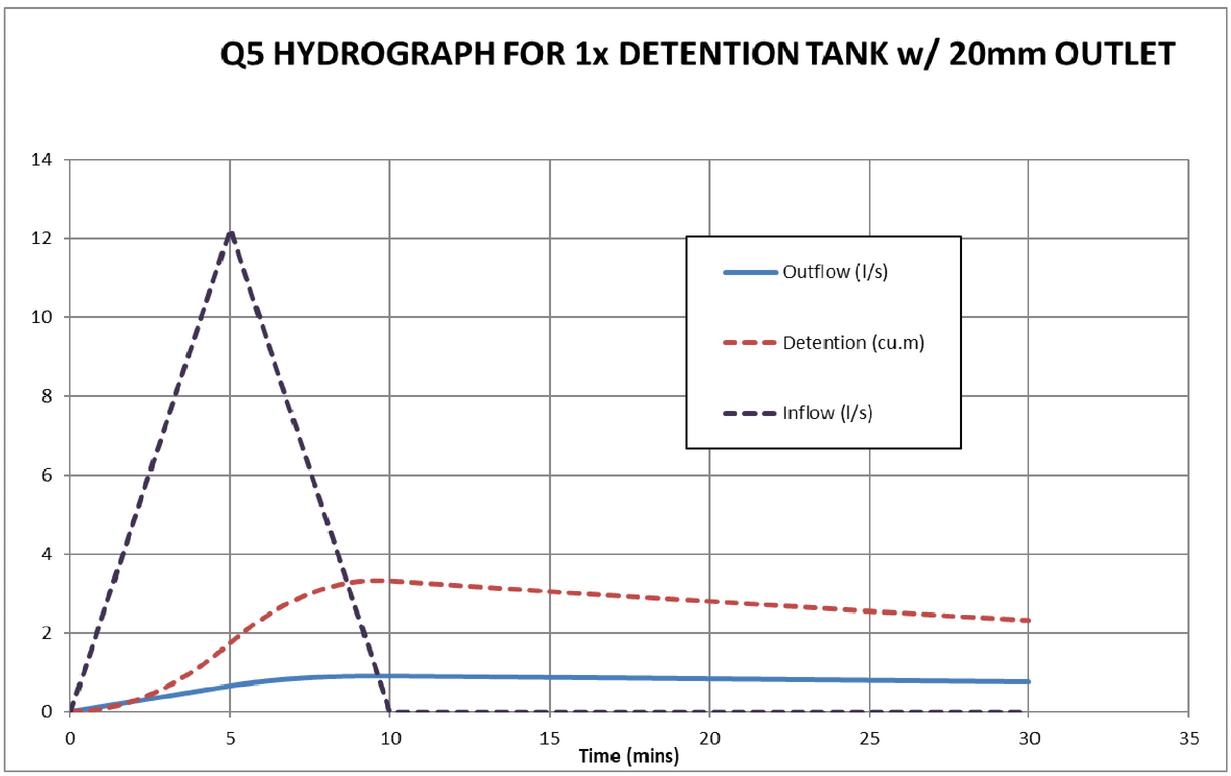
COMPARING Q100 FLOWS POST TREATMENT			
PRE DEV.	0.0555	m3/sec	
POST DEV	0.0553	m3/sec	
EQUALS	0.36	% DECREASE IN MAJOR FLOWS	

Max outlet flow			
0.001257635	cumecs		
Max Vol in tank		**Max Ht in tank**	
6301.989651	l	1.45207	m
Outlet Pipe Diameter			
20	mm Ø		

Q5 Detention

Q5 HYDROGRAPH FOR 1x DETENTION TANK

TIME (sec)	INFLOW (Cu.mecs)	OUTFLOW (Cu.Mecs)	Detention (l)
60	0.002	0.000	70.7
120	0.005	0.000	280.4
180	0.007	0.000	629.2
240	0.010	0.001	1116.9
300	0.012	0.001	1743.6
360	0.010	0.001	2360.4
420	0.007	0.001	2824.9
480	0.005	0.00089	3139.0
540	0.002	0.001	3304.1
600	0.000	**0.001**	**3321.6**
660	0.000	0.001	3267.0
720	0.000	0.001	3212.9
780	0.000	0.001	3159.2
840	0.000	0.001	3106.0
900	0.000	0.001	3053.3
960	0.000	0.001	3001.0
1020	0.000	0.001	2949.1
1080	0.000	0.001	2897.7
1140	0.000	0.001	2846.8
1200	0.000	0.001	2796.3
1260	0.000	0.001	2746.2
1320	0.000	0.001	2696.7
1380	0.000	0.001	2647.5
1440	0.000	0.001	2598.8
1500	0.000	0.001	2550.6
1560	0.000	0.001	2502.8
1620	0.000	0.001	2455.5
1680	0.000	0.001	2408.6
1740	0.000	0.001	2362.2
1800	0.000	0.001	2316.2



COMPARING Q5 FLOWS POST TREATMENT			
PRE DEV.	0.0248	m3/sec	
POST DEV	0.0230	m3/sec	
EQUALS	7.24	% DECREASE IN MINOR FLOWS	

Max outlet flow			
0.000914502	cumecs		
Max Vol in tank		**Max Ht in tank**	
3332.254701	l	0.76780	m
Outlet Pipe Diameter			
20	mm ø		

Q=	**F*C*I*A**								
Post Developed Roof to Tanks						TC=	5	min	
		0.0303	ha						
	F	**C**	**I**	**A**	**Q**				
C1	sq kms	co eff	mm/hr	sq kms	m3/sec		Fi	1.000	
Q2	0.278	0.765	128.0	0.00030	0.0082		$^{1}I_{10}$	65.10	mm/hr
Q5	0.278	0.855	170.0	0.00030	0.0122		C_{10}	0.9	
Q10	0.278	0.9	200.0	0.00030	0.0152				
Q20	0.278	0.945	229.0	0.00030	0.0182				
Q50	0.278	1	268.0	0.00030	0.0226				
Q100	0.278	1	300.0	0.00030	**0.0253**				
ENTIRE SITE									
Q=	**F*C*I*A**								
PRE DEVELOPED						TC=	9	min	
Development Area		**0.1084**	ha						
	F	**C**	**I**	**A**	**Q**				
	sq kms	co eff	mm/hr	sq kms	m3/sec		Fi	0.000	
Q2	0.278	0.5015	111.0	0.00108	0.0168		$^{1}I_{10}$	65.10	mm/hr
Q5	0.278	0.5605	147.0	0.00108	0.0248		C_{10}	0.590	
Q10	0.278	0.59	172.0	0.00108	0.0306		From QUDM T4.5.4		
Q20	0.278	0.6195	198.0	0.00108	0.0370				
Q50	0.278	0.6785	233.0	0.00108	0.0476				
Q100	0.278	0.708	260.0	0.00108	**0.0555**				
Q=	**F*C*I*A**								
POST DEVELOPED						TC=	5	min	
Development Area		**0.1084**	ha						
	F	**C**	**I**	**A**	**Q**				
AreaA	sq kms	co eff	mm/hr	sq kms	m3/sec		Fi	0.360	
Q2	0.278	0.6001	128.0	0.00108	0.0231		$^{1}I_{10}$	65.10	mm/hr
Q5	0.278	0.6707	170.0	0.00108	0.0344		C_{10}	0.706	
Q10	0.278	0.706	200.0	0.00108	0.0426		From QUDM T4.5.3		
Q20	0.278	0.7413	229.0	0.00108	0.0512				
Q50	0.278	0.8119	268.0	0.00108	0.0656				
Q100	0.278	0.8472	300.0	0.00108	**0.0766**				

SETOUT POINT	EASTING	NORTHING
1	249672.1474	7414952.9493
2	249692.0653	7414951.0847
3	249685.6754	7414897.1057
4	249665.8324	7414899.6074
A	249681.2777	7414953.4331
B	249689.2880	7414953.0242
C	249688.8576	7414949.5420
D	249688.1515	7414943.5836
E	249686.2684	7414927.6946
F	249678.3239	7414928.6361
G	Not use	Not use
H	249680.2070	7414944.5251
J	249680.9131	7414950.4835

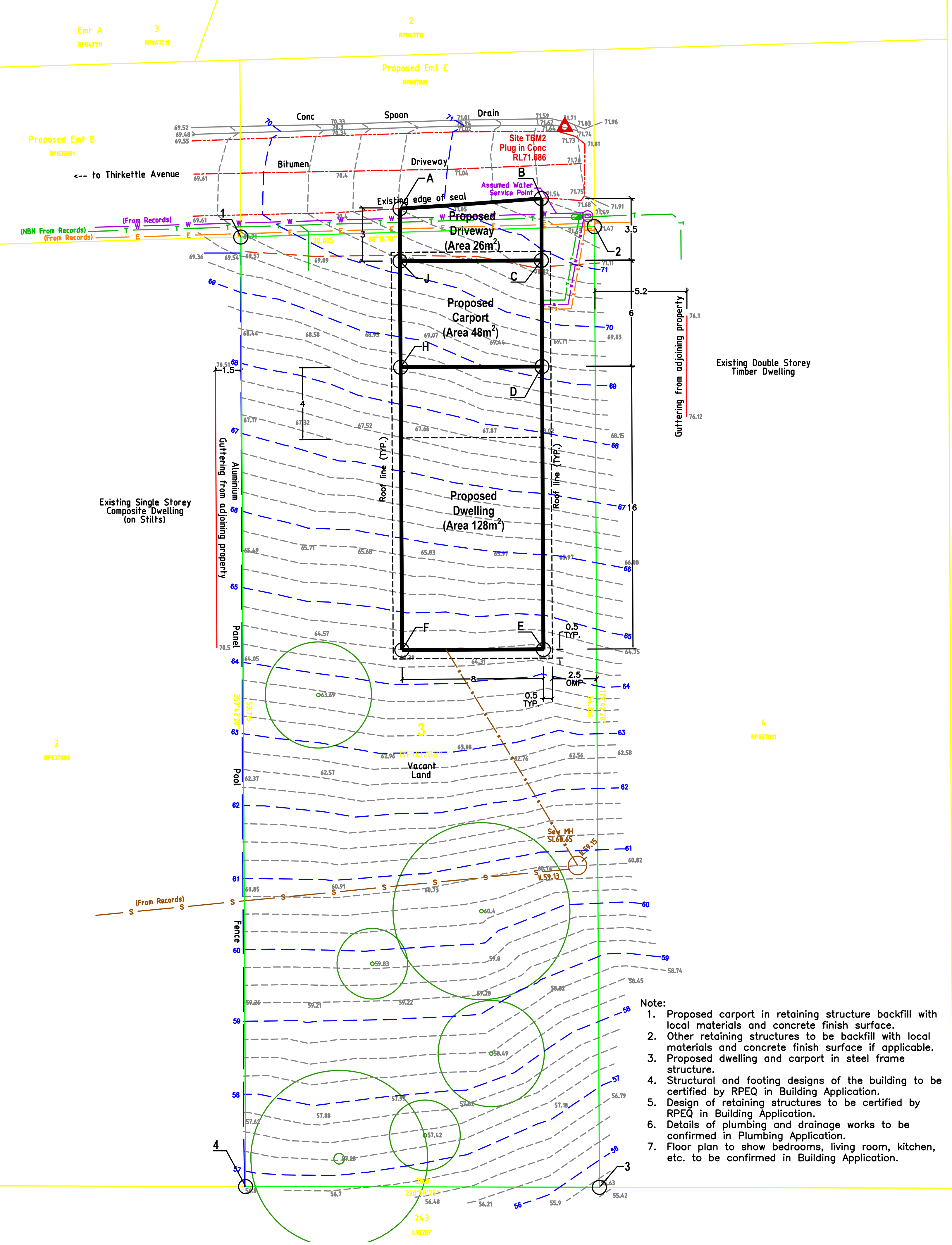
SERVICES DISCLAIMER

While every effort has been made to locate, identify, and where appropriate, indicate the extent & connectivity of all relevant visible and underground infrastructure within the survey area, no guarantee, either explicit or implied, can be given as to the correctness and completeness of such infrastructure shown hereon.

Due to the intrusive, high impact and potentially dangerous nature of exposing underground infrastructure, the risk of serious injury and damage to infrastructure is very high, therefore further investigation by suitably qualified personnel with the relevant skills, techniques and equipment will be required to comprehensively establish and qualify the true state of all infrastructure on site.

Please refer to each of the relevant service providers rules, procedures, guidelines, rights and responsibilities when designing or working in the vicinity of each respective plant or service.

This note is an integral part of this plan, being 1 sheet in total, and all subsequent iterations of this plan. ©



ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

5 July 2019

DATE

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/10-2019

Dated: 10 May 2019

Note:
1. Proposed carport in retaining structure backfill with local materials and concrete finish surface.
2. Other retaining structures to be backfill with local materials and concrete finish surface if applicable.
3. Proposed dwelling and carport is in steel frame structure.
4. Structural and footing designs of the building to be certified by RPEQ in Building Application.
5. Design of retaining structures to be certified by RPEQ in Building Application.
6. Details of plumbing and drainage works to be confirmed in Plumbing Application.
7. Floor plan to show bedrooms, living room, kitchen, etc. to be confirmed in Building Application.

GENERAL SYMBOL LEGEND

- Communication Cable Marker
- Communication Pit
- Electrical Cable Marker
- Electrical Turret
- Electrical Light Pole
- Electrical Light Bollard
- Electrical Pit
- Electrical Power Pole
- Electrical Power Pole + Light
- Electrical Power Pole + Transformer
- Electrical Stay Point
- Gas Valve
- Sewerage M/H
- Stormwater M/H
- Stormwater Pit
- Water Fire Hydrant
- Water Meter
- Water Valve
- Water Tap / Irrigation Tap
- Water Conduit Marker
- Guide Sign
- Bollard
- Flag Pole
- Australia Post Box
- Tree

PRINCIPAL

W. WONG

DESCRIPTION

LOT 3 RP837881

318 THIRKETTLE AVENUE, FRENCHVILLE

REAL PROPERTY DESCRIPTION

Lot/Plan :	Lot 3 on RP837881
Area :	1081m² (Deed)
Parish :	-
County :	-
Locality :	Frenchville
Local Authority :	Rockhampton Regional Council

NOTES

This plan was prepared for the purpose of designing new constructions on the subject land and should not be used by any other persons for any other purpose.

Property boundaries have not been reinstated or marked at the time of survey and are approximate only, based on appropriate boundary connections.

Where possible underground services have been located by field survey. Some services shown hereon are compiled from local authority and service provider plans and/or plans provided by the client and are noted accordingly on the plan.

Prior to any design, excavation or construction on site, the relevant authorities, and a qualified service locator should be engaged to ensure all services that may be affected by any future works have been located.

These plans have been prepared as verification plots only. Some text RL's have been omitted for clarity. Please refer to the relevant 3D data files for any spatial interrogation requirements.

This note is an integral part of this plan.

LEGEND

SERVICES LEGEND

- S — UG Sewerage Line
- SW — UG Stormwater Line
- Overland Flow/Direction
- E — UG Electrical Line
- OH Electrical Line
- T — UG Communication Line
- W — UG Water Line
- W — AG Water Line
- G — UG Gas Line
- Top of Bank
- Toe of Bank
- C/L of Bitumen
- Edge of Bitumen
- Line Marking
- Fence Line
- Gate

CONTOUR LEGEND

- 0.25m Interval
- 1.00m Interval

DATUM

Vertical Datum :	AHD Vide Smartnet Aus
Horizontal Datum :	Cadastral Vide RP837881
Contour Interval :	0.25m, 1.0m Index
Co-ord System :	MGA94 Zone 56

WARNING

LOCATION AND CONNECTIVITY OF U/G SERVICES SHOWN HEREON HAVE BEEN DETERMINED BY DIRECT ACCESS OR COMPILED FROM LOCAL AUTHORITY & SERVICE PROVIDER PLANS ONLY. FURTHER INVESTIGATION MAY BE REQUIRED TO DETERMINE LOCATIONS OF ALL INACCESSIBLE SERVICES.

REVISION

Issue	Date	Details	Authorised
A	5-12-2018	Initial Issue	
B	23-05-2019	Amendment to reduce building footprint	
C	31-05-2019	Amendment to reduce building footprint	
D	07-06-2019	Amendment to reduce building footprint	

CREATED

General Arrangement

SCALE

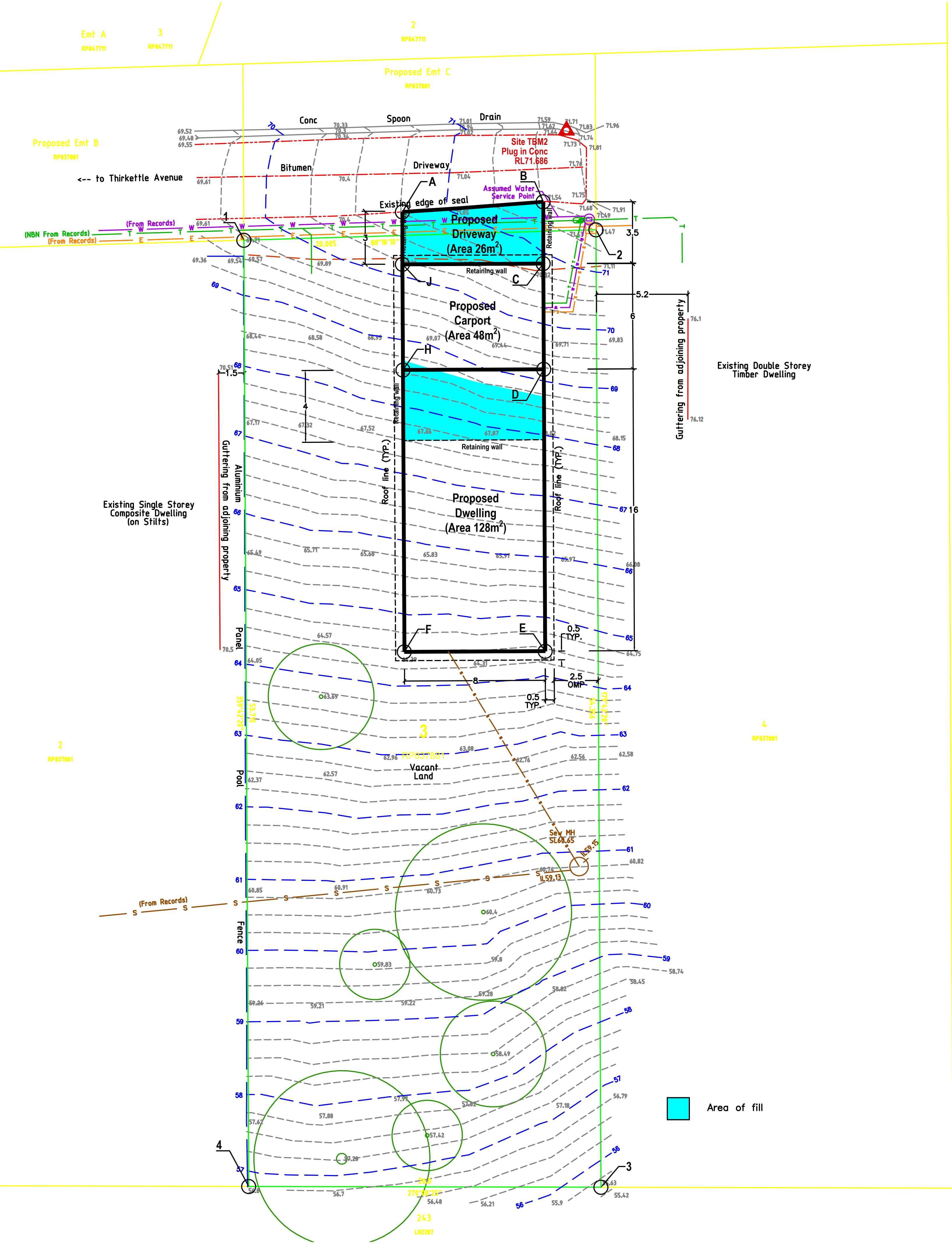
1:125 @ A1

DRAWING NUMBER

7256-01-DTL (1/3)

ISSUE

D



SETOUT POINT	EASTING	NORTHING
1	249672.1474	7414952.9493
2	249692.0653	7414951.0847
3	249685.6754	7414897.1057
4	249665.8324	7414899.6074
A	249681.2777	7414953.4331
B	249689.2880	7414953.0242
C	249688.8576	7414949.5420
D	249688.1515	7414943.5836
E	249686.2684	7414927.6946
F	249678.3239	7414928.6361
G	Not use	Not use
H	249680.2070	7414944.5251
J	249680.9131	7414950.4835

SERVICES DISCLAIMER

While every effort has been made to locate, identify, and where appropriate, indicate the extent & connectivity of all relevant visible and underground infrastructure within the survey area, no guarantee, either explicit or implied, can be given as to the correctness and completeness of such infrastructure shown hereon.

Due to the intrusive, high impact and potentially dangerous nature of exposing underground infrastructure, the risk of serious injury and damage to infrastructure is very high, therefore further investigation by suitably qualified personnel with the relevant skills, techniques and equipment will be required to comprehensively establish and qualify the true state of all infrastructure on site.

Please refer to each of the relevant service providers rules, procedures, guidelines, rights and responsibilities when designing or working in the vicinity of each respective plant or service.

This note is an integral part of this plan, being 1 sheet in total, and all subsequent iterations of this plan. ©

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

5 July 2019

DATE

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/10-2019

Dated: 10 May 2019

GENERAL SYMBOL LEGEND

- Communication Cable Marker
- Communication Pit
- Electrical Cable Marker
- Electrical Turret
- Electrical Light Pole
- Electrical Light Bollard
- Electrical Pit
- Electrical Power Pole
- Electrical Power Pole + Light
- Electrical Power Pole + Transformer
- Electrical Stay Point
- Gas Valve
- Sewerage M/H
- Stormwater M/H
- Stormwater Pit
- Water Fire Hydrant
- Water Meter
- Water Valve
- Water Tap / Irrigation Tap
- Water Conduit Marker
- Guide Sign
- Bollard
- Flag Pole
- Australia Post Box
- Tree

PRINCIPAL

W. WONG

DESCRIPTION

LOT 3 RP837881

318 THIRKETTLE AVENUE, FRENCHVILLE

REAL PROPERTY DESCRIPTION

Lot/Plan :	Lot 3 on RP837881
Area :	1081m² (Deed)
Parish :	-
County :	-
Locality :	Frenchville
Local Authority :	Rockhampton Regional Council

NOTES

This plan was prepared for the purpose of designing new constructions on the subject land and should not be used by any other persons for any other purpose.

Property boundaries have not been reinstated or marked at the time of survey and are approximate only, based on appropriate boundary connections.

Where possible underground services have been located by field survey. Some services shown hereon are compiled from local authority and service provider plans and/or plans provided by the client and are noted accordingly on the plan.

Prior to any design, excavation or construction on site, the relevant authorities, and a qualified service locator should be engaged to ensure all services that may be affected by any future works have been located.

These plans have been prepared as verification plots only. Some text RL's have been omitted for clarity. Please refer to the relevant 3D data files for any spatial interrogation requirements.

This note is an integral part of this plan.

LEGEND

SERVICES LEGEND

- S — UG Sewerage Line
- SW — UG Stormwater Line
- Overland Flow/Direction
- E — UG Electrical Line
- OH Electrical Line
- T — UG Communication Line
- W — UG Water Line
- W — AG Water Line
- G — UG Gas Line
- Top of Bank
- Toe of Bank
- C/L of Bitumen
- Edge of Bitumen
- Line Marking
- Fence Line
- Gate

CONTOUR LEGEND

- 0.25m Interval
- 1.00m Interval

DATUM

Vertical Datum :	AHD Vide Smartnet Aus
Horizontal Datum :	Cadastral Vide RP837881
Contour Interval :	0.25m, 1.0m Index
Co-ord System :	MGA94 Zone 56

WARNING

LOCATION AND CONNECTIVITY OF U/G SERVICES SHOWN HEREON HAVE BEEN DETERMINED BY DIRECT ACCESS OR COMPILED FROM LOCAL AUTHORITY & SERVICE PROVIDER PLANS ONLY. FURTHER INVESTIGATION MAY BE REQUIRED TO DETERMINE LOCATIONS OF ALL INACCESSIBLE SERVICES.

REVISION

Issue	Date	Details	Authorised
A	5-12-2018	Initial Issue	
B	23-05-2019	Amendment to reduce building footprint	
C	31-05-2019	Amendment to reduce building footprint	
D	07-06-2019	Amendment to reduce building footprint	

CREATED

Retaining Structures (Cut & Fill)

SCALE

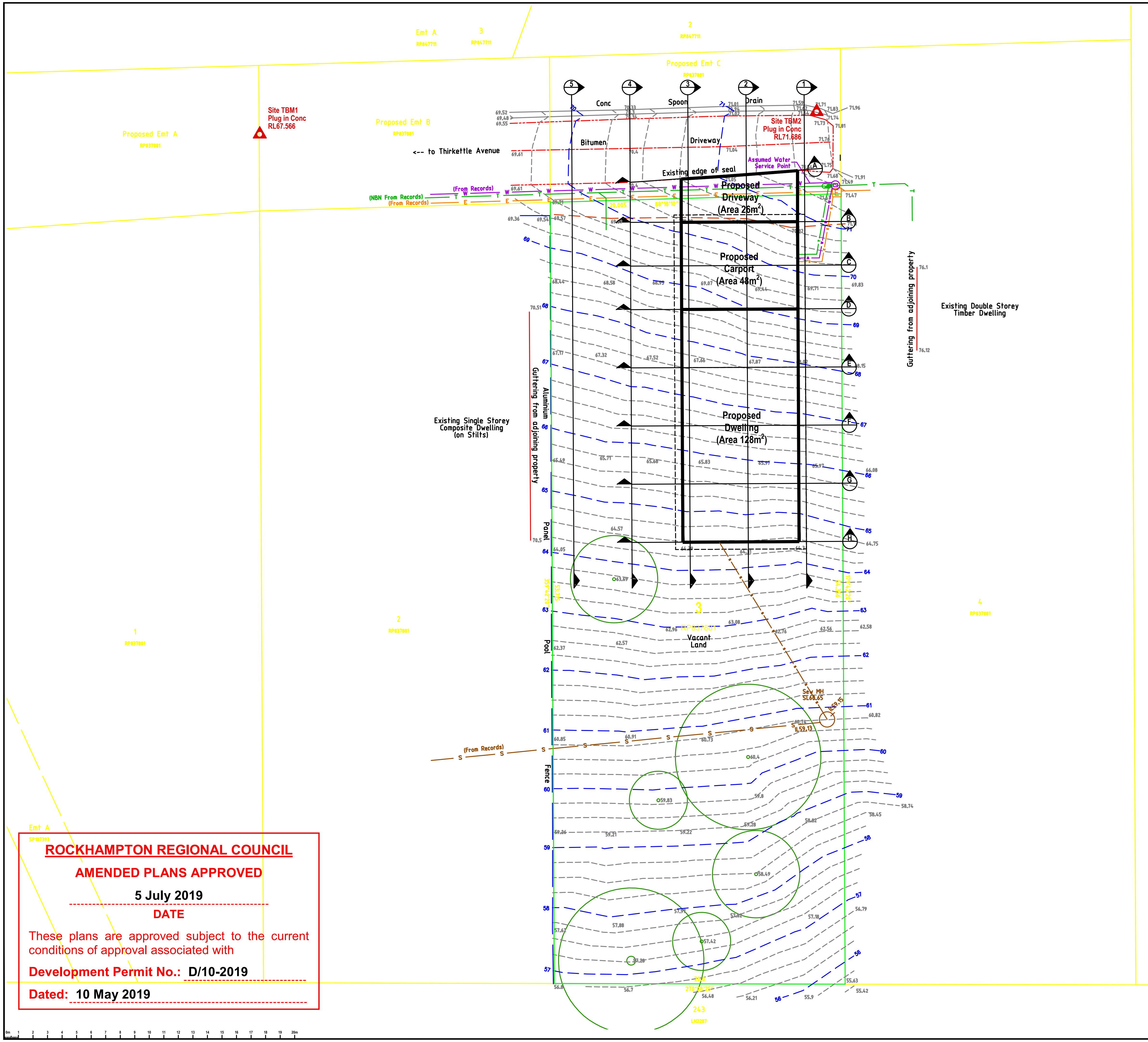
1:125 @ A1

DRAWING NUMBER

7256-01-DTL (2/3)

ISSUE

D



GENERAL SYMBOL LEGEND

- Communication Cable Marker
- Communication Pit
- Electrical Cable Marker
- Electrical Turret
- Electrical Light Pole
- Electrical Light Bollard
- Electrical Pit
- Electrical Power Pole
- Electrical Power Pole + Light
- Electrical Power Pole + Transformer
- Electrical Stay Point
- Gas Valve
- Sewerage M/H
- Stormwater M/H
- Stormwater Pit
- Water Fire Hydrant
- Water Meter
- Water Valve
- Water Tap / Irrigation Tap
- Water Conduit Marker
- Guide Sign
- Bollard
- Flag Pole
- Australia Post Box
- Tree

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

5 July 2019

DATE

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/10-2019

Dated: 10 May 2019

PRINCIPAL

W. WONG

DESCRIPTION

LOT 3 RP837881

318 THIRKETTLE AVENUE, FRENCHVILLE

REAL PROPERTY DESCRIPTION

Lot/Plan :	Lot 3 on RP837881
Area :	1081m² (Deed)
Parish :	-
County :	-
Locality :	Frenchville
Local Authority :	Rockhampton Regional Council

NOTES

This plan was prepared for the purpose of designing new constructions on the subject land and should not be used by any other persons for any other purpose.

Property boundaries have not been reinstated or marked at the time of survey and are approximate only, based on appropriate boundary connections.

Where possible underground services have been located by field survey. Some services shown hereon are compiled from local authority and service provider plans and/or plans provided by the client and are noted accordingly on the plan.

Prior to any design, excavation or construction on site, the relevant authorities, and a qualified service locator should be engaged to ensure all services that may be affected by any future works have been located.

These plans have been prepared as verification plots only. Some text RL's have been omitted for clarity. Please refer to the relevant 3D data files for any spatial interrogation requirements.

This note is an integral part of this plan.

LEGEND

SERVICES LEGEND

- S — UG Sewerage Line
- SW — UG Stormwater Line
- Overland Flow/Direction
- E — UG Electrical Line
- OH Electrical Line
- T — UG Communication Line
- W — UG Water Line
- W — AG Water Line
- G — UG Gas Line
- Top of Bank
- Toe of Bank
- C/L of Bitumen
- Edge of Bitumen
- Line Marking
- Fence Line
- Gate

CONTOUR LEGEND

- 0.25m Interval
- 1.00m Interval

DATUM

Vertical Datum :	AHD Vide Smartnet Aus
Horizontal Datum :	Cadastral Vide RP837881
Contour Interval :	0.25m, 1.0m Index
Co-ord System :	MGA94 Zone 56

WARNING

LOCATION AND CONNECTIVITY OF U/G SERVICES SHOWN HEREON HAVE BEEN DETERMINED BY DIRECT ACCESS OR COMPILED FROM LOCAL AUTHORITY & SERVICE PROVIDER PLANS ONLY. FURTHER INVESTIGATION MAY BE REQUIRED TO DETERMINE LOCATIONS OF ALL INACCESSIBLE SERVICES.

REVISION

Issue	Date	Details	Authorised
A	5-12-2018	Initial Issue	
B	23-05-2019	Amendment to reduce building footprint	
C	31-05-2019	Amendment to reduce building footprint	
D	07-06-2019	Amendment to reduce building footprint	

CREATED

Cross and Longitudinal Sections

SCALE

1:125 @ A1

DRAWING NUMBER

7256-01-DTL (3/3)

ISSUE

D

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

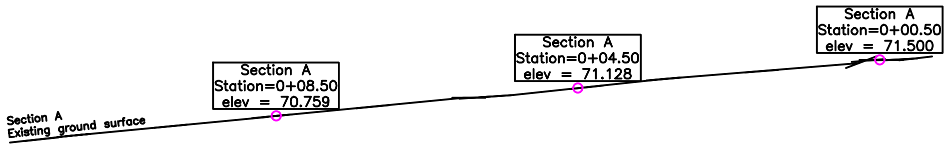
5 July 2019

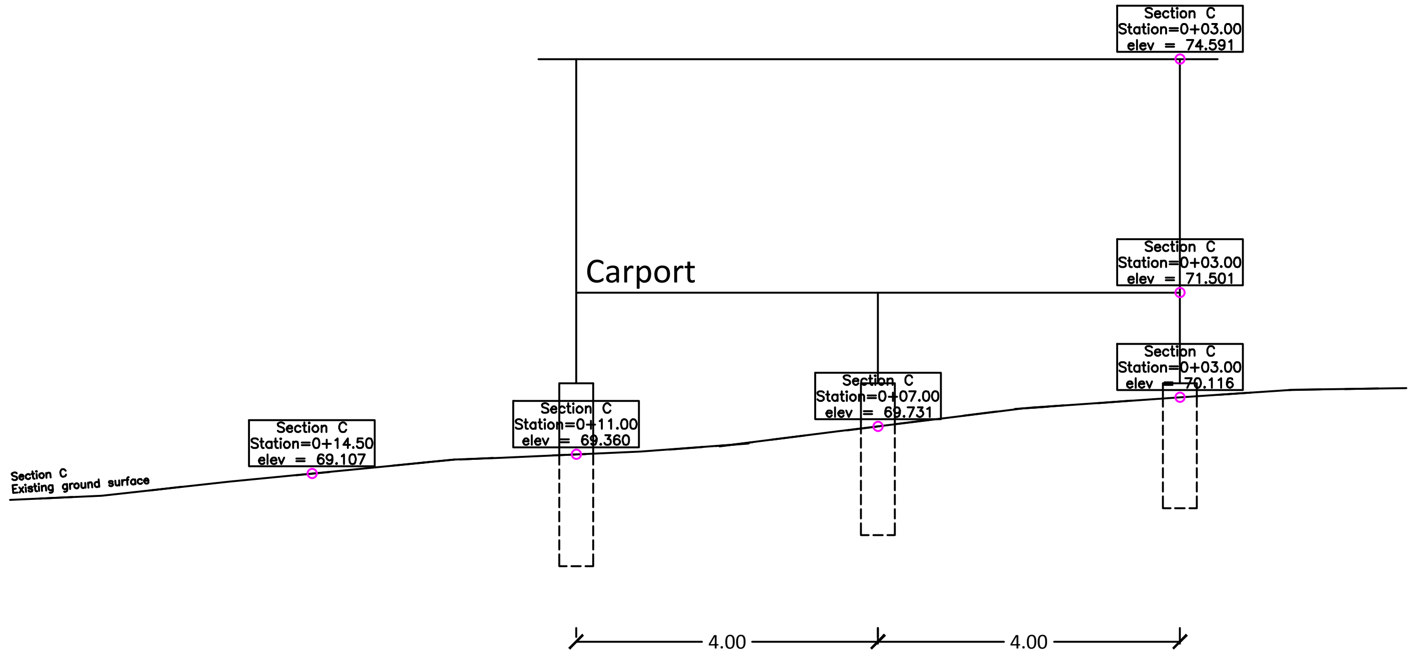
DATE

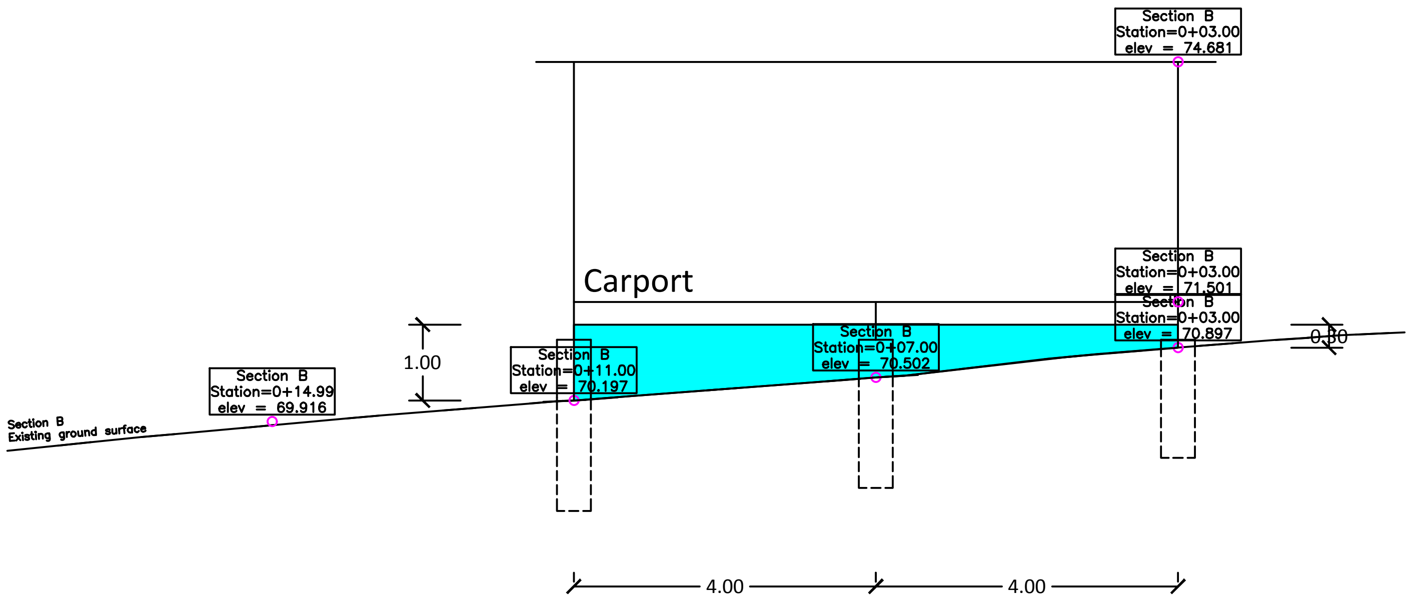
These plans are approved subject to the current conditions of approval associated with

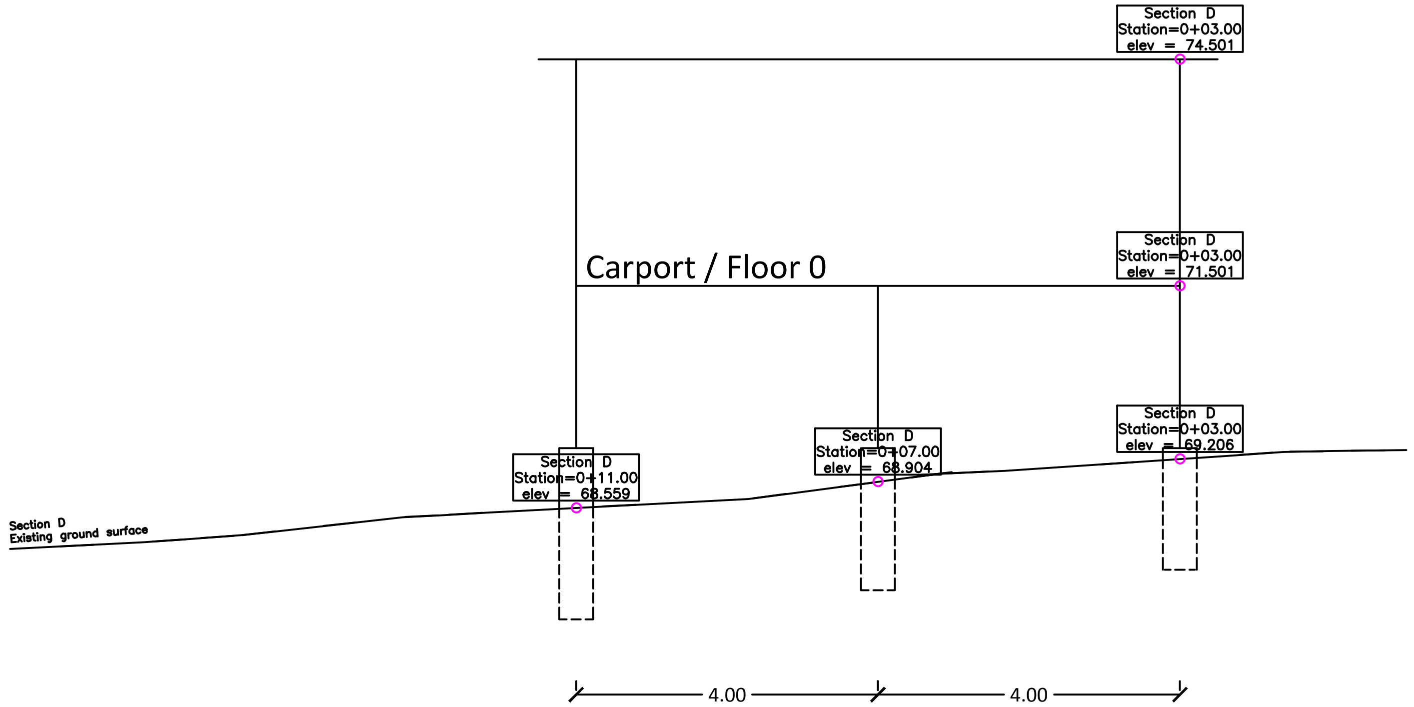
Development Permit No.: D/10-2019

Dated: 10 May 2019









Note:

1. Building structure shown for information only. Details to be confirmed in Building Application.
2. Footings shown indicative only. Design to be certified by RPEQ in Building Application.
3. Retaining walls to be certified by RPEQ in Building Application.

REVISIONS

No.	BY	DATE	DESCRIPTION	APPD
		07.06.19	Amendment to reduce building footprint	

Scale 0 1.25 2.5 m

ACTION	INITIALS	DATE
DRAFTER		
CHECKED		
CORRECTED		

CAD REF: C:\Users\WongW4\Documents\1. WW\P\Home\RRC\Development Application\Application\3rd submission\CAD\
CAD REF: 318 Thirkettle_Cross Sections and South_v06_WW_240219.dwg
Last Modified: Sat, 15 Jun 2019 11:54 am

Datum: GDA94
Horiz. Grid: MGA94 Zone 56
Height Origin: AHD

Unit: M

Plan of

318 Thirkettle Avenue, Frenchville QLD 4701
Sections A, B, C & D

Status

Drg No. SK01 D

Rev.

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

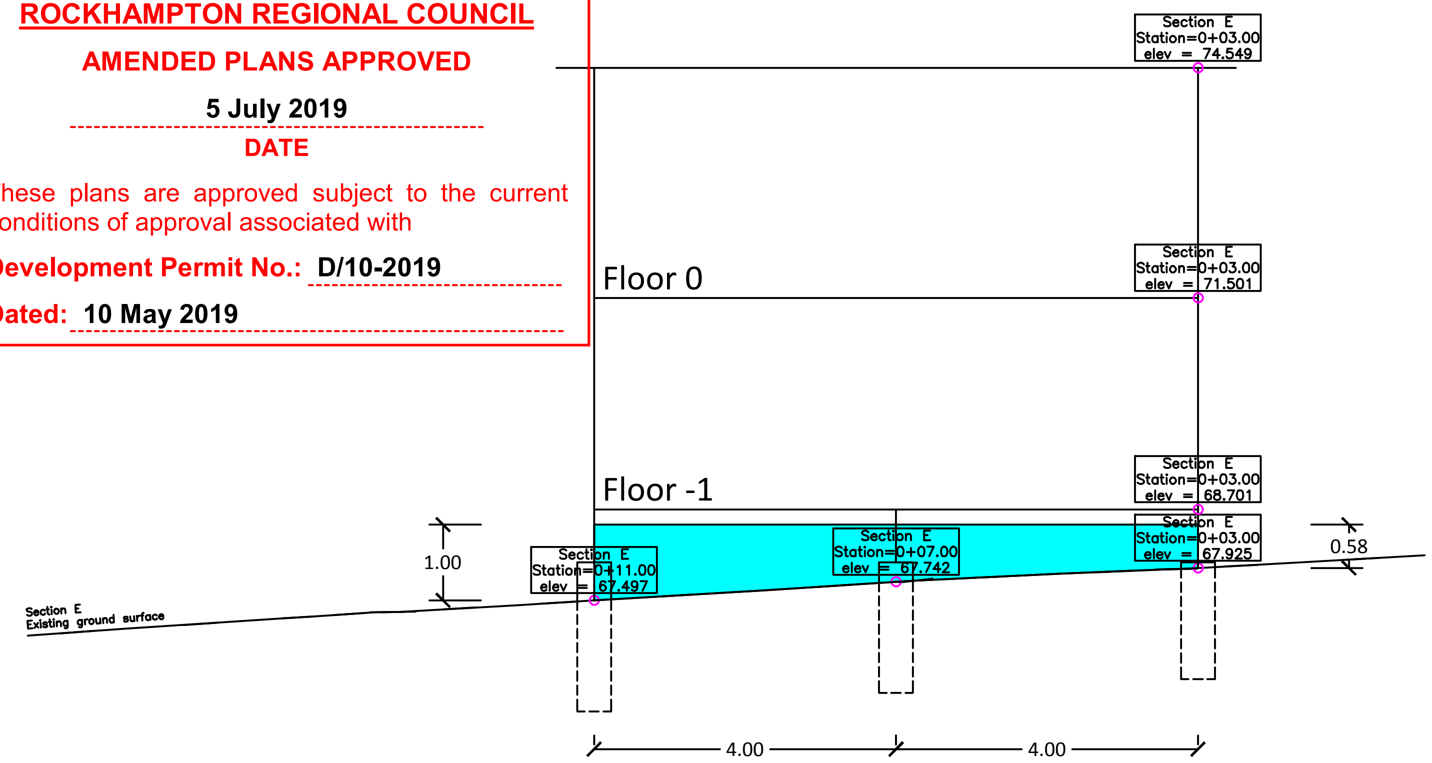
5 July 2019

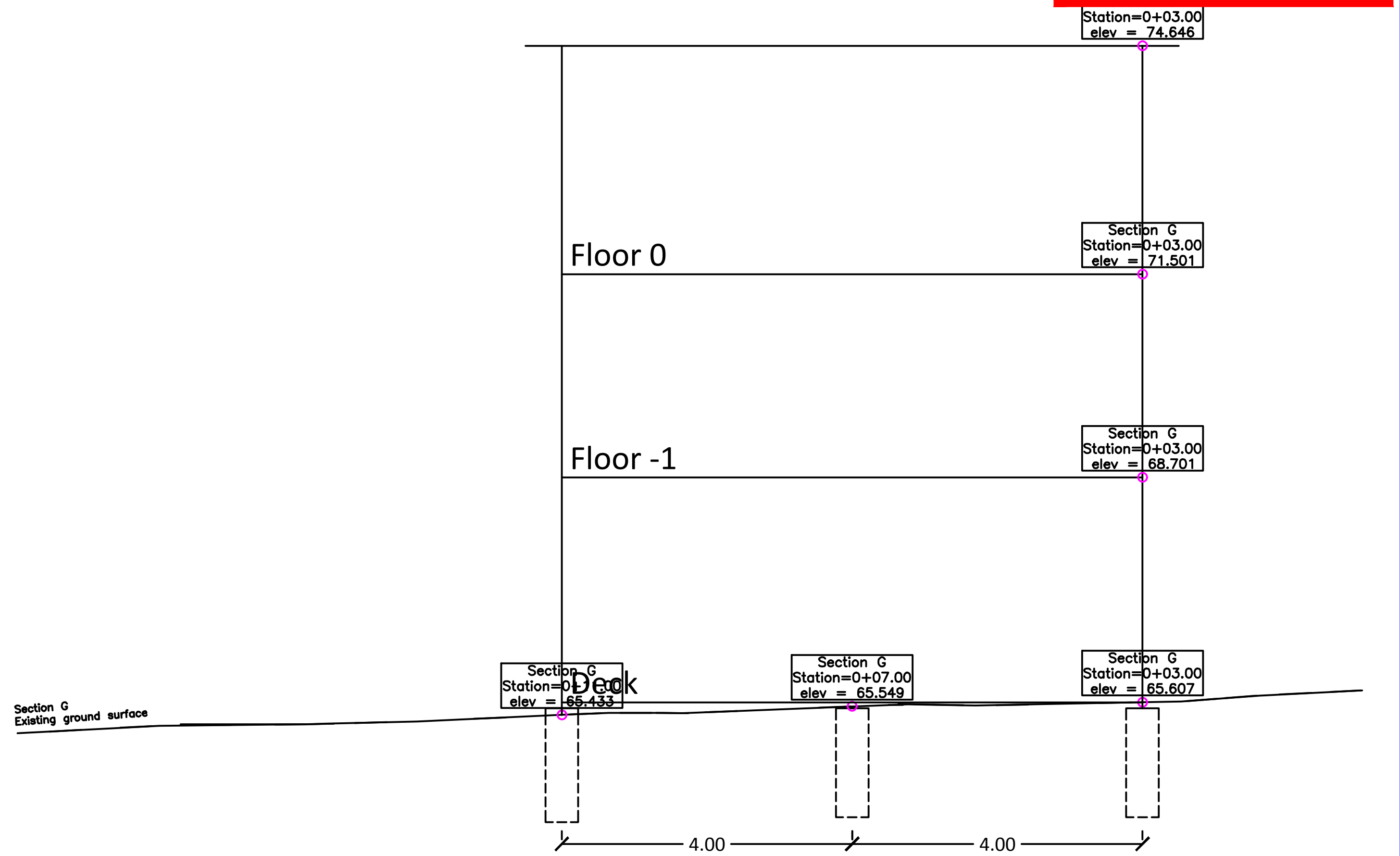
DATE

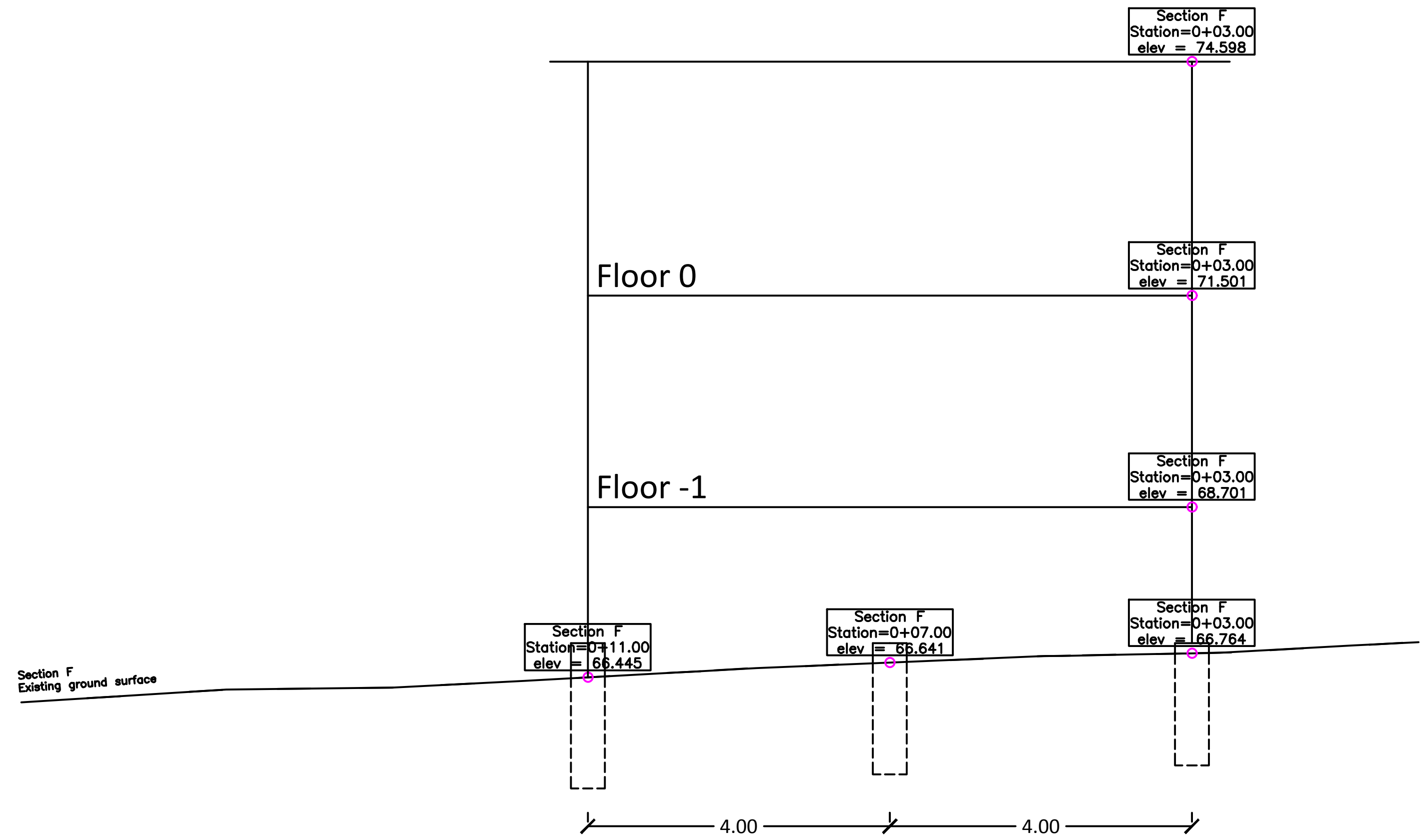
These plans are approved subject to the current conditions of approval associated with

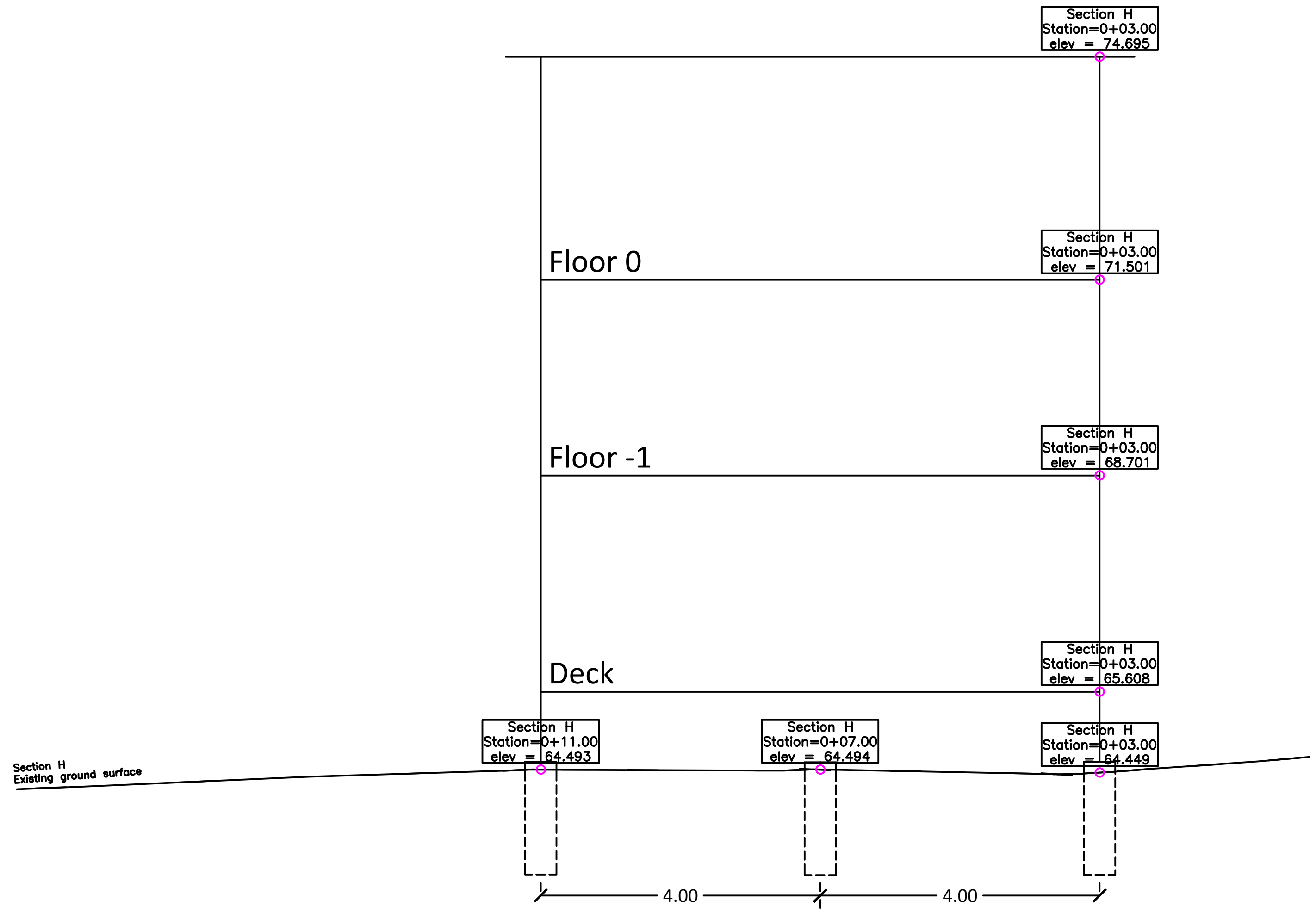
Development Permit No.: **D/10-2019**

Dated: **10 May 2019**









Note:

1. Building structure shown for information only. Details to be confirmed in Building Application.
2. Footings shown indicative only. Design to be certified by RPEQ in Building Application.
3. Retaining walls to be certified by RPEQ in Building Application.

REVISIONS

No.	BY	DATE	DESCRIPTION	APPD
		07.06.19	Amendment to reduce building footprint	

Scale 0 1.25 2.5 m

	ACTION	INITIALS	DATE
	DRAFTER		
	CHECKED		
	CORRECTED		

CAD REF: C:\Users\WongW4\Documents\1. WW\P\Home\RRC\Development Application\Application\3rd submission\CAD\
CAD REF: 318 Thirkettle_Cross Sections and South_v06_WW_240219.dwg
Last Modified: Sun, 16 Jun 2019 11:52 am

Datum: GDA94
Horiz. Grid: MGA94 Zone 56
Height Origin: AHD
Unit: M

Plan of

318 Thirkettle Avenue, Frenchville QLD 4701
Sections E, F, G & H

Status

Drg No. SK02 D

Rev.

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

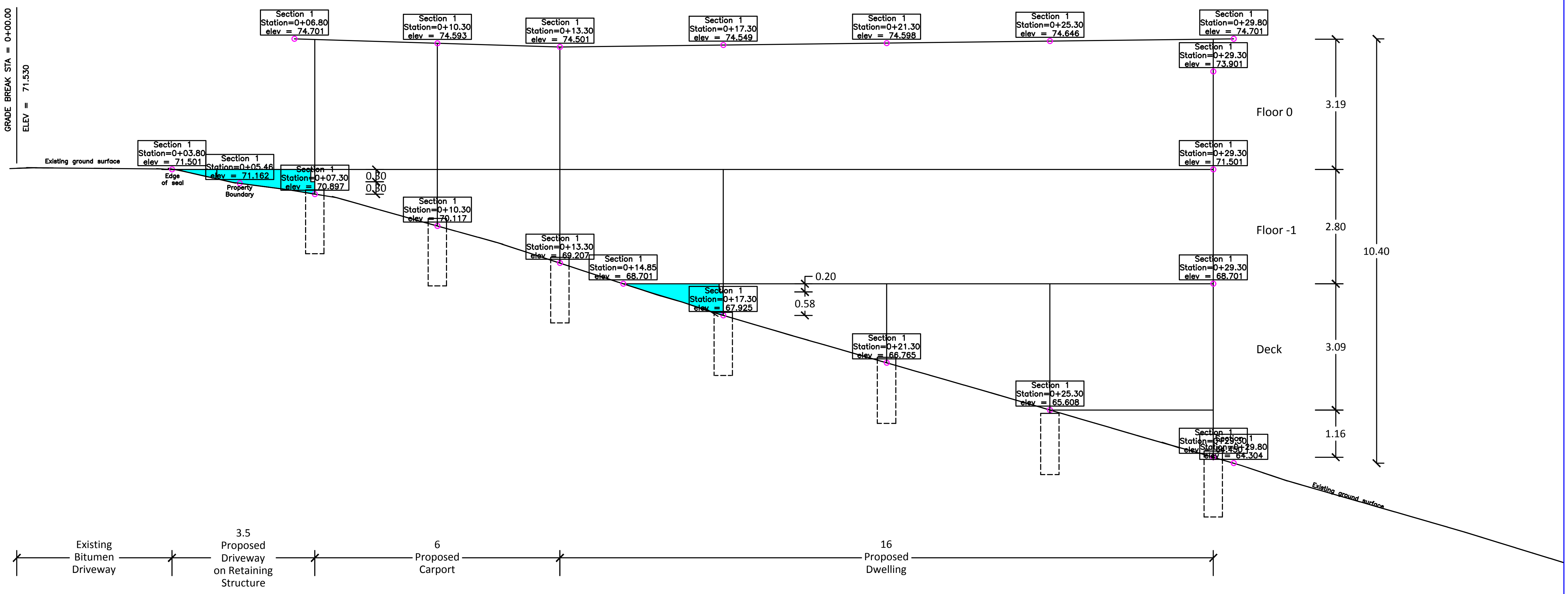
5 July 2019

DATE

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/10-2019

Dated: 10 May 2019



Note:

1. Proposed driveway and all retaining structures to be designed and certified by RPEQ in Building Application.
2. Footings shown are indicative only. Design to be certified by RPEQ in Building Application.

Legend:

Area of fill

No.	BY	DATE	DESCRIPTION	APPD
		07.06.19	Amendment to reduce building footprint	

REVISIONS

Scale 0 1.25 2.5 m

ACTION	INITIALS	DATE
DRAFTER		
CHECKED		
CORRECTED		

CAD REF: C:\Users\WongW4\Documents\1. WW\P\Home\RRC\Development Application\Application\3rd submission\CAD\
CAD REF: 318 Thirkettle_Long Sections_v05_WW_140219.dwg
Last Modified: Sun, 16 Jun 2019 11:53 am

Datum: GDA94
Horiz. Grid: MGA94 Zone 56
Height Origin: AHD
Unit: M

Plan of

318 Thirkettle Avenue, Frenchville QLD 4701
Section 1

Status

Drg No. SK03 D

Rev.

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

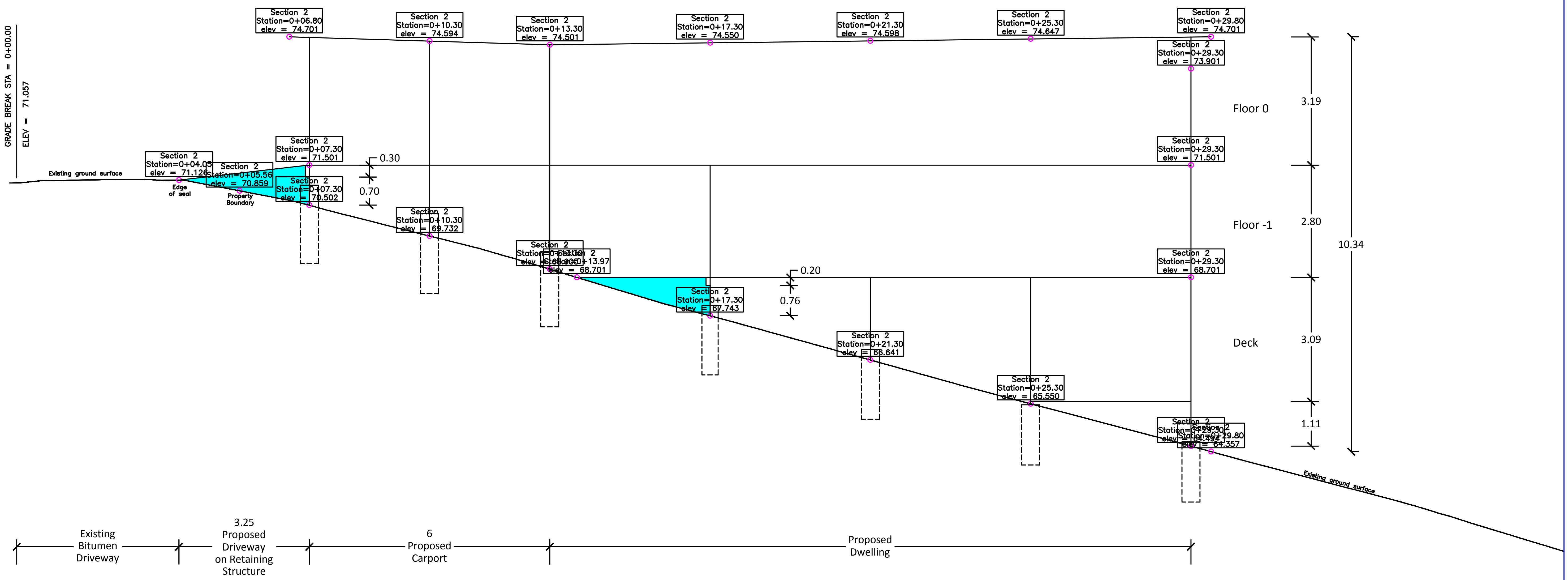
5 July 2019

DATE

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/10-2019

Dated: 10 May 2019



Note:

1. Proposed driveway and all retaining structures to be designed and certified by RPEQ in Building Application.
2. Footings shown are indicative only. Design to be certified by RPEQ in Building Application.

Legend:

- Area of fill

No.	BY	DATE	DESCRIPTION	APPD
		07.06.19	Amendment to reduce building footprint	

REVISIONS

Scale 0 1.25 2.5 m

	ACTION	INITIALS	DATE
	DRAFTER		
	CHECKED		
	CORRECTED		

CAD REF: C:\Users\WongW4\Documents\1_WW\P\Home\RRC\Development Application\Application\3rd submission\CAD\
CAD REF: 318 Thirkettle_Long Sections_v05_WW_140219.dwg
Last Modified: Sun, 16 Jun 2019 11:53 am

Datum: GDA94
Horiz. Grid: MGA94 Zone 56
Height Origin: AHD
Unit: M

Plan of

318 Thirkettle Avenue, Frenchville QLD 4701
Section 2

Status

Drg No. SK04 D

Rev.

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

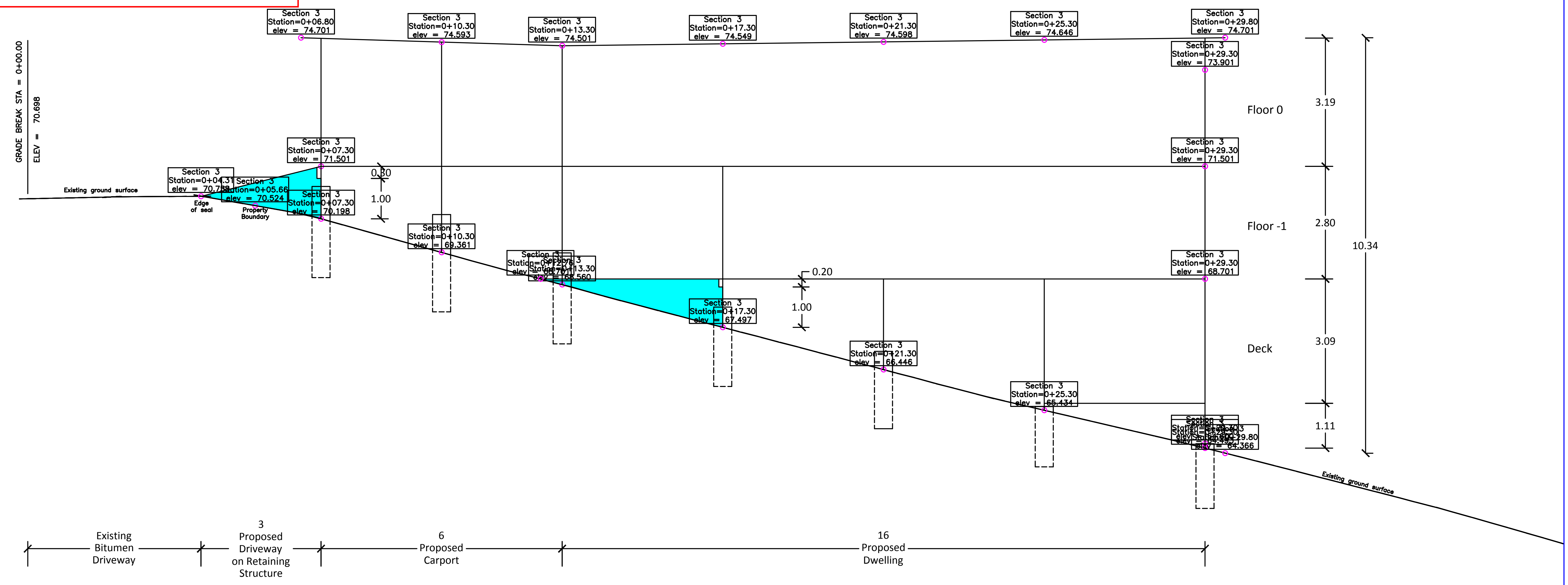
5 July 2019

DATE

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/10-2019

Dated: 10 May 2019



Note:

1. Proposed driveway and all retaining structures to be designed and certified by RPEQ in Building Application.
2. Footings shown are indicative only. Design to be certified by RPEQ in Building Application.

Legend:

■ Area of fill

No.	BY	DATE	DESCRIPTION	APPD
		07.06.19	Amendment to reduce building footprint	

REVISIONS

Scale 0 1.25 2.5 m

	ACTION	INITIALS	DATE
	DRAFTER		
	CHECKED		
	CORRECTED		

CAD REF: C:\Users\WongW4\Documents\1. WW\P\Home\RRC\Development Application\Application\3rd submission\CAD\
CAD REF: 318 Thirkettle_Long Sections_v05_WW_140219.dwg
Last Modified: Sun, 16 Jun 2019 11:54 am

Datum: GDA94
Horiz. Grid: MGA94 Zone 56
Height Origin: AHD

Unit: M

Plan of

318 Thirkettle Avenue, Frenchville QLD 4701
Section 3

Status

Drg No. SK05 D

Rev.

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

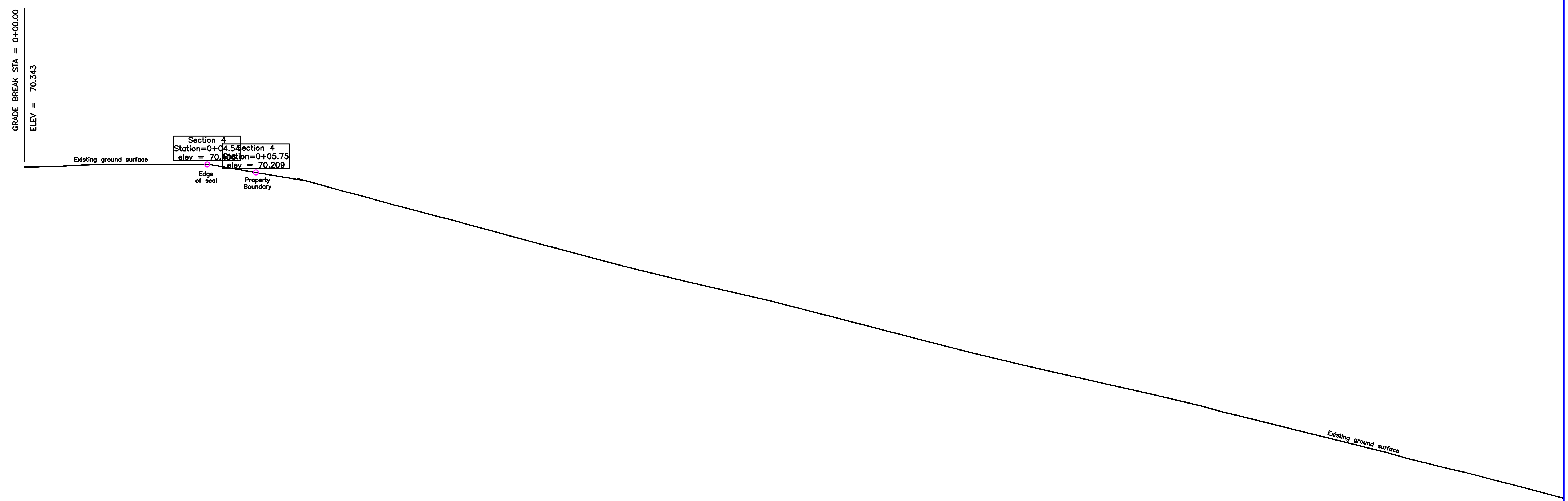
5 July 2019

DATE

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: **D/10-2019**

Dated: **10 May 2019**



Note:

1. Proposed driveway and all retaining structures to be designed and certified by RPEQ in Building Application.
2. Footings shown are indicative only. Design to be certified by RPEQ in Building Application.

Legend:

- Area of fill

REVISIONS				
		07.06.19	Amendment to reduce building footprint	
No.	BY	DATE	DESCRIPTION	APPD

Scale 0 1.25 2.5 m

	ACTION	INITIALS	DATE
	DRAFTER		
	CHECKED		
	CORRECTED		

CAD REF: C:\Users\WongW4\Documents\1. WW\P\Home\RRC\Development Application\Application\3rd submission\CAD\
CAD REF: 318 Thirkettle_Long Sections_v05_WW_140219.dwg
Last Modified: Sat, 15 Jun 2019 11:19 am

Datum: GDA94
Horiz. Grid: MGA94 Zone 56
Height Origin: AHD

Unit: M

Plan of

318 Thirkettle Avenue, Frenchville QLD 4701
Section 4

Status

Drg No. SK06 D

Rev.

ROCKHAMPTON REGIONAL COUNCIL

AMENDED PLANS APPROVED

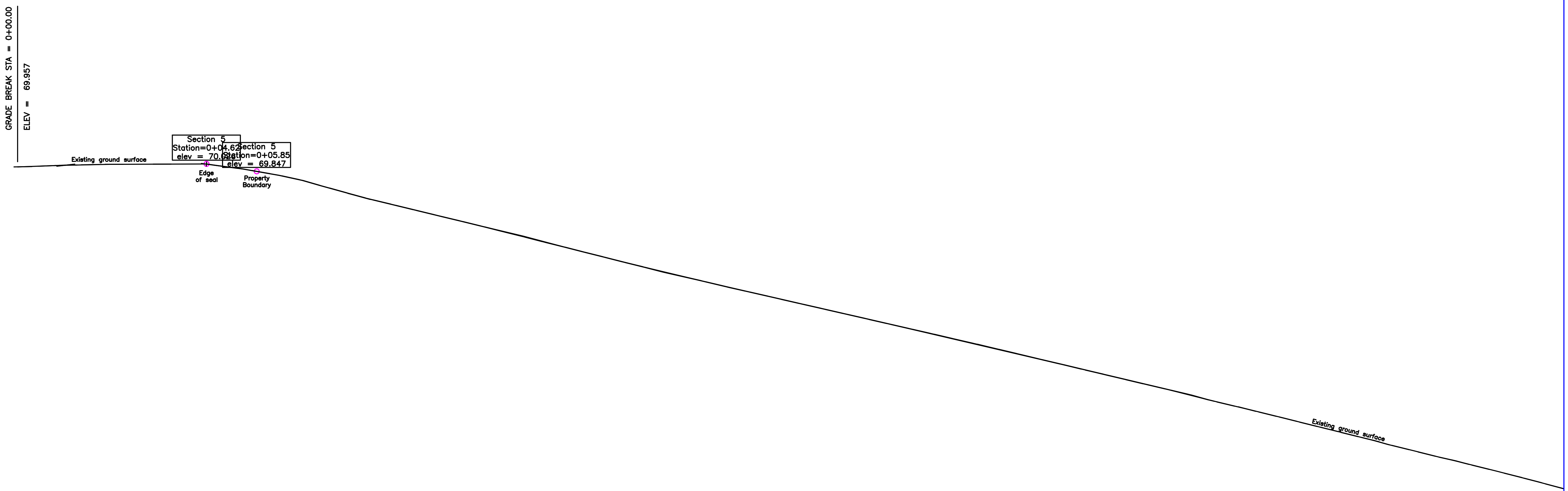
5 July 2019

DATE

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: **D/10-2019**

Dated: **10 May 2019**



Note:

1. Proposed driveway and all retaining structures to be designed and certified by RPEQ in Building Application.
2. Footings shown are indicative only. Design to be certified by RPEQ in Building Application.

Legend:

Area of fill

No.	BY	DATE	DESCRIPTION	APPD
		07.06.19	Amendment to reduce building footprint	

REVISIONS

Scale 0 1.25 2.5 m

ACTION	INITIALS	DATE
DRAFTER		
CHECKED		
CORRECTED		

CAD REF: C:\Users\WongW4\Documents\1. WW\P\Home\RRC\Development Application\Application\3rd submission\CAD\
CAD REF: 318 Thirkettle_Long Sections_v05_WW_140219.dwg
Last Modified: Sat, 15 Jun 2019 11:19 am

Datum: GDA94
Horiz. Grid: MGA94 Zone 56
Height Origin: AHD
Unit: M

Plan of

318 Thirkettle Avenue, Frenchville QLD 4701
Section 5

Status

Drg No. SK07 D

Rev.