PP153/2019-1

45 Old Iluka Access YUULONG

Lot: 2 PS: 425161 V/F: 10455/175

Use and Development of a Secondary School, Removal of Native Vegetation, Alteration of Access to a Road Zone in Category 1 and Waiver of Bicycle Requirements (9 spaces) and Associated works

Tract Consultants

Officer - Ian Williams

EXHIBITION FILE

Submissions to this planning application will be accepted until a decision is made on the application.

If you would like to make a submission relating to a planning permit application, you must do so in writing to the Planning Department

ST. QUENTIN
Surveyors • Town Planners • Engineers

LAND CAPABILITY ASSESSMENT FOR PROPOSED DEVELOPMENT

5835 Great Ocean Road, Yuulong

Prepared for:
Ballarat & Clarendon College

Report No:
16006G-LCA Rev2

October 2019

CONTENTS

1.0 EXECUTIVE SUMMARY

Our land capability assessment has established that the proposed development is acceptable for effluent disposal. Our land capability assessment has identified some critical 'major' constraints (**soil permeability rate, allotment slope, high rainfall, proximity to surface waters and landslide risk**) that will need to be considered to enable safe and sustainable effluent disposal on site. These constraints do not prevent the satisfactory completion of the proposed development however the effluent system does require careful planning and design. Subject to constraints and our recommendations the dispersal of wastewater on the development poses a low and manageable environmental risk.

On the basis of the above constraints we have determined this site has a sensitivity rating of 'Moderate' in accordance with the Colac Otway Shire Council Domestic Wastewater Management Plan.

We understand the following development has been proposed for the site:

- Area 1: Student Accommodation (40 Students)
- Area 2: Staff Accommodation (10 Staff) and Support Accommodation (10 Additional Support Staff)

Given the proposed development and allotment size (40 ha) we have judged the optimum environmental solution is to treat the proposed development structures separately with individual secondary treatment systems. Treated wastewater for each development will then be dispersed by ETA beds.

Secondary treatment is required to ensure that '20/30/10 standard' (i.e. 20 mg/l Biochemical Oxygen Demand, 30 mg/l Suspended Solids and E.coli <10 cfu /100mL) effluent is produced prior to dispersal on the land using ETA beds. Treatment of development wastewater to '20/30/10 standard' with treated wastewater dispersion using ETA beds will maximise the potential for evapo-transpiration and minimise the risk of contamination of adjoining sites.

Without continual treatment via UV or chlorination dosing the system will not output at a minimum '20/30/10 standard'. It is therefore important that regular maintenance is performed by a qualified professional so that this higher level of treatment is sustained for the life of the system.

We recommend the following minimum ETA bed areas be adopted for the proposed development:

- Area 1 (Student Accommodation): **456 m^2 (not including spacing between ETA beds)**
- Area 2 (Staff Accommodation): **228 m^2 (not including spacing between ETA beds)**

The treated effluent field must be positioned in accordance with offset and siting requirements as outlined in section 7.4 of our report 'Effluent disposal area siting'.

We also recommend adding both lime and gypsum at a rate of 0.5 kg/m^2 to the base of the excavations to assist sodicity, improve soil absorption and shrinkage characteristics of the underlying clay.

It is important upslope and downslope cut-off drains are constructed for the effluent disposal area to reduce surface flows to and from the disposal field, as shown in Appendix F. We also recommend upslope diversion drains are adopted to reduce stormwater infiltration in the effluent disposal area. The surface runoff should be directed away from the effluent area and ultimately connected to the legal point of discharge.

Guidance is given concerning the design and layout of a suitable system.

Final approval is subject to any specific policy requirements or other limiting environmental constraints not previously brought to our attention.

2.0 INTRODUCTION

St Quentin Consulting was commissioned by the client Ballarat & Clarendon College to provide a Land Capability Assessment (LCA) report for the site. We understand it is proposed to construct a number of buildings associated with the school that includes a commons, dorms and dwellings.

The aims of the assessment were:

1. To assess various features of the site in their present condition in accordance with published standards and guidelines, principally various Septic Tanks Codes published by EPA Victoria and others.

2. Recommend an appropriate and environmentally sustainable treatment and disposal method for the development wastewater.

3.0 PRACTITIONER

The author of this report is Cameron Farrar who is a professional geotechnical engineer with a Bachelor of Engineering degree and registered member of Engineers Australia and of Australian Geomechanics Society. The author has more than 20 years of experience in the land capability assessment for effluent disposal.

4.0 PROPOSED DEVELOPMENT

This report provides recommendations for each building development. If the proposed development is changed significantly this report may be inappropriate. Planning report has revealed the site features a number of sensitive overlays and is included in Appendix H.

We understand the following development has been proposed for the site:

- Area 1: Student Accommodation (40 Students)
- Area 2: Staff Accommodation (10 Staff) and Support Accommodation (10 Additional Support Staff)

Supplied plans indicate that the development will incorporate two main development areas, including staff residence buildings, that will be constructed on a prominent ridgeline and close to an existing homestead building and shed. A second development area is proposed on a separate site, but similarly close to a ridgeline and near an existing shearing shed.

5.0 SITE FEATURES

The subject site is on the south-east side of Great Ocean Road on an uplifted and deeply dissected spurs and ridges. High rainfall has shaped the landscape with extensive water course incision and related large to very large landslide activity. The site aspect is good with respect to exposure to sunshine and wind. Surface drainage is considered to be fair to good. The natural soil types comprise silts, clays and weathered rock prominently developed from Cretaceous age sediments (Eumeralla Formation). Existing vegetation consists mainly of grasses in the proposed effluent disposal area. A satellite view of the site is presented in Figure 1.

Figure 1: Aerial photograph of the site and surrounding area, nearmap.com.

6.0 TESTING PROGRAM AND RESULTS

6.1 Soil profile and geomorphology

Eight (8) boreholes were assessed to investigate predominate soil types across the site. The visual and tactile estimation as outlined in the site and soil evaluation procedure AS1547:2012 was used to identify the relevant soil characteristics. Disturbed soil samples were sampled over the full depth of the soil profile and examined and classified. The soil profiles encountered were compared to soil descriptions in published reports, maps and charts from Department of Primary Industries (DPI) and other sources.

An experienced and qualified geotechnical engineer conducted a thorough geomorphological survey and visual appraisal of the site features the surrounding area to identify any important land features. Slope angles were measured with an inclinometer.

The resulting soil and land description is as follows:

Landform:	Hills
Geology:	Residual clay derived from Cretaceous age sediments
Aust. Soil Classification:	Brown dermosol

Our boreholes indicate clay loam followed by light clay and weathered sandstone.

Geology mapping with contours is presented in Figure 2. A description of the soils typically encountered during our drilling and sampling is presented on the attached sheet in Appendix B.

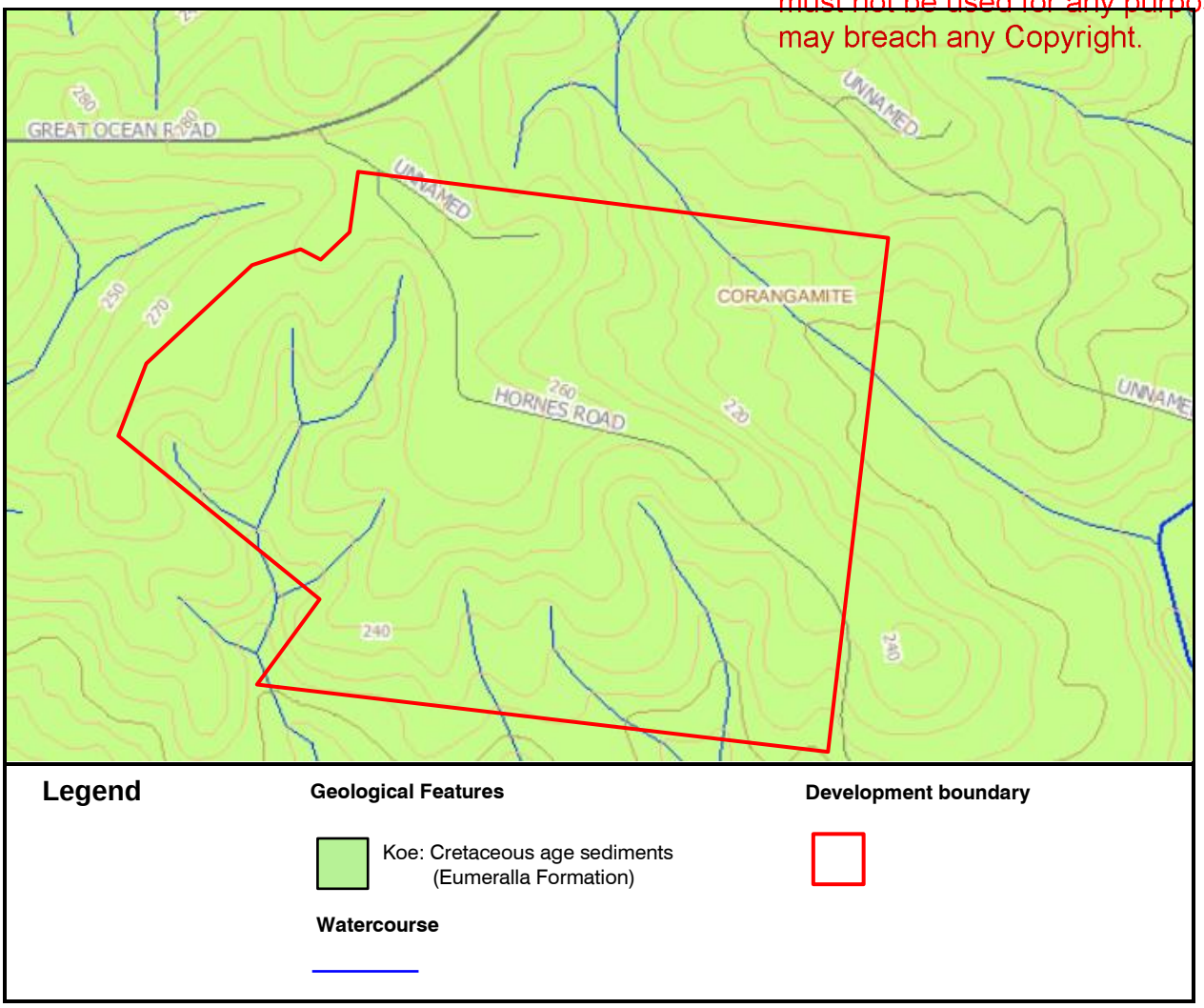


Figure 2: Site geology, source: geovic.vic.gov.au

6.2 Water table

There is limited published bore data available on permanent / transient water table for this area of Yuulong. No perched water table were encountered during testing in nearby gullies however we expect a transient perched water table may develop in very wet conditions above the clay layer. For this reason, it is important upslope and downslope cut-off drains are provided to prevent/reduce transient water flows near the effluent area.

6.3 Land assessment and constraints

Various features of the site were assessed in accordance with the guidelines of the EPA Publications and reported in accordance with constraint levels outlined in VLCA-2nd Ed. Field measurements and observations were made and where necessary, samples were returned to our laboratory for further analysis. The results are shown in Table 1.

Table 1: Land assessment

Land feature	Result	Level of Constraint	Mitigation
Buffer Distances	Buffer distances achievable. Refer to section 7.4 for relevant offset requirements	Nil	Not Required
Climate	Median rainfall* Johanna ~ 1016 mm/yr, Median evaporation# Johanna ~ 881 mm/yr	Major	Rainfall exceeds evaporation in the wettest months. Adopt ETA beds, upslope diversion drain and cut-off drains and
Drainage	Proposed effluent area well drained	Minor	Adopt ETA beds, upslope diversion drain and cut-off drains
Erosion or Landslide Risk	Landslide risk evident on site	Major	Requires assessment by a suitable qualified geotechnical engineer
Exposure & Aspect	Good exposure to wind and sun: surrounding area consisting of open grassland	Minor	Position disposal field in well drained position exposed position to maximise evaporation
Flooding	Flooding not evident (>1:100 year flood level)	Nil	Not Required
Groundwater	Groundwater not evident above 4.50 m	Nil	Not Required
Imported Fill	Likely minor disturbed surface	Nil	Not Required
Site Drainage	The site receives negligible run-off and provides significant run-on.	Moderate	Position disposal field in well drained position and install cut-off drains (upslope and downslope) to prevent water logging
Slope	3-10% in the proposed effluent disposal area	Moderate	Install upslope diversion drain and cut-off drains (upslope and downslope) to reduce infiltration in LAA
Landform	A single landform exists on this site. No significant features were noted on or near the site	Nil	Not Required
Vegetation	Good grass cover	Nil	Not Required
Surface Waters	Non-potable streams within 100m.	Major	Adopt secondary treatment to '20/30/10 std' and 30m setback distance
Rock Outcrops	Not present	Nil	Not Required
Lot size	Considering the site constraints and proposed development size the allotment has sufficient area for effluent disposal	Nil	Not Required

* Closest / longest rainfall recording station record in the area.
# Closest / longest evaporation recording station record in the area (in accordance with Coffey Report: Wye River and Separation Creek - Geotechnical, Land Capability and Wastewater Solutions Land Capability Assessment.

Based on the land assessment criteria, we have judged the land capability of the site is acceptable, provided constraints are addressed with corresponding and appropriate mitigation measures.

6.4 Soil assessment and constraints

An appraisal of the soil was conducted by visual and tactile estimation in accordance with the site and soil evaluation procedure as outlined in AS1547:2012 and reported in accordance with constraint levels outlined in VLCA-2nd Ed.

Based on our analysis we have determined the limiting geological stratum as moderately structured 'clay loam'. As outlined in AS/NZS1547:2012 we have adopted an indicative permeability (K_{sat}) of 0.5-1.5 m/day and a design loading rate of 12 mm/day.

Testing including pH, Emerson Class No. and salinity were also conducted and results are presented in Table 2.

Table 2: Soil assessment

Land feature	Result	Level of Constraint	Mitigation
Soil Depth	4.50 m*	Nil	Not Required
Soil Structure	Topsoil: moderately structured clay loam (soil category 4, AS 1547:2012) Subsoil: moderately structured clay loam (soil category 5, AS 1547:2012)	Minor	Adopt a low DLR and ETA beds
Permeability	Limiting layer ~ 0.5-1.5 m/d	Minor	Adopt a low DLR. Adopt ETA beds
Soil Plasticity	Moderate shrink swell potential	Moderate	Consider ameliorate with addition of **lime** at a rate of 0.5 kg/m^2
Emerson	Topsoil: clay loam (Clayey Silt): Class 3, no dispersion Subsoil: clay loam (Silty Clay/XW Rock): Class 2, some dispersion	Moderate	Ameliorate with addition of **gypsum** at a rate of 0.5 kg/m^2
Salinity	< 0.8 dS/m	Nil	Not Required
pH	6.0 (Neutral)	Nil	Not Required

Based on the above soil assessment criteria, we have judged the soil capability of the site is acceptable subject to relevant outlined mitigation procedures.

6.5 Sensitivity Rating

Further to our land and soil assessment we have completed a sensitivity rating included a Sensitivity Proforma Checklist in accordance with Colac Otway Shire Domestic Wastewater Plan shown in Table 3. Based on the information gathered and our knowledge of the area we have assessed the site sensitivity rating as 'Moderate'.

Table 3: Sensitivity Proforma Checklist

Land feature	Site specific input
PFI Identification Number	45516154
Property/Parcel Address	5835 Great Ocean Road
Locality	Yuulong
Zoning	Rural Conservation
Area (m^2)	400,000 m^2
Soil Texture	clay loam overlying clay loam
Soil Depth (m)	4.50 m
Soil Structure	moderately structured
Soil Limitations	Low permeability rate, minor dispersion
Permeability (Ksat) (m/day)	0.5-1.5 m/d
Slope (%)	~3-10%
Presence of Surface Waters	Watercourses present at the site
Useable Lot Area (m^2)	Approximately 10,000 m^2

A corresponding checklist has been completed and is attached in Appendix I.

6.6 Wastewater volume

We envisage that given that separate areas for students and staff are proposed, with distinctly different usage requirements it will be appropriate to assess each area separately, and where applicable provide separate wastewater treatment for each development. This will also provide the best environmental solution for the site. Note that if the type of development changes our recommendation may not valid and further assessment will be required to confirm wastewater volumes.

Based on indicative volumes outlined in the EPA Victoria Code of Practice for Small Wastewater Treatment Plants, we have calculated the appropriate wastewater volumes in Table 4.

Table 4: Estimated wastewater load

Proposed Development	EPA Daily Flow (Litres / person /day)	Proposed Occupancy	Total Wastewater Volume (Litres/day)
Area 1: Student Accommodation (adopt EPA estimation for school)	120*	40	4800 L/day
Area 2: Staff Accommodation (adopt EPA estimation for school)	120*	20	2400 L/day

* Limited water supply (where water is sourced only from rain water collection from roofs)

7.0 CONCLUSIONS AND RECOMMENDATIONS

Our Land Capability Assessment has found the proposed site is acceptable for effluent disposal. Our assessment however has concluded the site sensitivity is 'Moderate' and we have identified some major constraints which will need to be considered to enable safe and sustainable effluent disposal on site. Our assessment has found the site is constrained due to limiting factors including soil permeability rate, allotment slope, high rainfall, proximity to surface waters and landslide risk. These constraints however can be mitigated by careful planning and design.

Subject to constraints and our recommendations the dispersal of wastewater on the development poses a low and manageable environmental risk.

We recommend that the proposed development wastewater receive secondary treatment and that the treated effluent be dispersed by using ETA beds.

Secondary treatment is required so that '20/30/10 standard' (i.e. 20 mg/l Biochemical Oxygen Demand, 30 mg/l Suspended Solids and E.coli <10 cfu /100mL) effluent is finally produced prior to dispersal on the land using ETA beds. Treatment of development wastewater to '20/30/10 standard' with dispersal of the treated wastewater using ETA beds will maximise the potential for evapo-transpiration and minimise the risk of contamination of adjoining sites. This will ensure a sustainable environmental outcome for the site and the surrounding sites.

Without continual treatment via UV or chlorination dosing the system will not output at a minimum '20/30/10 standard'. It is therefore important that regular maintenance is performed by a qualified professional so that this higher level of treatment is sustained for the life of the system.

We recommend adding both lime and gypsum at a rate of 0.5 kg/m^2 to the base of the excavations to improve soil absorption and reduce shrinkage characteristics of the underlying clay.

Upslope and downslope cut-off drains must be provided to prevent/reduce transient water flows near the effluent area or building envelope. We also recommend upslope diversion drains are adopted to reduce stormwater infiltration in the effluent disposal area. The surface runoff should be directed away from the effluent area and ultimately connected to the legal point of discharge.

7.1 Treatment system

'20/30/10 standard' can be achieved using both a septic tank (anaerobic treatment) and a pressure dosed sand filter (aerobic treatment) or by using a powered aerated water treatment system (AWTS) combined with additional treatment (using UV, ozone or chlorination).

Various AWTS are available on the market and these are generally the preferred method of treatment, note however that an AWTS may not be suitable where irregular or intermittent flows are likely such as from a holiday house. All AWTS require a current EPA certificate of approval for operation. Regular maintenance of AWTS is essential to ensure correct performance and it is usually a requirement of the approval certificate that a service contract be maintained for the unit.

Note that due to the proposed intermittent flows we strongly recommend the use of a sand filter system, rather than an AWTS. The following minimum sand filter sizes and filter media characteristics are recommended, in accordance with EPA standards (CA 1.3/03).

Table 5: Sand Filter requirements

Number of bedrooms	Wastewater volume	Sand filter size	Dosage rate	Clay & Fine Silt Content	Effective Size*	Uniformity Coefficient**
40	4800L/day	96 m^2	≤50 L/m^2/day	<5 %	0.25 to 0.6mm	<4
20	2400L/day	48 m^2	≤50 L/m^2/day	<5 %	0.25 to 0.6mm	<4

*Effective size: maximum particle size of smallest 10% by mass of the sand
**Uniformity coefficient: the ratio of the maximum particle size of the smallest 60% by mass of sand to the maximum particle size of the smallest 10% by mass of the sand

7.2 Land application area

7.2.1 Disposal area size based on material type

Based on the material type and through interpretation of Table 5.1 & 5.2 in AS/NZS1547:2012 for “clay loam”, the minimum disposal area and ETA bed length required to successfully disperse treated development wastewater based on the material type on the site assuming a bed width of 4 m is:

- Area 1 (Student Accommodation): 400 m^2 and 100 m respectively.
- Area 2 (Staff Accommodation): 200 m^2 and 50 m respectively.

Note: these areas assumed zero storage capacity and may need to be further modified dependant on water balance calculations shown in section 7.2.2.

7.2.2 Disposal area size based on water balance model

Based on the water balance model (refer Appendix D) minimum required to successfully disperse treated development wastewater on the site site assuming a bed width of 4 m is

- Area 1 (Student Accommodation): 449.5 m^2 and 113 m respectively.
- Area 2 (Staff Accommodation): 224.7 m^2 and 57 m respectively.

The water balance model was calculated using the following input data:

- Precipitation – Johanna ~ 1016 mm/yr (the closest / longest rainfall data recording station).
- Evaporation – Johanna ~ 881 mm/yr (the closest / longest evaporation data recording station).
- Crop factor – seasonally variable from 0.6 to 0.8
- Coefficient of runoff – 0.75

7.2.3 Minimum design effluent area for combined blackwater/greywater treatment

Based on our tests and calculations and using design loading rates from AS/NZS1547:2012 we have determined that the following minimum ETA bed area and length required to successfully disperse treated wastewater for the proposed development. ETA bed sizing calculations are shown in Appendix D.

Table 6: Design effluent area for 40-bedroom residence

Effluent volume produced (unlimited water supply)	Minimum Effluent Disposal Area#	ETA Bed Width*	ETA Bed Length+
40 Students - 2400 L/day	456 m^2	4 m	114 m
20 Staff - 2400 l/day	228 m^2	4 m	57 m

Not including the spacing between the ETA Bed units
Recommended minimum spacing between trench/bed units: 1.0m
* Bed width range between 1m and 4m, designer may choose a different width
+ Maximum length of 20m recommended

7.3 Effluent system design

It is beyond the scope of this report to provide a detailed design specific layout of the treatment and effluent disposal system. We have provided an indicative suggestion of the effluent disposal area shape used for illustrative purposes in Appendix A. We endorse variation in ETA bed length / width and location, provided the design is in accordance with our recommendations.

We recommend that an experienced contractor or consultant be engaged to design and install the system. The AWTS manufacturer may be able to provide this service. A typical ETA bed system layout and cross section are shown on Appendix E & F (by way of example only).

Trenches for the disposal system should be properly backfilled and field should be left as undisturbed as possible before and after construction and must be protected from traffic by vehicles.

Uneven effluent distribution is a significant factor in AWTS failure. We recommend that the capacity of the pump is verified prior to installation to select the adequate pump and ensure a uniform irrigation of the effluent.

Stormwater and roof runoff water must be diverted around the disposal field to an appropriate point of discharge for stormwater. Cut-off drains should be installed at the top and bottom of the irrigation field to reduce surface runoff. Drains should include lined agriculture drains and backfilled with free draining coarse aggregate. We also recommend upslope diversion drains are adopted to reduce stormwater infiltration in the effluent disposal area.

7.4 Effluent disposal area siting

We have judged there are no specific restrictions on the effluent disposal siting, notwithstanding minimum offset requirements presented below.

The effluent irrigation area must be located as follows:

1. In an area not subject to vehicular traffic.
2. No closer than 3.0m from a gas or water pipe (primary treatment).
3. No closer than 3.0m on the low side or 6.0m on the high side of a property boundary (primary treatment).
4. No closer than 1.5m from a gas or water pipe (secondary treatment).
5. No closer than 1.5m on the low side or 3.0m on the high side of a property boundary (secondary treatment).
6. No closer than 3.0m from a swimming pool or stormwater drain.
7. No closer than 7.5m from an underground tank, cutting or escarpment.
8. No closer than 10m from a non-potable groundwater bore.

9. No closer than 30m from a dam, stream or channel (non-potable).
10. No closer than 100m from a stream or river in a potable water supply catchment.

The disposal area must be permanently dedicated and marked with at least two clear warning signs.

Our analysis has shown there is sufficient available land for an effluent disposal area of 456 m^2 and 228 m^2 (not including spacing between ETA beds), as shown in Appendix A.

7.5 Reserve field

The EPA Septic Tanks Code of Practice requires that provision for a "reserve" effluent disposal field in the event that the primary disposal field fails, proves to be inadequate or needs to be rested. **We have judged that a reserve field is not required for wastewater that has been treated to '20/30/10 standard', as is proposed for this site.** However, given the potential for wastewater variation, a minimum area of 30% can be allocated for reserve field. The reserve field must be located on the site in compliance with all the minimum setback distances etc. as described above.

7.6 Vegetation cover

Efficient effluent disposal assumes good vegetative cover. Therefore, it is recommended to establish and maintain grasses or suitable shrubs. Such vegetation can significantly assist the overall disposal process by transpiration from leaves and by maintaining soil permeability through fine root channels. Refer to the attached "Land Capability Assessment Addendum" for additional information and indicative list of suitable plant species.

7.7 Drainage management

Careful attention to drainage is essential to reduce risk of system failure. Surface water must therefore be prevented from ponding anywhere on or near the site.

We recommend installation of upslope cut-off drains above and below the effluent disposal area with run-off directed to the legal point of discharge. We also recommend upslope diversion drains are adopted to reduce stormwater infiltration in the effluent disposal area.

The drains must be positioned and constructed with sufficient fall to discharge completely to prevent water from accumulating in the soil anywhere near the buildings. Any blockages must be cleared and repaired promptly.

Care must also be taken to ensure that all levelled areas (vehicle parking bays, recreation areas etc.) have a slight fall (≥2°) to prevent surface water from ponding or seeping into the ground and diverted away from the buildings.

7.8 Management, monitoring, care and operation

Secondary treatment is required so that '20/30/10 standard' (i.e. 20 mg/l Biochemical Oxygen Demand, 30 mg/l Suspended Solids and E.coli <10 cfu /100mL) effluent is finally produced prior to dispersal on the land using ETA beds. Treatment of development wastewater to '20/30/10 standard' with dispersal of the treated wastewater using ETA beds will maximise the potential for evapo-transpiration and minimise the risk of contamination of adjoining sites.

E.coli <10 cfu /100 mL can be achieved via chlorine, UV and Ozone however from experience dosing using chlorine may provide the simplest solution for the site conditions. An appropriate dose for secondary treatment is generally 15-45 mg/L however recommend specialist advice from supplier of the domestic wastewater treatment supplier. Further specific requirements with regard to disinfection is discussed in AS1547:2102 Appendix P.

We reiterate the importance of maintaining dosing throughout the life of the system so that continual treatment to a '20/30/10 standard' is achieved.

The septic system requires regular servicing and maintenance by an approved contractor to meet the conditions on the council approval certificate and the requirements of the manufacturer to ensure that the minimum '20/30/10 standard' of effluent is consistently achieved.

A healthy system should include a biological scum on the surface and be relatively free from strong odours. We recommend the effluent disposal system be checked by a suitably qualified plumber / drainer every 12 months. The tank level and quality should also be assessed. If necessary, the tank should be 'desludged' i.e. pumped out and any faulty mechanics repaired. Desludging is required concurrently at 3 to 5 year intervals. Similarly, when constructed, sand filter media should be checked concurrently every 3 to 5 years and media replaced where required. Drainage lines should be checked for blockages or fixture failures. Grease trap should be checked for blockages and pumped every 6-12 months.

The following guidelines regarding the care and operation of septic tanks as recommend in the EPA Septic Tanks Code of Practice:

- Restrict the use of germicides (strong detergents, disinfectants, nappy sanitisers, bleaches etc.),
- Use cleaning products, detergents etc. sparingly and check their suitability for septic tank systems,
- Use detergents with low levels of salt, phosphorus and chlorine. Detergents with low phosphorus and sodium are best suited for septic tanks and the environment. For more information regarding detergents we highly recommend visiting Lanfax Laboratories at lanfaxlabs.com.au under "Laundry Products Research" and click the downloadable "laundry brochure".
- Do not flush sanitary napkins, disposable nappies or similar products into the system,
- Minimise the amounts of oil and fat washed into the system,
- Use a sink strainer to restrict food scrapes entering system,
- Do not use garbage disposal units,
- Do not modify the system without council approval,
- Conserve water.

Prepared by:

C Farrar
Geotechnical Engineer B.Eng. MIE Aust (Reg. No. 4367740)
St Quentin Consulting Pty Ltd

References

Australian Soil Resource Information System (ASRIS). Accessed June 2019 https://www.asris.csiro.au

Australian Standard AS/NZS1547:2012 On-site Domestic Wastewater Management, Standards Australia, 2012

Australian Standard AS1726-2017 Geotechnical site investigations, Standards Australia, 2017

Colac Otway Shire Council Domestic Wastewater Management Plan – Technical Document Final, November 2015

Colac Otway Shire Council Domestic Wastewater Management Plan – Operational Document Final, November 2015

EPA Publication 891.4 Code of Practice - Onsite Wastewater Management, July 2016

EPA Publication 746.1 Land Capability Assessment for Onsite Domestic Wastewater Management, March 2003

GeoVic 3 Energy and Earth Resources, State Government of Victoria. Accessed June 2019 http://www.energyandresources.vic.gov.au/earth-resources/maps-reports-and-data/geovic

Google Earth. Accessed June 2019 https://earth.google.com/web/

Nearmap, nearmap.com. Accessed June 2019 https://au.nearmap.com/

Victorian Land Capability Assessment Framework, VLCA-2nd Ed, January 2014

ST. QUENTIN

Appendix A

Site Plans

Site Plan - Commons & Student Accommodation Area

Notes:

1. Dimensions and areas shown are approximate only.
2. Disposal area shape can be modified provided that the offsets requirements and minimum effluent disposal area is maintained.
3. Recommended minimum spacing between trench/bed units: 1.0m
4. Bed width range between 1m and 4m, designer may choose a different width
5. Maximum ETA bed length of 20m recommended

ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909
stqc.com.au

Legend:

- Borehole Locations
- Development Area
- Site slope
- Suitable area
- Min. disposal area
- Setback distance
- Rock outcrop
- Groundwater bh
- Watercourse / waterbody

Site Plan - Student Area

Location: 5835 Great Ocean Road
Yuulong, Victoria

Source: Nearmap.com - Jan-2005

Project No: 16006G-LCA
Inv. date: 21/05/2019
Drawing No: 1
Scale: NOT TO SCALE

Drawn by: O.R.
Date: 25/06/2019
Approved by: C.F.
Date: 25/06/2019

N
mga zone 55

Site Plan - Staff Accommodation Area

Notes:

1. Dimensions and areas shown are approximate only.
2. Disposal area shape can be modified provided that the offsets requirements and minimum effluent disposal area is maintained.
3. Recommended minimum spacing between trench/bed units: 1.0m
4. Bed width range between 1m and 4m, designer may choose a different width
5. Maximum ETA bed length of 20m recommended

ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909
stqc.com.au

Legend:

- Borehole Locations
- Development Area
- Site slope
- Suitable area
- Min. disposal area
- Setback distance
- Rock outcrop
- Groundwater bh
- Watercourse / waterbody

Site Plan - Staff Area

Location: 5835 Great Ocean Road
Yuulong, Victoria

Source: Nearmap.com - Jan-2005

Project No: 16006G-LCA
Inv. date: 21/05/2019
Drawing No: 1
Scale: NOT TO SCALE

Drawn by: O.R.
Date: 25/06/2019
Approved by: C.F.
Date: 25/06/2019

N
mga zone 55

Appendix B

Borehole Logs

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 1
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3	0.50	Silty Clay / Clayey SILT (Clay Loam) Grey Moderately structured Firm, slightly moist	CL	Mo	F	SM			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6 0.9 1.2 1.5	1.50	Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.8	2.00	Silty CLAY/ XW Rock (Clay Loam) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
2.1 2.4 2.7 3.0	3.00	HW Sandstone (Clay Loam) Brown to yellow Strongly structured Hard, slightly moist	LC	Str	H	SM			
3.3		Borehole 1 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 2
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.5	0.60	Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.9	1.20	Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.4	4.00	Silty CLAY/ XW Rock (Clay Loam) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
4.1	4.50	HW Sandstone (Clay Loam) Brown to yellow Strongly structured Hard, slightly moist	LC	Str	H	SM			
4.5		Borehole 2 terminated at 4.5m							
5									

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 3
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3		Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6	0.60								
0.9		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.2									
1.5									
1.8									
2.1									
2.4	2.50								
2.7		Silty CLAY/ XW Rock (Clay Loam) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
3.0	3.00								
3.3		Borehole 3 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 4
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3		Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6	0.60								
0.9		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.2	1.20								
1.5		Silty CLAY/ XW Rock (Clay Loam) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
1.8									
2.1									
2.4									
2.7									
3.0	3.00								
3.3		Borehole 4 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client:	Ballarat & Clarendon College	**Project No.:**	16006G-LCA
Location:	5835 Great Ocean Road	**Borehole No:**	BH 5
	Yuulong, Victoria	**Inv. Date:**	21/05/2019
		Sheet:	1 of 1
		Logged by:	S.L.
		Checked by:	C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3		Clayey Sand FILL, with rock (Loam) Dark grey Weakly structured Medium dense, moist	CL	Mo	MD	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.40									
0.6		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
0.9									
1.2									
1.5									
1.8									
2.1									
2.4									
2.7									
3.0									
3.00		Borehole 5 terminated at 3m							
3.3									

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road
Yuulong, Victoria

Project No.: 16006G-LCA
Borehole No: BH 6
Inv. Date: 21/05/2019

Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3		Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6	0.60								
0.9		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.2									
1.5									
1.8									
2.1									
2.4									
2.7									
3.0	3.00								
3.3		Borehole 6 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 7
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3	0.40	Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6 0.9 1.2	1.20	Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.5 1.8 2.1 2.4 2.7 3.0	3.00	Silty CLAY/ XW Rock (Clay Loam) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
3.3		Borehole 7 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 8
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3	0.20	Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
0.9	1.00								
1.2		Silty CLAY/ XW Rock (Clay Loam) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
1.5									
1.8									
2.1									
2.4									
2.7									
3.0	3.00								
3.3		Borehole 8 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

ST. QUENTIN

Appendix C

Site Photographs

5835 Great Ocean Road - Photographs

Photo 1: Existing site conditions, aerial view proposed commons & student accommodation area.

Photo 2: Existing site conditions, aerial view proposed commons & student accommodation area.

ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

Title: Photographs
Locality: 5835 Great Ocean Road
Yuulong, Victoria

Project No: 16006G-LCA
Prepared by: O.R.
Date: 26/06/2019

5835 Great Ocean Road - Photographs

Photo 3: Existing site conditions, view of proposed commons & student accommodation area.

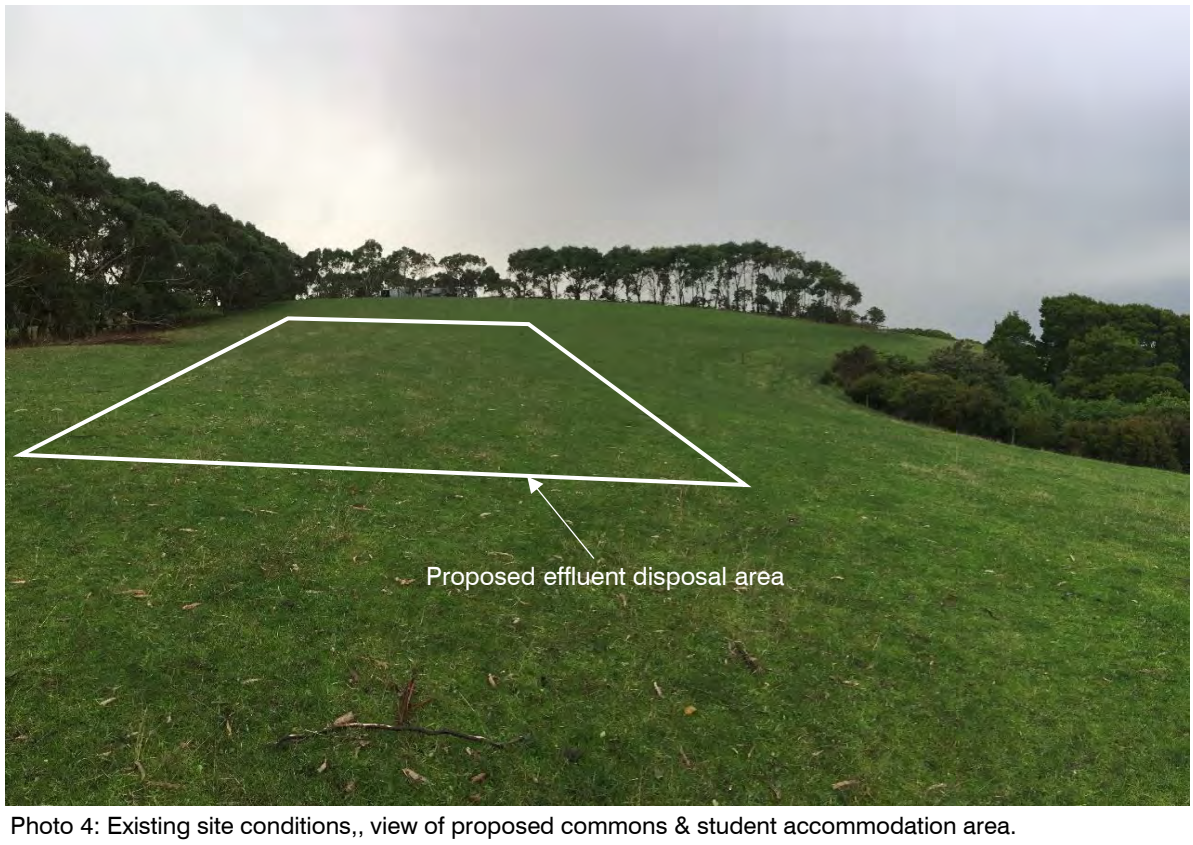


Photo 4: Existing site conditions,, view of proposed commons & student accommodation area.

ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

Title: Photographs
Locality: 5835 Great Ocean Road
Yuulong, Victoria

Project No: 16006G-LCA
Prepared by: O.R.
Date: 26/06/2019

5835 Great Ocean Road - Photographs

Photo 5: Existing site conditions, view of proposed staff accommodation area.

Photo 6: Existing site conditions,, view of proposed staff accommodation area.

ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

Title: Photographs
Locality: 5835 Great Ocean Road
Yuulong, Victoria

Project No: 16006G-LCA
Prepared by: O.R.
Date: 26/06/2019

5835 Great Ocean Road - Photographs

Photo 7: Existing site conditions, existing dwelling.

Photo 8: Existing site conditions, existing dwelling and shed.

ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

Title: Photographs
Locality: 5835 Great Ocean Road
Yuulong, Victoria

Project No: 16006G-LCA
Prepared by: O.R.
Date: 26/06/2019

5835 Great Ocean Road - Photographs

Photo 9: Existing site conditions, existing shed and proposed staff accommodation area.

Photo 10: Existing site conditions, existing shed and proposed staff accommodation area.

ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

Title: Photographs
Locality: 5835 Great Ocean Road
Yuulong, Victoria

Project No: 16006G-LCA
Prepared by: O.R.
Date: 26/06/2019

Appendix D

Water Balance Model

VICTORIAN LAND CAPABILITY ASSESSMENT FRAMEWORK

WATER BALANCE MODEL - ETA SYSTEMS / TRENCHES / BEDS

ST. QUENTIN
Surveyors · Town Planners · Engineers

Client: Ballarat & Clarendon College
Assessor: Omar Reyes
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Date: 25/06/2019

DISPOSAL AREA SIZING USING NOMINATED AREA WATER BALANCE

INPUT DATA

Number of Students:	40	Expected number of students
Water Supply:	120	Limited (water sourced only from rain water collection)
Design Wastewater Flow (Q):	4800 L/day	Based on maximum potential occupancy and derived from Table 4 in the EPA Code of Practice (July 2016)
Design Loading Rate (DLR):	12.0 mm/day	Based on soil texture class/permeability and derived from Table 9 in the EPA Code of Practice (July 2016)
Minimum Disposal Area:	400 m²	Based on material type and through interpretation of Table 5.1 & 5.2 of AS/NZS 1547:2012
ETA Bed Width	4.0 m	As selected by designer
ETA Bed Length	100.0 m	
Crop Factor (C):	0.6-0.8	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type (suitable for pasture grass)
Rainfall Runoff Factor (RF):	0.75	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Rainfall Data:	Johanna (70th Percen.)	BoM Station and number or 70th Percentile from Council Specific Data
Pan Evaporation Data:	Johanna (70th Percen.)	BoM Station and number
Design storage depth:	250 mm	Maximum storage depth of 550mm

Parameter	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month (D):		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall (R):		mm/month	45.0	43.0	58.0	79.0	96.0	108.0	109.0	118.0	94.0	83.0	64.0	54.0	951
Evaporation (E):		mm/month	126.0	103.0	88.0	58.0	39.0	28.0	31.0	45.0	61.0	85.0	100.0	118.0	882
Crop Factor (C):		unitless	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.8	0.8	0.8	
OUTPUTS															
Evapotranspiration (ET):	E x C	mm/month	100.8	82.4	61.6	40.6	23.4	16.8	18.6	27.0	42.7	68.0	80.0	94.4	656.3
Percolation (B):	DLR x D	mm/month	372	336	372	360	372	360	372	372	360	372	360	372	4380
Outputs:	ET + B	mm/month	472.8	418.4	433.6	400.6	395.4	376.8	390.6	399.0	402.7	440.0	440.0	466.4	5036.3
INPUTS															
Retained Rainfall (RR):	R x RF	mm/month	34	32	44	59	72	81	82	89	71	62	48	41	713.25
Applied Effluent (W):	(Q x D) / L	mm/month	331.1	299.0	331.1	320.4	331.1	320.4	331.1	331.1	320.4	331.1	320.4	331.1	3897.9
Inputs:	RR+W	mm/month	364.8	331.3	374.6	379.6	403.1	401.4	412.8	419.6	390.9	393.3	368.4	371.6	4611.2
STORAGE CALCULATION															
Storage remaining from previous month		mm/month	0	0	0	0	0	26	107	181	250	211	55	0	
Storage for the month (S):	(RR+W) - (ET+B)	mm/month	-108.0	-87.1	-59.0	-21.0	7.7	24.6	22.2	20.6	-11.8	-46.7	-71.6	-94.8	
Increase in depth of stored effluent		mm/month	-360.0	-290.4	-196.8	-69.9	25.5	81.9	74.0	68.5	-39.4	-155.6	-238.7	-316.1	
Cumulative Storage (M):		mm/month	0.0	0.0	0.0	0.0	25.5	107.5	181.5	250.0	210.6	55.0	0.0	0.0	
Max. Storage for Nominated Area (N):		mm	250												
Max. Volume for Nominated Area (V):	N x L	L	112367												
LAND AREA REQUIRED FOR ZERO STORAGE		m^2	338.91	348.05	381.44	421.85	460.11	486.82	481.79	479.23	433.47	393.91	367.35	349.38	

Minimum ETA bed area for zero storage: 487 m²

Area for design storage (L): 449.5 m²

Nominated ETA bed length: 113 m

VICTORIAN LAND CAPABILITY ASSESSMENT FRAMEWORK

WATER BALANCE MODEL - ETA SYSTEMS / TRENCHES / BEDS

ST. QUENTIN
Surveyors · Town Planners · Engineers

Client: Ballarat & Clarendon College
Assessor: Omar Reyes
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Date: 25/06/2019

DISPOSAL AREA SIZING USING NOMINATED AREA WATER BALANCE

INPUT DATA

Number of Staff:	20	Expected number of staff
Water Supply:	120	Limited (water sourced only from rain water collection)
Design Wastewater Flow (Q):	2400 L/day	Based on maximum potential occupancy and derived from Table 4 in the EPA Code of Practice (July 2016)
Design Loading Rate (DLR):	12.0 mm/day	Based on soil texture class/permeability and derived from Table 9 in the EPA Code of Practice (July 2016)
Minimum Disposal Area:	200 m²	Based on material type and through interpretation of Table 5.1 & 5.2 of AS/NZS 1547:2012
ETA Bed Width	4.0 m	As selected by designer
ETA Bed Length	50.0 m	
Crop Factor (C):	0.6-0.8	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type (suitable for pasture grass)
Rainfall Runoff Factor (RF):	0.75	Proportion of rainfall that remains onsite and infiltrates, allowing for any runoff
Rainfall Data:	Johanna (70th Percen.)	BoM Station and number or 70th Percentile from Council Specific Data
Pan Evaporation Data:	Johanna (70th Percen.)	BoM Station and number
Design storage depth:	250 mm	Maximum storage depth of 550mm

Parameter	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month (D):		days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall (R):		mm/month	45.0	43.0	58.0	79.0	96.0	108.0	109.0	118.0	94.0	83.0	64.0	54.0	951
Evaporation (E):		mm/month	126.0	103.0	88.0	58.0	39.0	28.0	31.0	45.0	61.0	85.0	100.0	118.0	882
Crop Factor (C):		unitless	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.8	0.8	0.8	
OUTPUTS															
Evapotranspiration (ET):	E x C	mm/month	100.8	82.4	61.6	40.6	23.4	16.8	18.6	27.0	42.7	68.0	80.0	94.4	656.3
Percolation (B):	DLR x D	mm/month	372	336	372	360	372	360	372	372	360	372	360	372	4380
Outputs:	ET + B	mm/month	472.8	418.4	433.6	400.6	395.4	376.8	390.6	399.0	402.7	440.0	440.0	466.4	5036.3
INPUTS															
Retained Rainfall (RR):	R x RF	mm/month	34	32	44	59	72	81	82	89	71	62	48	41	713.25
Applied Effluent (W):	(Q x D) / L	mm/month	331.1	299.0	331.1	320.4	331.1	320.4	331.1	331.1	320.4	331.1	320.4	331.1	3897.9
Inputs:	RR+W	mm/month	364.8	331.3	374.6	379.6	403.1	401.4	412.8	419.6	390.9	393.3	368.4	371.6	4611.2
STORAGE CALCULATION															
Storage remaining from previous month		mm/month	0	0	0	0	0	26	107	181	250	211	55	0	
Storage for the month (S):	(RR+W) - (ET+B)	mm/month	-108.0	-87.1	-59.0	-21.0	7.7	24.6	22.2	20.6	-11.8	-46.7	-71.6	-94.8	
Increase in depth of stored effluent		mm/month	-360.0	-290.4	-196.8	-69.9	25.5	81.9	74.0	68.5	-39.4	-155.6	-238.7	-316.1	
Cumulative Storage (M):		mm/month	0.0	0.0	0.0	0.0	25.5	107.5	181.5	250.0	210.6	55.0	0.0	0.0	
Max. Storage for Nominated Area (N):		mm	250												
Max. Volume for Nominated Area (V):	N x L	L	56184												
LAND AREA REQUIRED FOR ZERO STORAGE		m^2	169.46	174.03	190.72	210.93	230.06	243.41	240.89	239.61	216.74	196.96	183.67	174.69	

Minimum ETA bed area for zero storage: 243 m²

Area for design storage (L): 224.7 m²

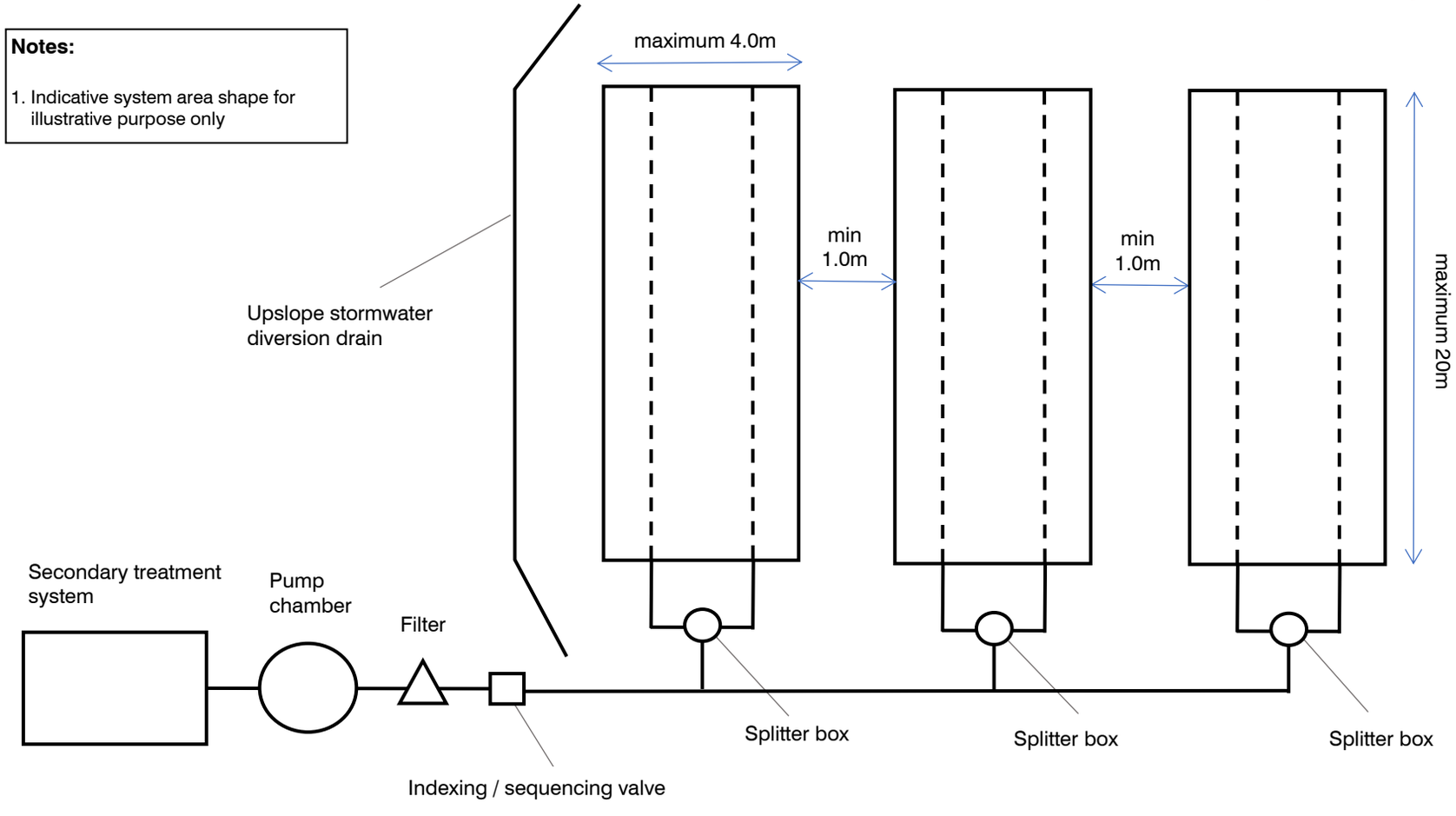
Nominated ETA bed length: 57 m

Appendix E

Typical ETA Bed System Layout

Notes:

1. Indicative system area shape for illustrative purpose only



ST. QUENTIN
Surveyors · Town Planners · Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

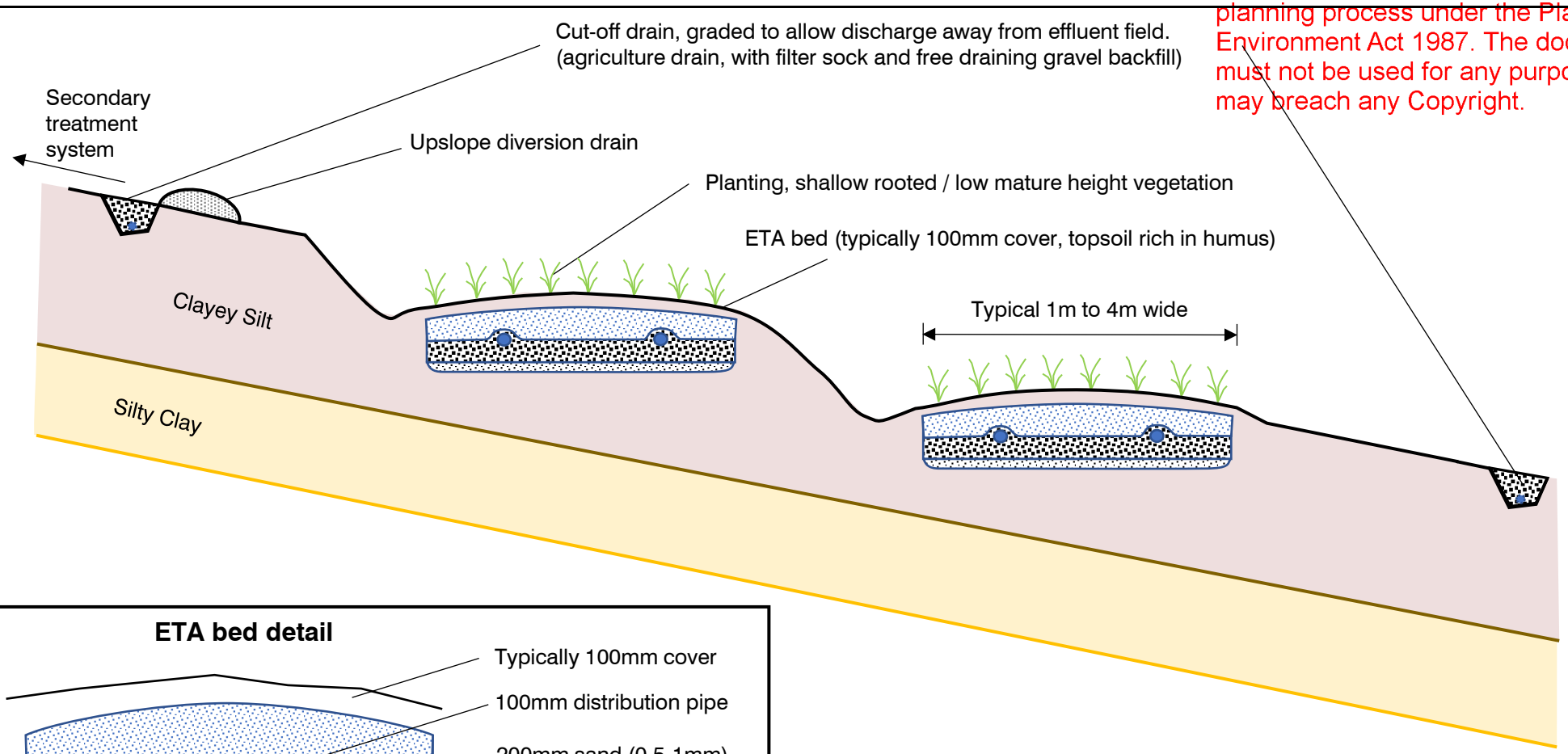
Typical ETA Bed Layout

Location: 5835 Great Ocean Road
Yuulong, Victoria
Project No: 16006G-LCA
Scale: NOT TO SCALE

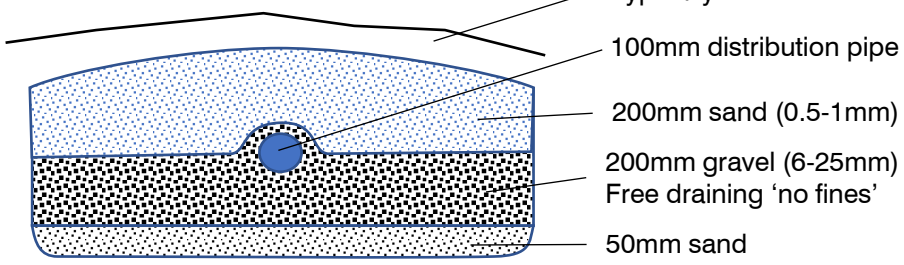
Drawn by: O.R.
Date: 28/06/2019
Approved by: C.F.
Date: 28/06/2019

Appendix F

Typical Effluent Disposal Cross Section



ETA bed detail



Notes:

1. Indicative cross section for illustrative purpose only
2. Spacing between trenches to be 1.0m as a minimum
3. Install cut-off drains to direct stormwater away from system

ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

Typical ETA Bed

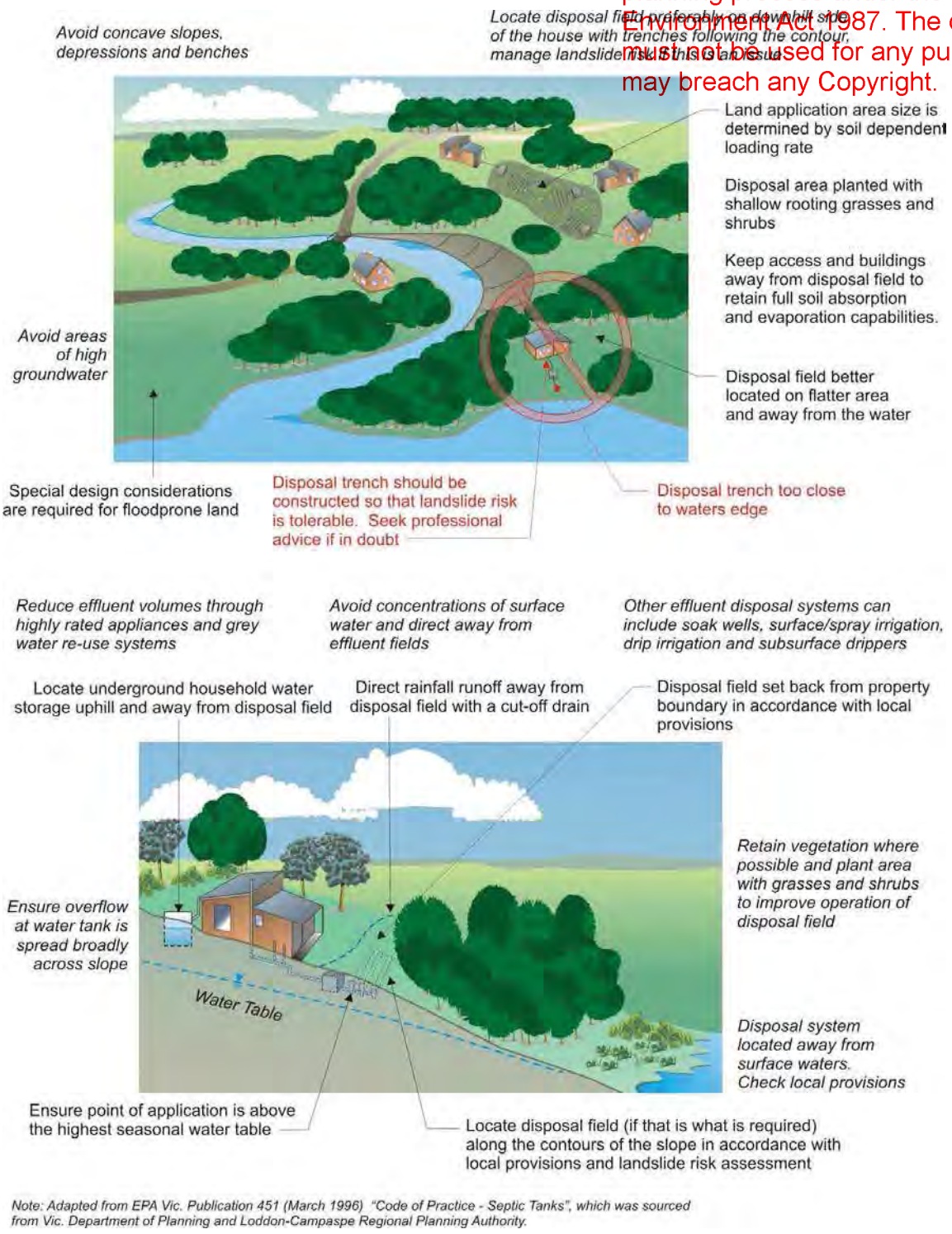
Cross Section

Location:	5835 Great Ocean Road	**Drawn by:**	O.R.
	Yuulong, Victoria	**Date:**	28/06/2019
Project No:	16006G-LCA	**Approved by:**	C.F.
Scale:	NOT TO SCALE	**Date:**	28/06/2019

Appendix G

Australian Geoguides LR9 (Effluent Disposal)

AUSTRALIAN GEOGUIDE LR9 (EFFLUENT DISPOSAL)



Note: Adapted from EPA Vic. Publication 451 (March 1996) "Code of Practice - Septic Tanks", which was sourced from Vic. Department of Planning and Loddon-Campaspe Regional Planning Authority.

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 LR8 - Hillside Construction
- 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.

ST. QUENTIN

Appendix H

Planning Report

PLANNING PROPERTY REPORT

From www.planning.vic.gov.au on 25 June 2019 01:13 PM

PROPERTY DETAILS

Address:	**5835 GREAT OCEAN ROAD YUULONG 3237**
Lot and Plan Number:	**Lot 1 PS401775**
Standard Parcel Identifier (SPI):	**1\PS401775**
Local Government Area (Council):	**COLAC OTWAY** www.colacotway.vic.gov.au
Council Property Number:	**21665**
Planning Scheme:	**Colac Otway** planning-schemes.delwp.vic.gov.au/schemes/colacotway
Directory Reference:	**VicRoads 100 F5**

UTILITIES

Rural Water Corporation:	**Southern Rural Water**
Urban Water Corporation:	**Wannon Water**
Melbourne Water:	**outside drainage boundary**
Power Distributor:	**POWERCOR**

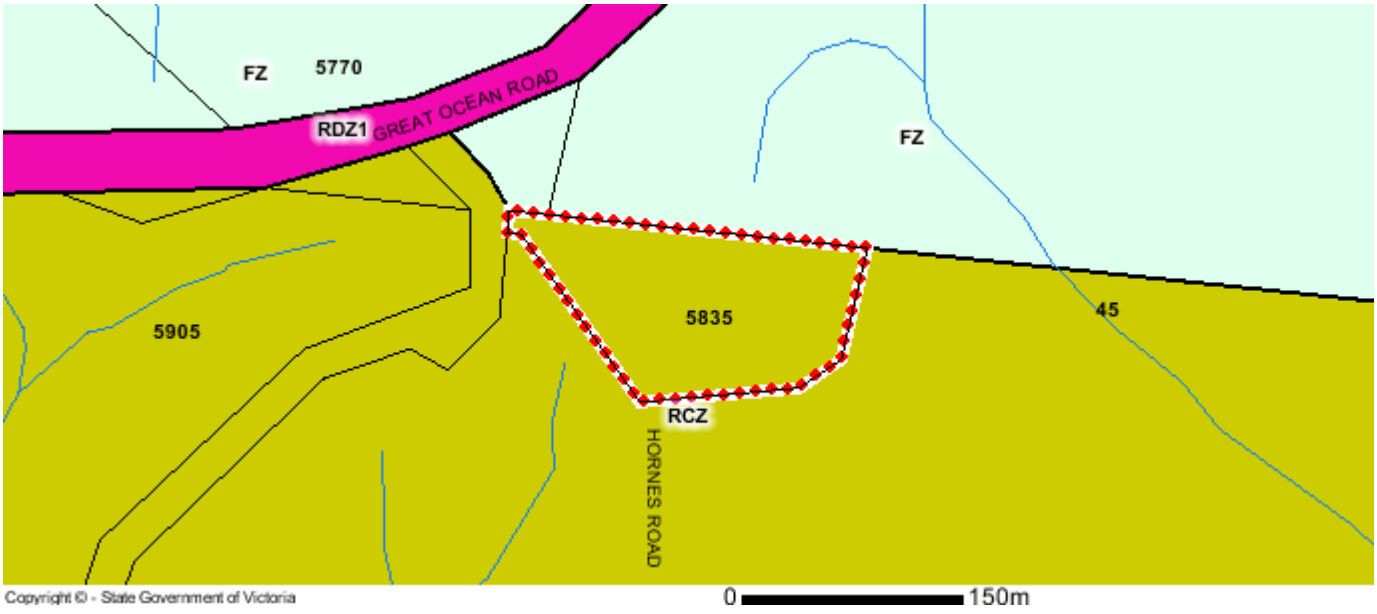
STATE ELECTORATES

Legislative Council:	**WESTERN VICTORIA**
Legislative Assembly:	**POLWARTH**

Planning Zones

RURAL CONSERVATION ZONE (RCZ)

SCHEDULE TO THE RURAL CONSERVATION ZONE (RCZ)



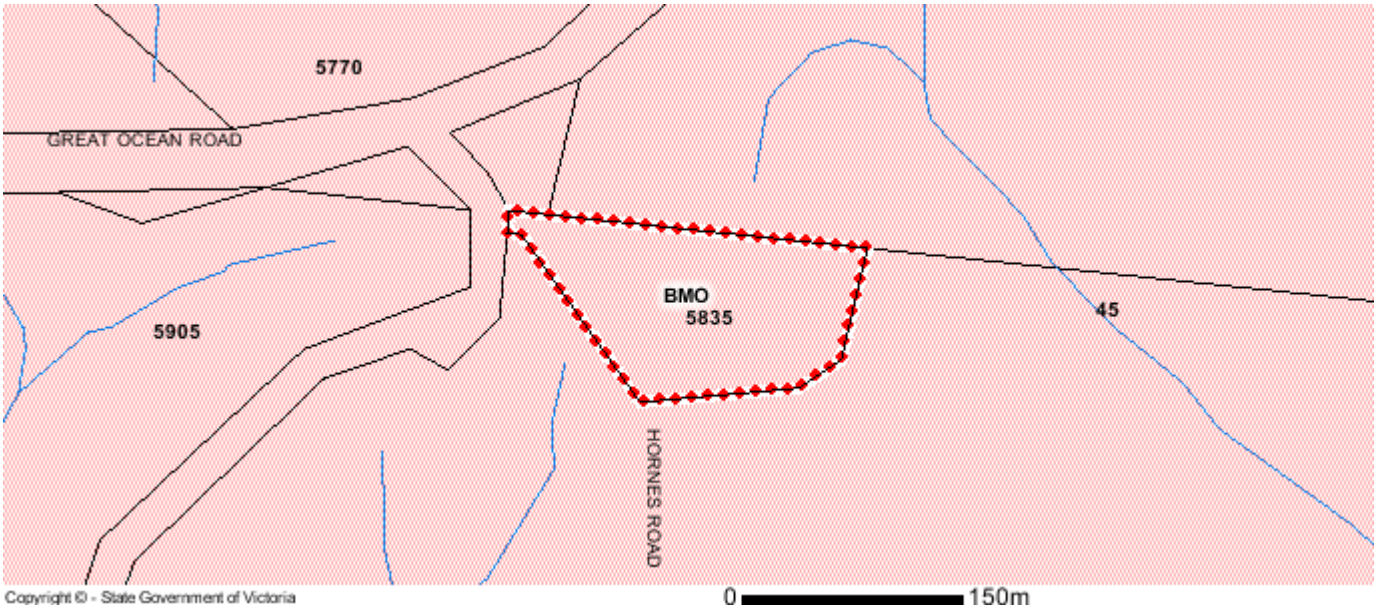
FZ - Farming | RCZ - Rural Conservation | RDZ1 - Road - Category 1

Note: labels for zones may appear outside the actual zone - please compare the labels with the legend.

PLANNING PROPERTY REPORT

Planning Overlays

BUSHFIRE MANAGEMENT OVERLAY (BMO)

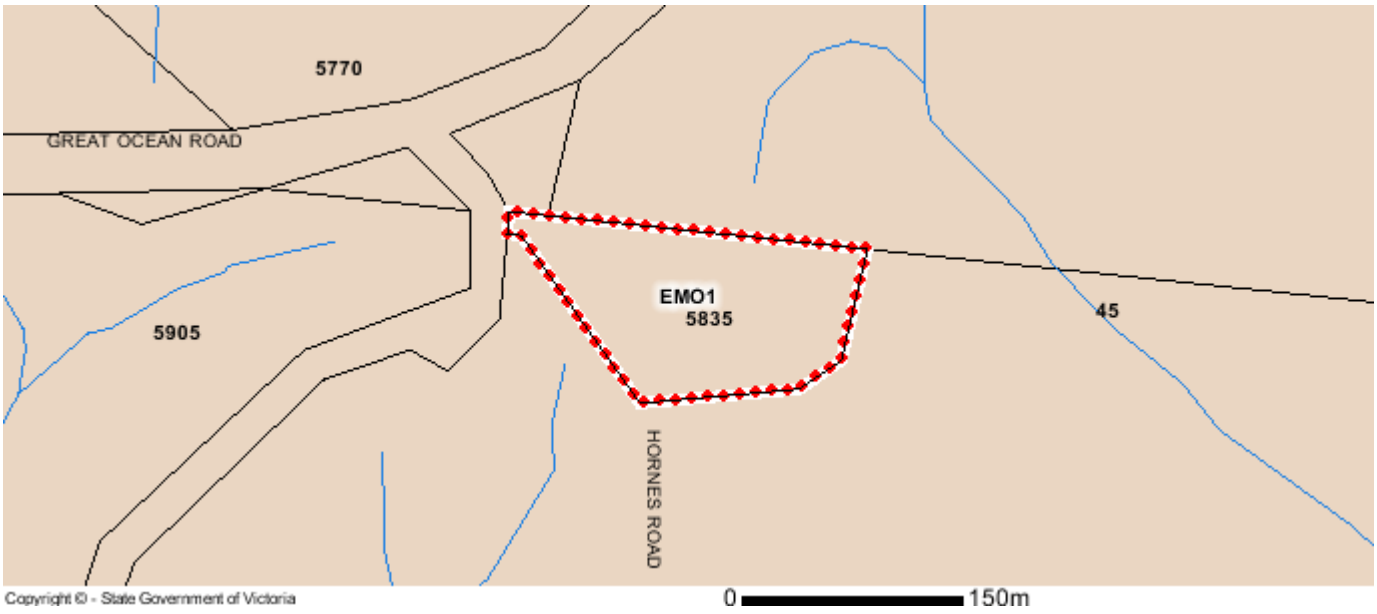


BMO - Bushfire Management

Note: due to overlaps, some overlays may not be visible, and some colours may not match those in the legend.

EROSION MANAGEMENT OVERLAY (EMO)

EROSION MANAGEMENT OVERLAY - SCHEDULE 1 (EMO1)



EMO - Erosion Management

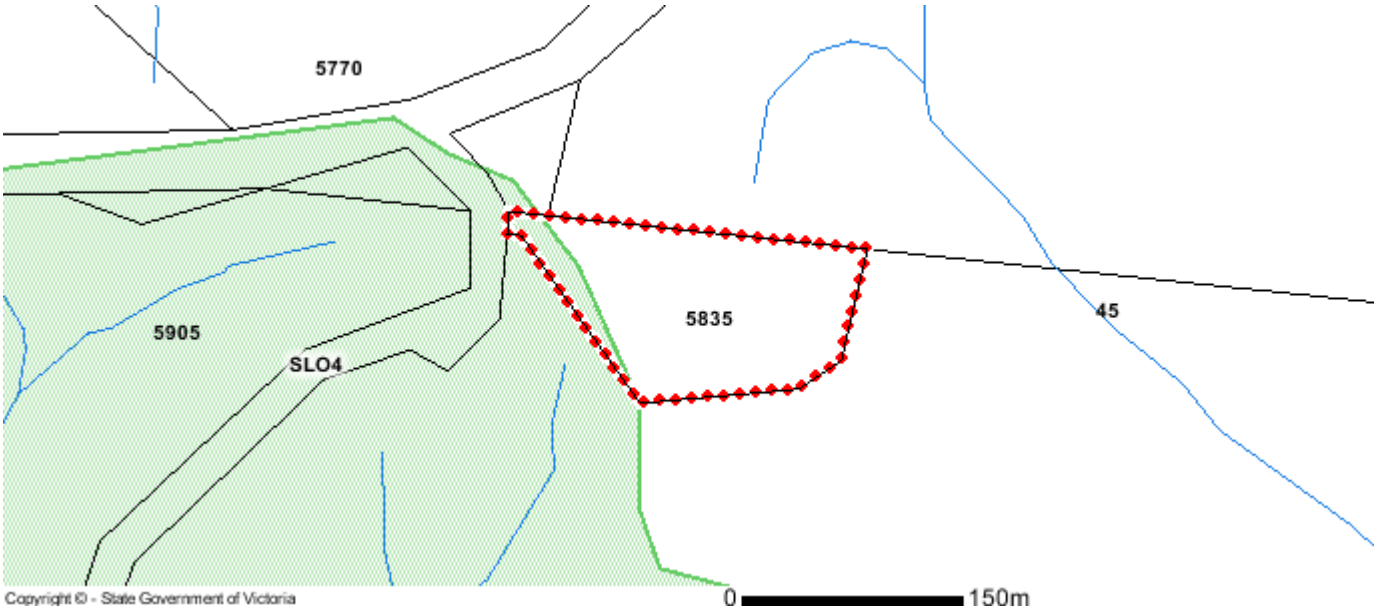
Note: due to overlaps, some overlays may not be visible, and some colours may not match those in the legend.

PLANNING PROPERTY REPORT

Planning Overlays

SIGNIFICANT LANDSCAPE OVERLAY (SLO)

SIGNIFICANT LANDSCAPE OVERLAY - SCHEDULE 4 (SLO4)



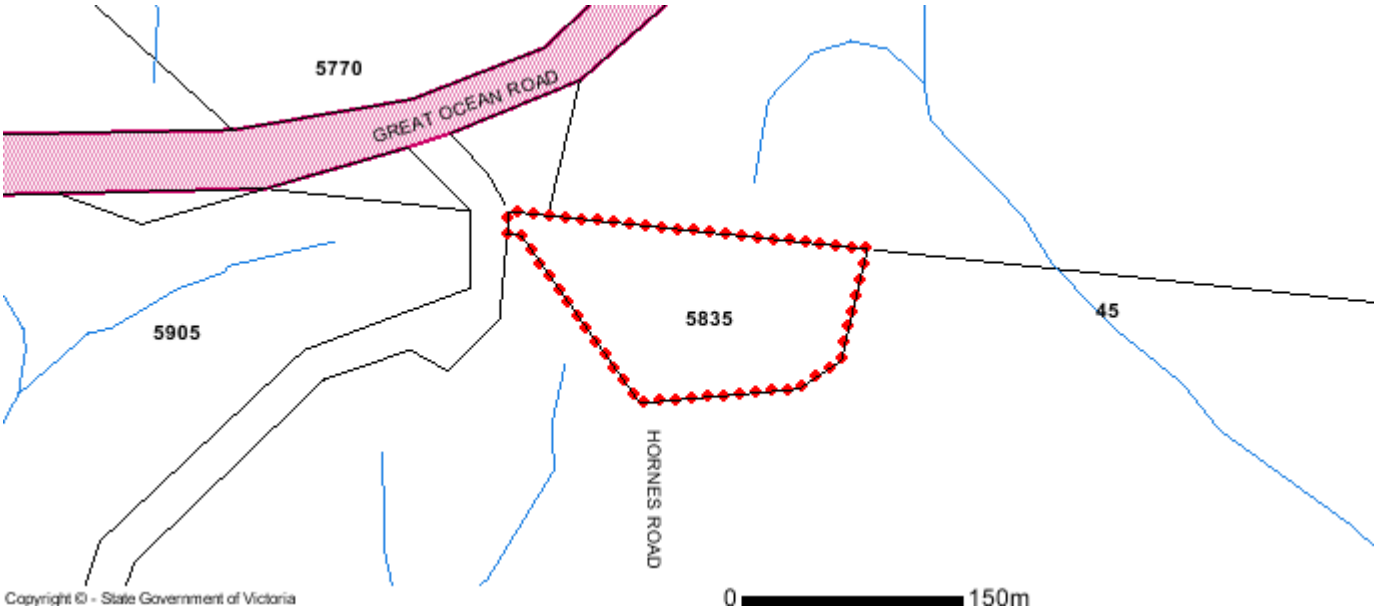
SLO - Significant Landscape

Note: due to overlaps, some overlaps may not be visible, and some colours may not match those in the legend.

OTHER OVERLAYS

Other overlays in the vicinity not directly affecting this land

HERITAGE OVERLAY (HO)



HO - Heritage

Note: due to overlaps, some overlaps may not be visible, and some colours may not match those in the legend.

PLANNING PROPERTY REPORT

Further Planning Information

Planning scheme data last updated on 17 June 2019.

A **planning scheme** sets out policies and requirements for the use, development and protection of land. This report provides information about the zone and overlay provisions that apply to the selected land. Information about the State and local policy, particular, general and operational provisions of the local planning scheme that may affect the use of this land can be obtained by contacting the local council or by visiting https://www.planning.vic.gov.au

This report is NOT a **Planning Certificate** issued pursuant to Section 199 of the *Planning and Environment Act 1987*. It does not include information about exhibited planning scheme amendments, or zonings that may abut the land. To obtain a Planning Certificate go to Titles and Property Certificates at Landata - https://www.landata.vic.gov.au

For details of surrounding properties, use this service to get the Reports for properties of interest.

To view planning zones, overlay and heritage information in an interactive format visit http://mapshare.maps.vic.gov.au/vicplan

For other information about planning in Victoria visit https://www.planning.vic.gov.au

PLANNING PROPERTY REPORT

Designated Bushfire Prone Area

This property is in a designated bushfire prone area.
Special bushfire construction requirements apply. Planning provisions may apply.

Designated Bushfire Prone Area

Designated bushfire prone areas as determined by the Minister for Planning are in effect from 8 September 2011 and amended from time to time.

The Building Regulations 2018 through application of the Building Code of Australia, apply bushfire protection standards for building works in designated bushfire prone areas.

Designated bushfire prone areas maps can be viewed on VicPlan at http://mapshare.maps.vic.gov.au/vicplan or at the relevant local council.

Note: prior to 8 September 2011, the whole of Victoria was designated as bushfire prone area for the purposes of the building control system.

Further information about the building control system and building in bushfire prone areas can be found on the Victorian Building Authority website www.vba.vic.gov.au

Copies of the Building Act and Building Regulations are available from www.legislation.vic.gov.au

For Planning Scheme Provisions in bushfire areas visit https://www.planning.vic.gov.au

PLANNING PROPERTY REPORT

From www.planning.vic.gov.au on 25 June 2019 05:12 PM

PROPERTY DETAILS

Lot and Plan Number:	**Lot 2 PS425161**
Address:	**45 OLD ILUKA ACCESS YUULONG 3237**
Standard Parcel Identifier (SPI):	**2\PS425161**
Local Government Area (Council):	**COLAC OTWAY** www.colacotway.vic.gov.au
Council Property Number:	**21629** (Part)
Planning Scheme:	**Colac Otway** planning-schemes.delwp.vic.gov.au/schemes/colacotway
Directory Reference:	**VicRoads 100 F5**

This parcel is one of 3 parcels comprising the property. For full parcel details get the free Basic Property report at Property Reports

UTILITIES

Rural Water Corporation:	**Southern Rural Water**
Urban Water Corporation:	**Wannon Water**
Melbourne Water:	**outside drainage boundary**
Power Distributor:	**POWERCOR**

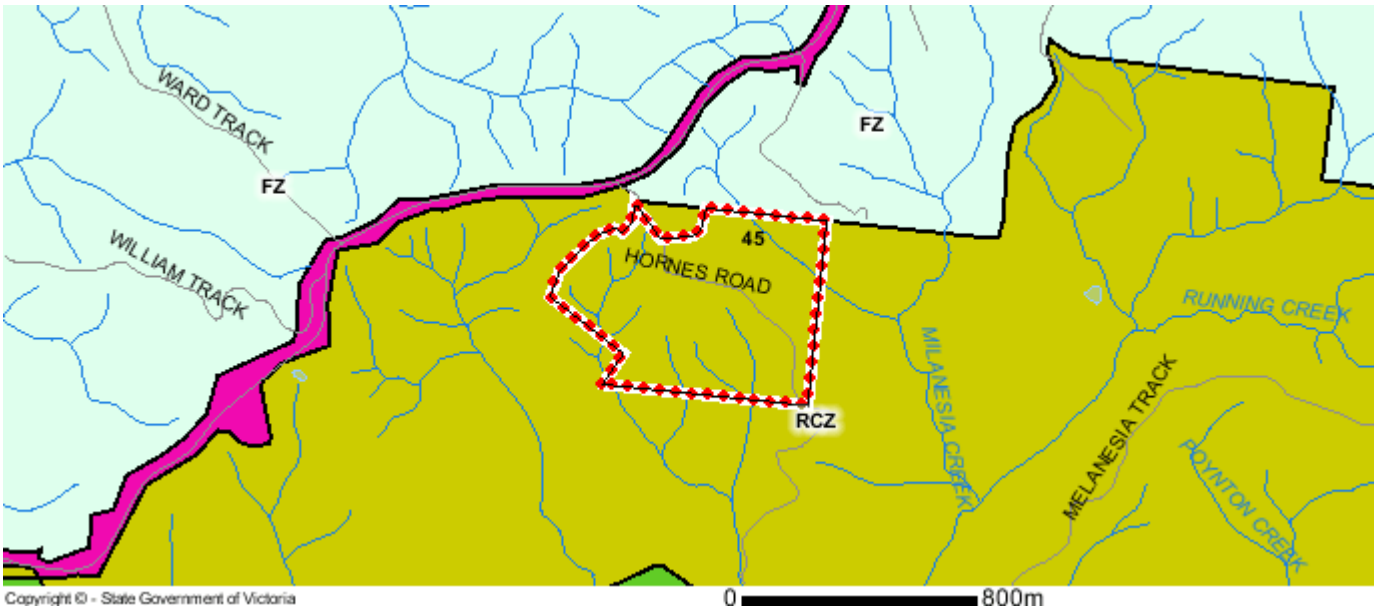
STATE ELECTORATES

Legislative Council:	**WESTERN VICTORIA**
Legislative Assembly:	**POLWARTH**

Planning Zones

RURAL CONSERVATION ZONE (RCZ)

SCHEDULE TO THE RURAL CONSERVATION ZONE (RCZ)



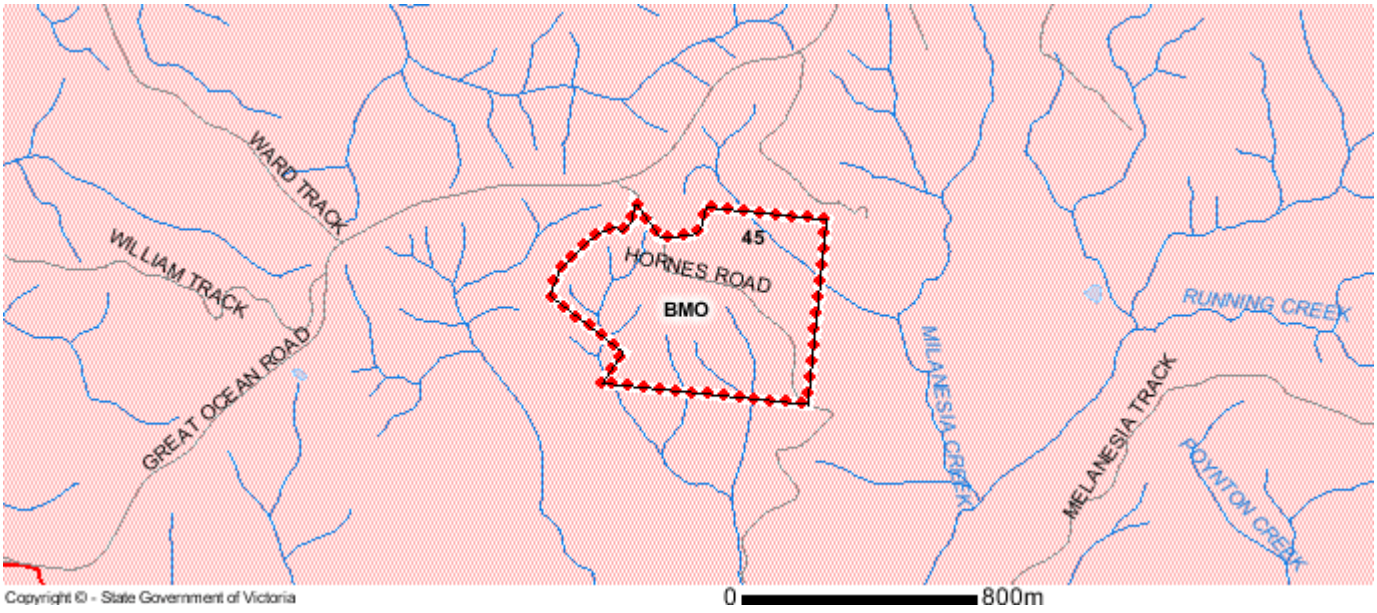
FZ - Farming | PCRZ - Public Conservation & Resource | RCZ - Rural Conservation | RDZ1 - Road - Category 1

Note: labels for zones may appear outside the actual zone - please compare the labels with the legend.

PLANNING PROPERTY REPORT

Planning Overlays

BUSHFIRE MANAGEMENT OVERLAY (BMO)

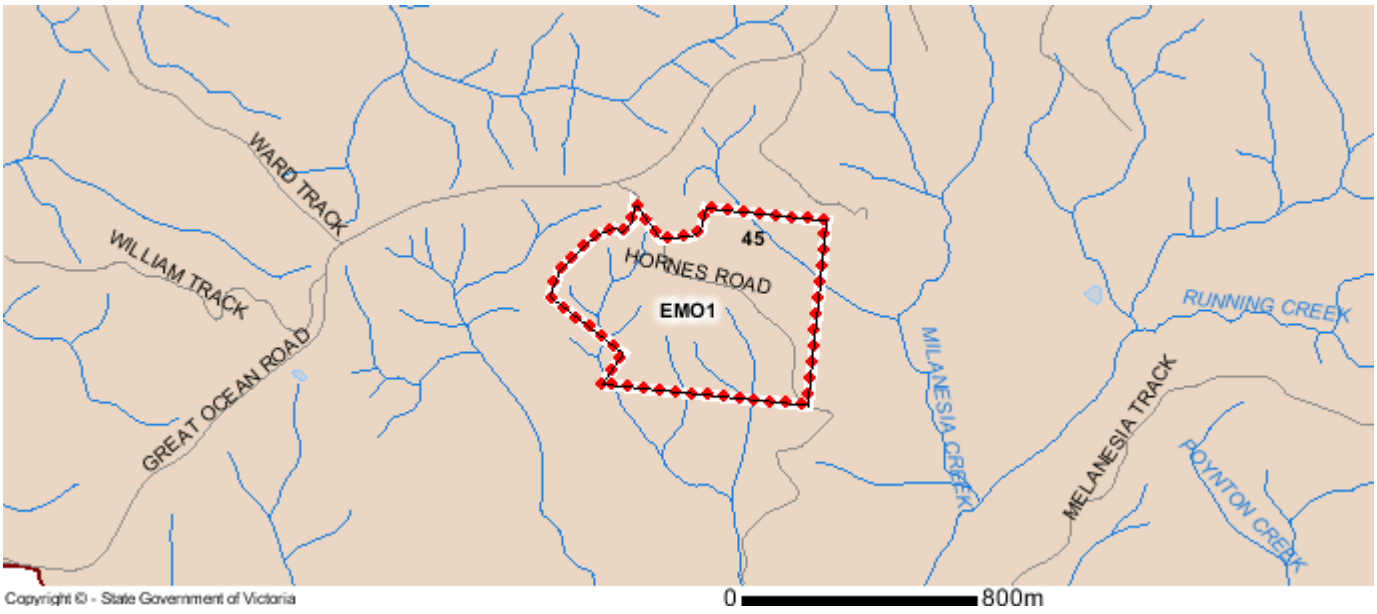


BMO - Bushfire Management

Note: due to overlaps, some overlays may not be visible, and some colours may not match those in the legend.

EROSION MANAGEMENT OVERLAY (EMO)

EROSION MANAGEMENT OVERLAY - SCHEDULE 1 (EMO1)



EMO - Erosion Management

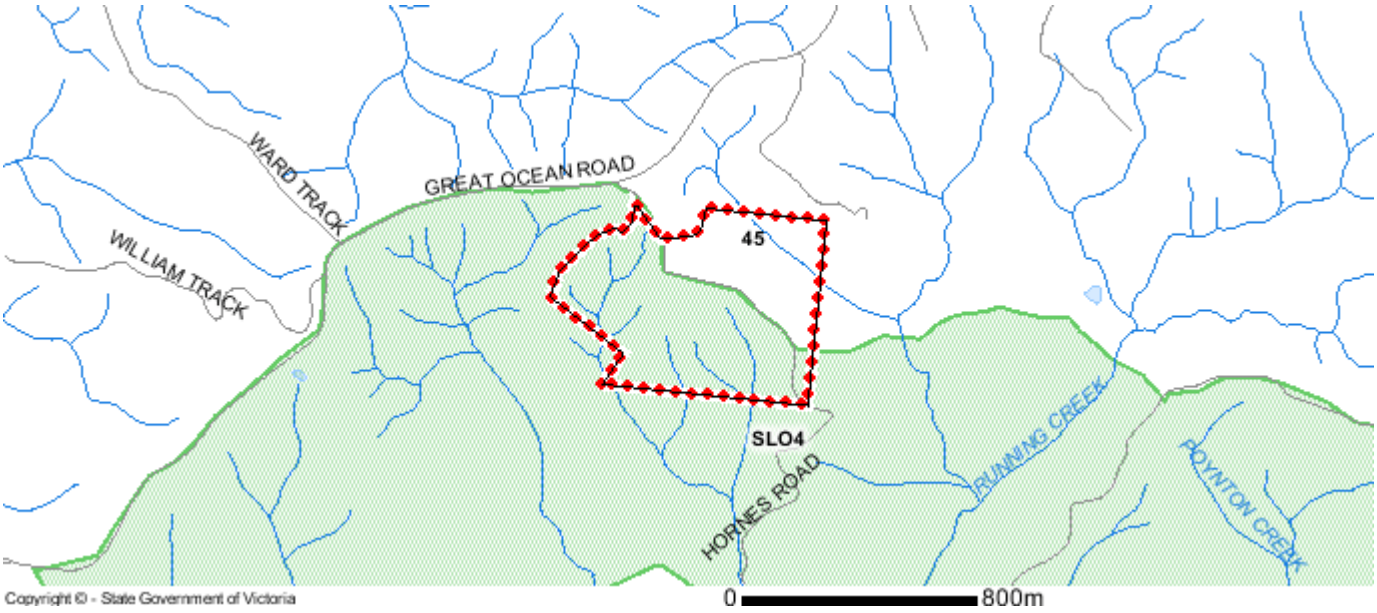
Note: due to overlaps, some overlays may not be visible, and some colours may not match those in the legend.

PLANNING PROPERTY REPORT

Planning Overlays

SIGNIFICANT LANDSCAPE OVERLAY (SLO)

SIGNIFICANT LANDSCAPE OVERLAY - SCHEDULE 4 (SLO4)



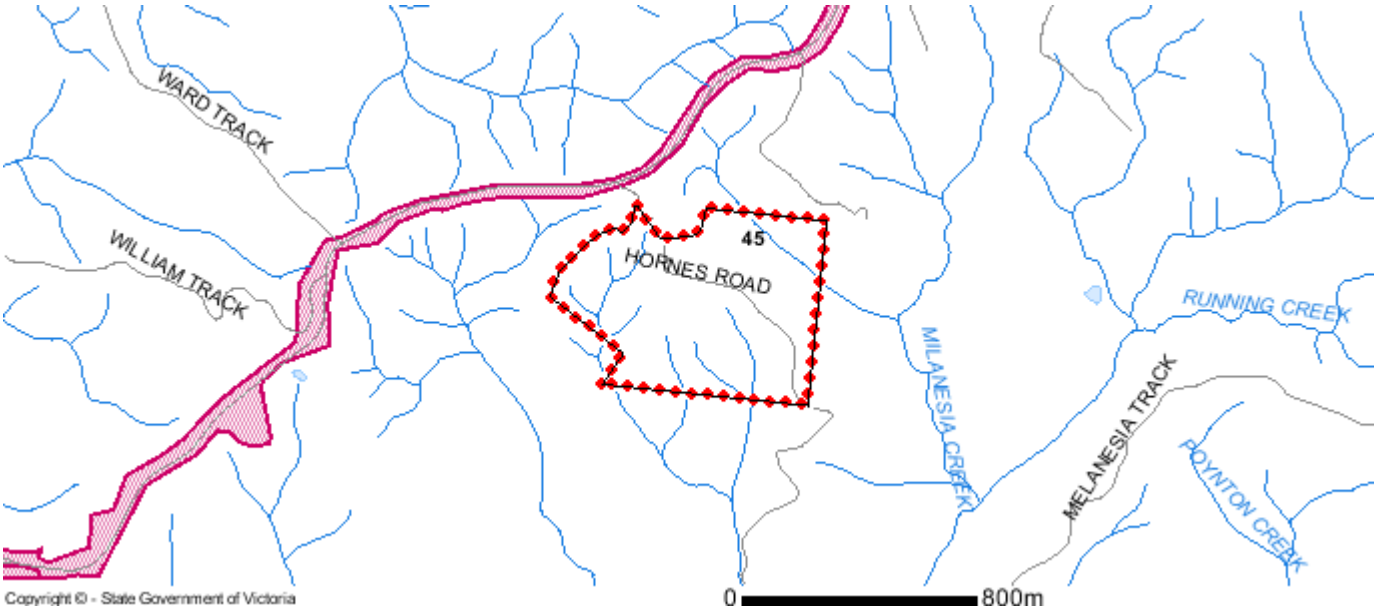
SLO - Significant Landscape

Note: due to overlaps, some overlays may not be visible, and some colours may not match those in the legend.

OTHER OVERLAYS

Other overlays in the vicinity not directly affecting this land

HERITAGE OVERLAY (HO)



HO - Heritage

Note: due to overlaps, some overlays may not be visible, and some colours may not match those in the legend.

PLANNING PROPERTY REPORT

Further Planning Information

Planning scheme data last updated on 17 June 2019.

A **planning scheme** sets out policies and requirements for the use, development and protection of land. This report provides information about the zone and overlay provisions that apply to the selected land. Information about the State and local policy, particular, general and operational provisions of the local planning scheme that may affect the use of this land can be obtained by contacting the local council or by visiting https://www.planning.vic.gov.au

This report is NOT a **Planning Certificate** issued pursuant to Section 199 of the *Planning and Environment Act 1987*. It does not include information about exhibited planning scheme amendments, or zonings that may abut the land. To obtain a Planning Certificate go to Titles and Property Certificates at Landata - https://www.landata.vic.gov.au

For details of surrounding properties, use this service to get the Reports for properties of interest.

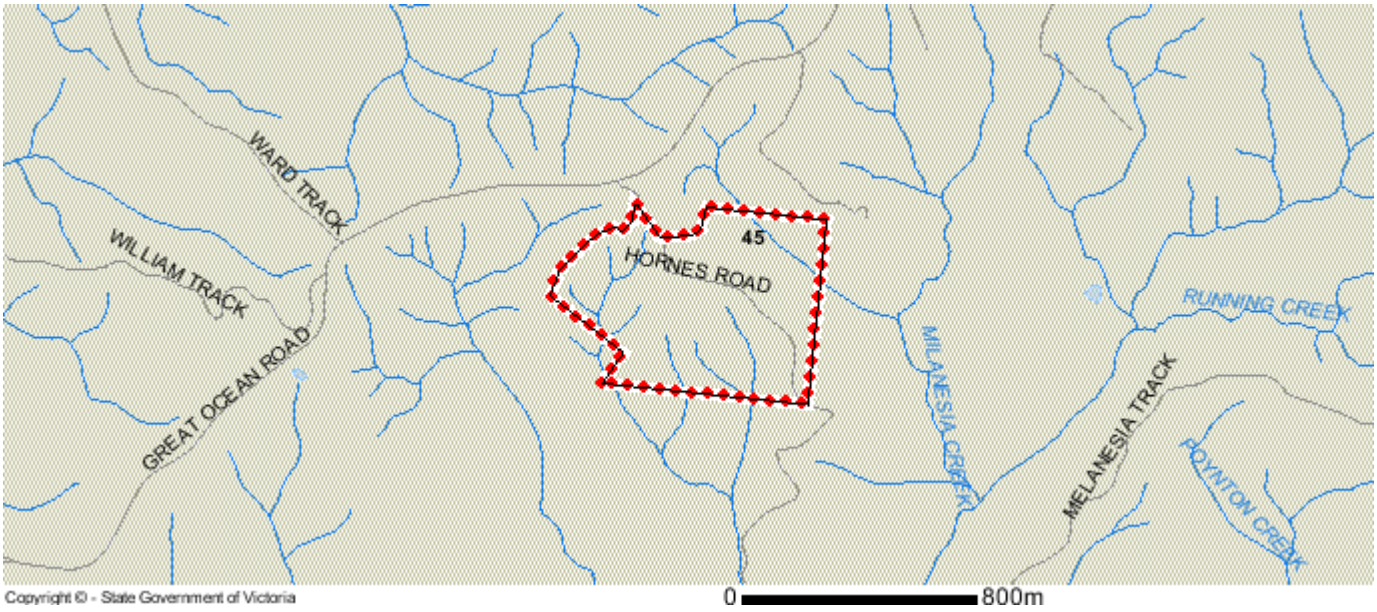
To view planning zones, overlay and heritage information in an interactive format visit http://mapshare.maps.vic.gov.au/vicplan

For other information about planning in Victoria visit https://www.planning.vic.gov.au

PLANNING PROPERTY REPORT

Designated Bushfire Prone Area

This parcel is in a designated bushfire prone area.
Special bushfire construction requirements apply. Planning provisions may apply.



Designated Bushfire Prone Area

Designated bushfire prone areas as determined by the Minister for Planning are in effect from 8 September 2011 and amended from time to time.

The Building Regulations 2018 through application of the Building Code of Australia, apply bushfire protection standards for building works in designated bushfire prone areas.

Designated bushfire prone areas maps can be viewed on VicPlan at http://mapshare.maps.vic.gov.au/vicplan or at the relevant local council.

Note: prior to 8 September 2011, the whole of Victoria was designated as bushfire prone area for the purposes of the building control system.

Further information about the building control system and building in bushfire prone areas can be found on the Victorian Building Authority website www.vba.vic.gov.au

Copies of the Building Act and Building Regulations are available from www.legislation.vic.gov.au

For Planning Scheme Provisions in bushfire areas visit https://www.planning.vic.gov.au

Appendix I

Land Capability Assessment Detailed Information Checklist

Minimum Requirement for a Standard LCA Assessment and Report (Moderate Risk)

Report Element	Standard Requirements	Completed
1. Introduction and Background	Report summary/ executive summary.	☑
	Confirmation of Sensitivity Rating.	☑
	Confirmation of any relevant sensitivity overlays (e.g. landslip) as per communications with Council.	☑
	Confirmation that property/parcel(s) meets minimum lot size criteria for COS Planning Scheme Zone.	☑
	Current land use and development overview (including occupancy); single property/parcel, increase in building entitlements (subdivision) or non-domestic development.	☑
	Name, contact details and qualifications (insurances) of LCA assessor (author).	☑
	Site location (including address and property/parcel details) and owner.	☑
	Property/parcel area.	☑
	Proposed/existing water supply.	☑
	Availability of sewer.	☑
	Locality map showing the site in relation to surrounding region.	☑
2. Site Inspection and Field Investigations	Gather information on relevant Council, Water Corporation, Catchment Management Authority and State Government requirements, including restrictions and caveats on title, and planning/building/bushfire/flood controls, e.g. zones and overlays. Note Environmental Significant Overlays, potable water supply and DWSCs. Impose this information on a base map (or site plan) which shows their location with respect to title boundaries.	☑
	Broad overview of locality and landscape characteristics that may pose a constraint to the sustainable application of wastewater on the site and adjacent land, e.g. climatic information, groundwater and bore water information. (Refer to stage 3 pp.34 EPA Code of Practice (2013)).	☑
	Details of date, time and methodology of site inspection and field investigations.	☑
	Site assessment that considers all of the parameters as per Table 1 of the Victorian LCA Framework (2014). Detailed explanation of the level of constraint with regards to DWM and recommended mitigation measures to overcome these constraints.	☑
	Minimum of two soil test pits or auger holes within the identified available effluent management area(s), with additional test pits required for more than one soil type (multiple soil landscapes or facets) as per the current EPA Code of Practice.	☑
	Soil assessment that considers the following parameters from Table 2 of the Victorian LCA Framework (2014): • colour and mottling; • electrical conductivity; • Emerson Aggregate Class; • permeability and design loading rate (using soil texture); • pH; • rock fragments; • soil depth; • soil texture (field textural analysis); and • depth to watertable (if required). Detailed explanation of the level of constraint with regards to DWM and recommended mitigation measures to overcome these constraints.	☑

Report Element	Standard Requirements	Completed
3. Available Area and Setback Distances	Calculation of available effluent management area and location on the Site Plan.	☑
	Discussion regarding the achievability of the applicable setback distances (Table 5 of the EPA Code of Practice (2013)). Justification required.	☑
4. LCA Confirmation	Confirm the results from Stages 1-3 of the LCA checklist with Council to assess the final Sensitivity Rating for the site to confirm LCA requirements for system selection and design. Provide a Site Plan showing the available effluent management area(s) and completed Sensitivity Pro-forma Checklist.	☑
5. Cumulative Impacts	Using the desktop and site assessment information for the site, comment on any possible cumulative detrimental impacts that the development may have on beneficial uses of the surrounding land, surface water and groundwater.	☑
6. System Selection and Design*	Design maximum wastewater load (generation rates) and organic load for the proposed development.	☑
	Description of existing system (if applicable).	☑
	Target effluent treatment quality.	☑
	Description and location of applicable DWM treatment system options (refer to relevant Locality Report and EPA website for list of currently approved systems).	☑
	List of effluent land application options and detailed description of preferred option and location (as per relevant Locality Report). Sizing of land application area as per the system Sizing Tables detailed in the Technical Document.	☑
7. Mitigation Measures	Detailed discussion of mitigation measures to overcome any site or soil constraints posed to the sustainable treatment and application of wastewater on-site. This may include the following: • Storm water management • Soil amelioration; and • Vegetation establishment and management.	☑
8. Site Management Plan	Description of ways to improve wastewater and DWM system performance for residents' reference.	☑
	Operation and Management Plan.	☑
9. Conclusion	Conclusion summarising all the important design, sizing and mitigation requirements to ensure sustainable on-site DWM.	☑
10. Site Plan Requirements	Site address, including property/parcel number and street number.	☑
	All title boundaries.	☑
	All relevant zones and overlays and/or restrictions (e.g. Council zoning and overlays, including Environmental Significant Overlays and DWSCs).	☑
	Type of catchment (e.g. potable or other special water supply catchment).	☑
	North arrow.	☑
	Location of groundwater bores.	☑
	Contour lines (at maximum 1 in 10m intervals), direction of slope and grade.	☑
	Location of soil test pits or auger holes.	☑
	Location of any significant site features e.g. rock outcrops or waterlogged regions.	☑
	Location of intermittent and permanent surface waterways (dams, creeks, reservoirs and springs).	☑
	Location of 1% and 5% Annual Exceedance Probability flood level	☑

Report Element	Standard Requirements	Completed
	contours lines (if applicable).	
	Location, depth and specified use of groundwater bores on the site and adjacent properties from the register of the relevant Rural Water Corporation. Depth to groundwater table in winter (if less than 2.1m deep).	☑
	Vegetation cover (can use aerial image as base map).	☑
	Relevant setback distances as per Table 5 EPA Code of Practice (2013).	☑
	Location of existing and proposed buildings, sheds, driveways, paths and any other improvements.	☑
	Available effluent management area(s).	☑
	Location of proposed land application area (sized to scale).	☑
	Location of proposed stormwater cut-off drains adjacent to the land application area.	☑
	Location of proposed DWM system (nominal).	☑
	Location of reserve land application area (sized to scale).	☑
11. Appendices	Figures	☑
	Site Plan	☑
	Soil bore logs for all test pits or auger holes	☑
	Certificate of Title(s) for property/parcel (plan)	☑
	Proposed building plans	☑
	Planning Permit application (where applicable)	☑
	Septic Tank Permit application	☑

** If site is located within Climate Zone 4, then site specific design is required and the Sizing Tables cannot be used. This is due to the higher rainfall and the need to utilise a water balance for design purposes. The LCA is to remain the same, except Stage 6 is to follow the requirements set out in the Detailed LCA Pro-forma.*

*** Properties/parcels with a Low Sensitivity Rating that are located within a DWSC are required to complete this Standard LCA as per the current EPA Code of Practice requirements.*

ST. QUENTIN
Surveyors • Town Planners • Engineers

St. Quentin Consulting Pty Ltd
51 Little Fyans St, South Geelong 3220 P.O. Box 919 Geelong 3220
P: (03) 5201 1811 F: (03) 5229 2909 E: admin@stqc.com.au
www.stqc.com.au ACN 054 348 767 ABN 15 054 348 767

LAND CAPABILITY ASSESSMENT ADDENDUM

TESTING PROGRAMME & REPORT

1. Report has been prepared by qualified persons and based on current available standards.
2. Recommendations are based on the assumption that limited test positions are representative of the sub-surface profile.
3. Whilst care has been taken to accurately report on the sub-surface conditions across the site it is not possible to anticipate unexpected sub-surface variations given the limited testing performed.
4. Changes in legislative policy may require report update or additional testing.

The purpose of this report is to determine the capability of the site to contain effluent with regard to the soil and land constraints. It is beyond the scope of this report to provide specific effluent system design. Where any variation or anomalies are encountered, we recommend additional investigation and reporting by us to resolve any potential issues.

EFFLUENT DISPOSAL CARE & MAINTENANCE

We recommend the following to assist in long term system serviceability and safe on site disposal:

1. Restrict germicides such as strong detergents, disinfectants, toilet clears with high acid content, nappy sanitisers, bleaches etc. that are likely to kill bacteria and affect the operation of the septic system.
2. Only use detergents with low alkaline salts and chlorine.
3. Sanitary napkins or disposable nappies must not be flushed into the system.
4. Limit the amount of fat and oils into the system.
5. Use sink strainer to limit the food that enters the system.
6. Do not use garbage disposal units.
7. Where odours occur, we recommend flushing approximately one cup of lime each day.
8. To reduce odours, we recommend filling the tank with water after installation or after desludging.
9. Grease trap should be checked for blockages and pumped every 6-12 months.
10. Inspect the system once a year by a qualified plumber or drainer.
11. Tank should be pumped concurrently every three years.

VEGETATION FOR TRANSPIRATION

Good vegetative cover is important to achieve effective transpiration of effluent disposal. It is therefore recommended to establish and maintain good grass cover over distribution areas and suitable shrubs or trees between distribution lines. Where trees are planted near drainage line, difficulties with root invasion can be anticipated. We do not recommend planting crops in disposal area.

ST. QUENTIN
Surveyors • Town Planners • Engineers

St. Quentin Consulting Pty Ltd
51 Little Fyans St, South Geelong 3220 P.O. Box 919 Geelong 3220
P: (03) 5201 1811 F: (03) 5229 2909 E: admin@stqc.com.au
www.stqc.com.au ACN 054 348 707 ABN 15 054 348 707

The following list includes some suitable water tolerant plants:

Botanical Names	Common Names
Phragmites australis	
Canna x generakis	Canna Lily, Calla Lily, Ginger Lily
Acacia Howittii	Sticky Wattle
Callistemon citrinus	Crimson Bottlebrush
Callistemon macropunctatus	Scarlet Bottlebrush
Leptospermun lanigerum	Wooley Tea-Tree
Melaleuca decussate	Cross Honey Myrtle
Melaleuca ericifolia	Swamp Paperbark
Melaleuca halmaturorum	Salt paperbark
Tamarix juniperina	Flowering Tamarisk
Eleocharis acuta	Cannas
	Common Spike-Rush
	Buffalo / kikuyu
	Geranium
	Hydrangeas
	Tall wheat grass
	Strawberry Clover, White Clover
	Perennial Rye
	Bougainvilliea

GENERAL COMMENTS

St Quentin Consulting does not accept responsibility for our report where it has been altered or not reproduced in full, including addendum.

Dimensions, slope, test locations are approximate only and must not be used for calculation of positioning.

Recommendations are based on information regarding the site and development type provided by the client or agent. If information supplied is not accurate or if significant changes are required our report may be inappropriate. We cannot accept responsibility for significant changes and anticipate additional fees should further tests or report update be required.

Offset distance to septic tanks or any subsurface excavations must not exceed the minimum angle of repose for the in-situ naturally occurring soil. We estimate the maximum angle of repose for sand is 30 and 45 for clay soils. We do not recommend steeper angles unless competent rock is encountered.

ST. QUENTIN

Surveyors • Town Planners • Engineers

stqc.com.au

Draft Report

Land Management Plan: 5835 Great Ocean Road, Yuulong

Prepared for

Ballarat Clarendon College

October 2019

Ecology and Heritage Partners Pty Ltd

MELBOURNE: 292 Mt Alexander Road Ascot Vale VIC 3056 **GEELONG:** PO Box 8048 Newtown VIC 3220
BRISBANE: Level 22, 127 Creek Street Brisbane QLD 4000 **ADELAIDE:** 8 Greenhill Road Wayville SA 5034
CANBERRA: PO Box 6067, O'Connor ACT 2602 **SYDNEY:** level 5, 616 Harris Street, Ultimo, NSW, 2007:

DOCUMENT CONTROL

Assessment	Land Management Plan
Address	5835 Great Ocean Road, Yuulong
Project number	12652
Project manager	Jordan Whitmore (Consultant Botanist)
Report Author	Elyse Harrison (Technical Officer - Botany)
Report reviewer	Shannon LeBel (Senior Ecologist)
Mapping	Monique Elsley (GIS Officer)
File name	12652_EHP_LMP_5835GreatOceanRoadYuulong_Final_01102019
Client	Ballarat Clarendon College
Bioregion	Otway Ranges
CMA	Corangamite
Council	Colac Otway Shire Council

Acknowledgements

We thank the following people and organisations for their contribution to the project:

- The Victorian Department of Environment, Land, Water and Planning for access to ecological databases.
- Tract Consultants for Coordination of all disciplines, and those involved with the project.

CONTENTS

1 INTRODUCTION

1.1 Background

Ecology and Heritage Partners Pty Ltd was commissioned to prepare a Land Management Plan (LMP) for the proposed Year 9 Clarendon College Yuulong Campus at 5835 Great Ocean Road, Yuulong.

Ecology and Heritage Partners have conducted a Biodiversity Assessment (Ecology and Heritage Partners 2019) at the proposed site in Yuulong, and it is understood that a Land Management Plan is required under the Rural Conservation Zone (RCZ) following the proposed building construction and removal of native vegetation.

A Land Management Plan must be submitted and approved by the Colac Otway Shire Council prior to the commencement of any building or works. The requirements needed to form the Land Management Plan as outlined in the Colac Otway Shire Planning Information – Land Management Plans document are provided below:

1.1.1 Land Management Plan Requirements and Objectives:

The LMP is a plan detailing the short and long-term management objectives for the entire property and includes:

- Site Description (Section 1.2)
    - Address;
    - Existing and proposed land use; and,
    - The uses of adjoining properties.
- List of the objectives for the property (Section 3)
    - How the property will be managed in the future; and,
    - Areas to extend native vegetation, protection of areas from grazing, and the location of proposed buildings.
- A description of native plant and animals on site and in the area (Section 2)
    - List of the existing native vegetation species on site, including Ecological Vegetation Classes, significant species location and condition, and bioregional conservation significance;
    - List all revegetation species to be established on site; and,
    - List any wildlife species that are present on the site and their conservation significance.
- A description of the site outside the native vegetation areas (Section 2)
    - Waterways, wetlands, springs, saline or eroding areas and how they will be protected and/or enhanced; and,
    - Existing pasture areas located on the property including areas that are either grazed or proposed for grazing.

- Wildfire Management (Section 4)
    - Description of how fire safety issues are addressed
- Identification of Land Management Issues (Section 4)
    - Identification of threats to planned objectives, and the environmental values on site such as: pest plants and animals, grazing in environmentally sensitive areas, feral animals, wildfire, domestic animals (interfering with wild animals), erosion/loss of topsoil, and over grazing.)
- Timelines (Section 5)
    - Setting of land management goals throughout construction, and ongoing management post construction (table form).

1.2 Study Area

The study area is located at 5835 Great Ocean Road, Yuulong, approximately 145 kilometres south-west of Geelong's CBD (Figure 1). The study area comprises two lots totalling approximately 50 hectares and is bound by the Great Ocean Road to the north and a combination of bushland and farmland to the south, east and west.

The study area is part farmland and part bushland with a significant portion of the bushland located to the gullies in the southern portion of the property. A dam/waterbody is located to the east of the shearing shed, located along Hornes Road, which in turn runs through the centre of the study area. A steep gully also runs through the top right-hand corner of the study area.

It is understood that Ballarat and Clarendon College propose to construct a Year 9 campus on the site.

According to the Department of Environment, Land, Water and Planning (DELWP) Native Vegetation Information Management (NVIM) Tool (DELWP 2019a), the study area occurs within the Otway Ranges bioregion. It is located within the jurisdiction of the Corangamite Catchment Management Authority (CMA) and the Colac Otway Shire Council municipality.

2 EXISTING CONDITIONS

2.1 Current Vegetation Condition

Current vegetation condition was determined during the ecological assessment completed in April 2019 as part of Ecology and Heritage Partners' initial Biodiversity Assessment of the study area (Ecology and Heritage Partners 2019)

2.1.1 Native vegetation Patches

Native vegetation in the study area is representative of one EVC: Shrubby Wet Forest (EVC 201). The remainder of the study area is cleared for pasture or comprises planted vegetation and associated regrowth. Specific details relating to observed EVCs are provided below.

Shrubby Wet Forest

The majority of the study area was dominated by Shrubby Wet Forest, which is typically characterised by tall eucalypt forest with scattered understorey trees over a tall broad-leaved shrubby understorey and a moist, shaded, fern-rich ground layer.

The tree canopy consisted predominantly of Manna Gum *Eucalyptus viminalis*. The understorey consisted scattered occurrences of Blackwood *Acacia melanoxylon* and a shrub layer composed of Prickly Currant-bush *Coprosma quadrifida,* Hazel Pomaderris *Pomaderris aspera,* Snowy Daisy-bush *Olearia lirata,* and Coast Daisy-bush *Olearia axillaris.* Groundcover was relatively sparse but where present, was dominated by Rush *Juncus* spp., Tall Sword Sedge *Lepidosperma elatius*, Rough Tree Fern *Cyathea australis* and Austral Bracken *Pteridium esculentum.*

Weed species, including Blackberry *Rubus* sp., Cocksfoot *Dactylis glomerata,* Toowoomba Canary-grass *Phalaris aquatica,* Flatweed *Hypochoeris radicata* and Brown-top Bent *Agrostis capillaris* were commonly found throughout many of native vegetation patches.

The small patch of Shrubby Wet Forest located along the roadside of Hornes Road (opposite the shearing shed) lacked an overstorey, aside from a few non-indigenous, planted eucalypts. The understorey was dominated by a shrub layer, which consisted primarily of Blackwood, Silver Wattle *Acacia dealbata,* and Snowy Daisy-bush *Olearia lirata*. Austral Bracken and Bidgee-widgee *Acaena nove-zelandiae* dominated the groundcover.

2.1.2 Introduced and Planted Vegetation

Introduced Vegetation

Areas not supporting native vegetation have a high cover of exotic grass and herb species, many of which have been direct-seeded for use as pasture. Scattered natives (Austral Bracken, Prickly Currant-bush, Rush, Bidgee-widgee and Violet *Viola* sp.) are generally present in these areas, however they did not have the required cover to be considered a patch (≥25% native perennial cover).

Disturbed areas were dominated by environmental weeds such as Wheat *Triticum aestivum,* Cocksfoot, Toowoomba Canary-grass, Pimpernel *Lysimachia arvensis*, Flatweed, Brown-top Bent, Mirror Bush, Agave *Agave* spp. and White Clover *Trifolium repens* var. *repens*.

Scattered occurrences of the noxious weed Spear Thistle *Cirsium vulgare* and two Weeds of National Significance (WON) Willow *Salix* sp, and Blackberry *Rubus fruticosus* were also present throughout the study area.

Plate 1. Shrubby Wet Forest within the study area (Ecology and Heritage Partners Pty Ltd 01/04/2019).

Plate 2. Shrubby Wet Forest along Hornes Road within (Ecology and Heritage Partners Pty Ltd 01/04/2019).

Planted Vegetation

Planted vegetation in the study area typically consisted of a mixture of exotic, non-Victorian and native tree species and were found as windrows between paddocks and along roadsides. These species included Manna Gum, Southern Blue-gum *Eucalyptus globulus*, Flowering Gum *Corymbia ficifolia*, Banksia *Banksia* sp., Honey-myrtle *Melaleuca* sp. and Lightwood *Acacia implexa.*

2.1.3 Fauna Habitat

The study area consists of large areas of pastoral land dominated by non-native herbs and grasses. Exotic and native trees were planted between paddocks, acting as windrows and comprised mostly of Eucalypts, Banksia and Melaleuca species. During flowering, these trees will provide foraging habitat for nectarivores (nectar eating) and frugivorous (fruit eating) bird and arboreal mammal species.

The highly modified agricultural land is likely to be used as a foraging resource by common generalist bird species which are tolerant of modified open areas. The patches of Shrubby Wet Forest that occur throughout the study area are likely to provide an important resource for birds and arboreal fauna, both in terms of feeding, nesting and breeding habitat.

Plate 3. Planted vegetation within the study area (Ecology and Heritage Partners Pty Ltd 01/04/2019).

Plate 4. Noxious vegetation within the study area (Ecology and Heritage Partners Pty Ltd 01/04/2019).

Plate 3. Exotic pasture within the study area (Ecology and Heritage Partners Pty Ltd 01/04/2019).

Plate 4. Exotic pasture and planted windrows within the study area (Ecology and Heritage Partners Pty Ltd 01/04/2019).

3 LAND MANAGEMENT ISSUES

3.1 Management Issues

Potential threatening ecological processes and management issues exist across the study area, including the presence of pest animals and plants, the interference of domestic animals with native fauna, agricultural activities, and the risk of erosion and Bushfire.

3.1.1 Defendable Space

Defendable Space is an area of land around a structure in which vegetation is modified and managed in a fuel reduced state to reduce the effects of flame contact and radiant heat associated with bushfires.

Clause 13.05 Bushfire has the objective to "*strengthen the resilience of settlements and communities to bushfire t2rough risk-based planning that prioritises the protection of human life*". This clause applies to land within the Bushfire Prone Area (BPA), BMO or proposed to be used or developed in a way that may create a bushfire hazard. Clause 13.02 contains five strategies to meet the objective, being:

- Protection of human life;
- Bushfire hazard identification and assessment;
- Settlement planning;
- Areas of high biodiversity conservation value; and
- Use and development control in a BPA.

The intention of the proposed development has consistently been to minimise the amount of tree and vegetation clearing on the site, however compliance with Table 3 of Clause 53.02 stipulates a requirement for 105 metres of defendable space due to the building use, vegetation type and steep terrain. Critical for further mitigating the bushfire risk was increasing the construction standard of the new buildings to BAL40.

A considered analysis of the location of all existing vegetation resulted in the proposed location of new buildings in both the Staff Accommodation and Student zones minimised the extent of bushland removal, noting that where possible, canopy trees will be retained in the defendable space areas in compliance with required canopy clearances to satisfy defendable space creation as per Clause 53.02 of the Colac Otway Shire Council Planning Scheme.

3.1.2 Removal of Native Vegetation (Defendable Space)

Approximately 1.915 hectares of native vegetation is proposed to be removed to create the required defendable space within the study area.

Native vegetation on site is consistent with the Shrubby Wet Forest EVC which makes up approximately 50% of the study area (Figure 2). Areas of Shrubby Wet Forest are split into four distinct patches (SWF1,SWF2,SWF3,and SWF4) (Figure 2), of which three (SWF1, SWF3, and SWF4) are consequentially lost due to the requirement of defendable space.

Offset calculations have considered areas impacted within defendable space as full loss (i.e. not partial) despite selective removal of trees to the minimum extent necessary to satisfy the requirement of defendable space. This is due to a majority loss of the canopy, as well as proposed methods to reduce biomass within patches.

3.1.3 Protection of Native Vegetation

The five distinct areas of Shrubby Wet Forest within the study area totals 28.81 hectares, with 1.915 hectares proposed to be removed for defendable space. A total of 25.39 hectares of Shrubby Wet Forest is to be protected on site.

Management actions must be implemented to ensure native vegetation (outside of the defendable space) does not degrade further as a result of the ongoing use of the site. As such, these areas should be treated as 'Conservation Zones' to100m of the defendable space boundary.

3.1.4 Weeds

As described above in Section 2.1.1 and Section 2.1.2,, large disturbed areas occurred throughout the study area, and which typically comprised of exotic grass and herb species.

Declared noxious weeds are plants proclaimed under the *Catchment and Land Protection Act 1994* (CaLP Act) because they cause environmental or economic harm or have the potential to cause such harm. WONS are those weeds that have been identified as already causing significant environmental damage and must be eradicated (<1% cover abundance).

It should be noted that it is the landowner's responsibility to ensure weeds are controlled to the specified amount under the legislation. Fines or prosecution are possible if landowners do not control weeds within their land.

3.1.4.1 Priorities for weed management

Priorities for weed management shown in Table 1 have been based on the following criteria:

Threat Level

- High – rapidly spreading species with the potential for high ecological impacts.
- Moderate – moderately spreading species with the potential for high ecological impacts.
- Low – slow spreading species with the potential for high ecological impacts.

Infestation Level

- High – weed infestation over large areas across the site.
- Moderate – weed infestation over moderate areas on the site.
- Low – localised weed infestation across the site.

Control Priority

- High priority: Issue poses a high level of threat to ecological values, and needs to be addressed immediately and on a frequent basis. (Management should commence in Year 1, with high frequency treatment ongoing as required).
- Moderate priority: Issue has a high to moderate threat level and needs to be addressed in the short-term or on a regular basis (Management should commence no later than Year 2, with moderate frequency treatment ongoing as required).

- Low priority: Issue has a medium to low threat level, or low likelihood of occurrence, and needs to be addressed on an irregular basis (Management should commence by Year 3 once High and Moderate priority threats have been minimised. Continue treatment as required).

Table 1. Priority weeds known to occur within the study area

Scientific Name	Common Name	Weed Classification (CCMA)	Threat Level	Extent of Infestation (2019)	Control Priority
Rubus fruticosus	Blackberry	C/WONS	High	Moderate	High
Cirsium vulgare	Spear Thistle	R	Moderate	Low	High
Salix sp.	Willow	WONs	Moderate	Low	High
Agapanthus sp.	Agapanthus	-	Low	Moderate	Moderate
Hypochaeris radicata	Flatweed	-	Low	Low	Moderate

Notes: WONS = Weeds of National Significance; R = Restricted weed.

3.1.5 Pest Animals

Although not seen whilst undertaking the site assessment, two pest animal species listed under the CaLP Act are likely to occur within the study area and surrounds (European Red Fox *Vulpes vulpes* and European Rabbit *Oryctolagus cuniculus*).

The European Red Fox is one of Australia's most serious pest animals. Their primary impact is the predation of livestock and native animals.

Rabbits are also one of Australia's most serious pest animals and typically:

- destroy pasture, crops and plant communities impacting on agriculture and the environment;
- cause soil erosion and associated sedimentation of waterways; and,
- compete with native fauna for food and habitat.

3.1.6 Domestic animals

Poor management of domestic animals can impact severely on the welfare of native fauna and the environment. A wide variety of native animals, ranging from the more common species like possums, kangaroos, wallabies, lizards and many species of bird, to rarer or threatened species such as bandicoots, koalas and quolls, may be at risk from domestic pets in urban and rural areas.

For example, unchecked, dogs can harass and even kill native animals as they move across country in search of food and shelter. Cats are by nature instinctive hunters and are more likely to kill birds and lizards.

Domestic pets also occur in high numbers in urban and modified areas, where native animal numbers are fewer. So even though each individual animal may only kill or injure a small number of native animals, it has a bigger effect on the already reduced population (DoEH 2004).

3.1.7 Erosion

Development and construction activities (e.g. soil excavation) may increase the potential for erosion and sedimentation. Erosion and the loss of topsoil can lead to increased pollution and sedimentation in streams

and rivers, causing declines in fish and other species. in addition, degraded lands are also often less able to retain water, which can worsen flooding situations.

4 LAND MANAGEMENT ACTIONS

4.1 Management Actions

The following management actions and performance measures are detailed below to protect and enhance ecological values within study area, and to ensure the long-term functionality of the site.

4.1.1 Defendable Space

Grassland

Defendable Space will be managed through biomass control via grazing with sheep in areas of open exotic grassland. The objective of biomass control is to manage and reduce fuel load within the grassland areas.

The grazing of cattle and sheep typically reduces the biomass and cover of vegetation within exotic grassland areas, which in turn, reduces the flame length and rate at which a wildfire will spread. As such, the potential for catastrophic fires during the peak fire season (December – February) will be greatly reduced. Furthermore, grassland areas which have not been controlled through grazing are to be mechanically cropped to <100mm during declared fire danger periods to maintain minimum fuel condition.

However, it is important to note that inappropriate grazing regimes may lead to the trampling, erosion and degradation of the grassland areas. Furthermore, uncontrolled or improper grazing may promote invasive plant growth by transporting seeds in the fur, feet or digestive tracts of livestock and creating disturbances which stress native plants and release invasive species from competition. As such, systematic or pulse grazing should be implemented, and restricted access within areas of retained vegetation within the defendable species boundary, whereby a period of grazing exclusion may be beneficial for enhancing ecological values of the understorey.

Bushland

Areas of open space out side of retained patches of native vegetation (Figure 1) are to be managed at a low-fuel state to reduce fire risk. This will require:

- Grass must be short cropped and maintained during the declared fire danger period;
- All organic ground litter must be removed at regular intervals during the declared fire danger period;
- Ensure plants within 3 metres of a window or glass feature of the building do not exceed 10 centimetres;
- Remove and maintain shrubs under the canopy of trees;
- Individual and clumps of shrubs must be maintained as not to exceed 5 square metres in area and must be separated by at least 5 metres;
- Trees must be maintained as to not overhang or touch any elements of the building;
- The canopy of trees must be separated by at least 5 metres; and,
- Tree branches below 2 metres must be pruned

The study area is subject to a Bushfire Management Overlay (BMO). Therefore, it is important that the development implements measures to mitigate the potential threats fire poses to life, property and infrastructure. The preliminary bushfire assessment completed by Terramatrix (2019) outlines the details of the BMO on the study area. The new buildings will be constructed to a rating of BAL-40, with a defendable space buffer of 105m which exceeds the requirements of Table 6 of clause 53.02 of the BMO.

4.1.2 Removal of Native Vegetation

Removal of native vegetation to create defendable space boundary must follow mitigation measures to avoid accidental or peripheral impacts to areas within and surrounding the defendable space boundary.

Tree Marking

Trees scheduled to be removed within patches of native vegetation (Figure 2) to satisfy the defendable space requirements must be clearly and appropriately marked with either flagging tape, and/or high visibility marking spray.

Temporary Fencing

Prior to commencement of works, all retained trees should be fenced in accordance to the Colac Otway Shire Council Tree Protective Fencing specifications (or the domestic area/defendable space, whichever is more practical). Fencing will be signposted 'tree protection zone'. Fill, machinery and building materials will not be placed, even for a short time within the tree protection zone.

Temporary flagged bunting must be erected at the boundary of the defendable space within patches of native vegetation to delineate defendable space from 'conservation areas'. Metal or wooden pickets with protective caps should be used to support the temporary bunting, and remain in position beyond the construction phase to identify the limit of ongoing defendable space management.

Site management

No machinery or vehicle may enter 'Conservation areas' at any time

4.1.3 Protection of Native Vegetation

Ongoing Management and Monitoring

Monitoring of 'Conservation areas' should be implemented to track condition and to identify management issues early.

The Following monitoring actions should be followed:

- Continual monitoring and control of invasive species within and adjacent to the conservation zone;
- Tracking of vegetation condition to identify the potential requirement for supplementary plantings (if needed); and,
- Identifying ongoing management issues requiring remediation (e.g. weeds, fauna grazing pressure, and erosion);

Sections 4.1.4, 4.1.5, 4.1.6, and 4.1.7 identify further management actions to protect 'conservation areas' on site.

4.1.4 Weed Control

Ongoing weed control is the primary management issue within the study area. Weed control objectives are to eliminate high threat weeds such as Spear Thistle and to control all other weed populations to manageable levels.

Weed control works should be carried out by an experienced contractor. Licensed weed control contractors will have a greater ability to make appropriate decisions on which technique to use based on individual situations and the targeted species. Contractors will also need to be aware of the potential for new outbreaks of weed species not recorded in this assessment and implement appropriate weed control techniques as necessary.

A list of priority weeds that require control within the study area, and their current level of threat are provided in Table 1. Several management techniques are recommended to control weeds, including physical removal, brush cutting and herbicide application. In the majority of cases, herbicide will only be applied to weeds by using the spot-spraying technique, to prevent death or damage to non-target species. A summary of weed management techniques for noxious weeds and WONS is provided in Table 2. Primary weed control techniques are outlined in Appendix 1.

Actions

- Undertake weed control works prior to flowering and setting seed;
- Eliminate all listed noxious weeds, WONS and other woody weeds;
- Where appropriate, promote persistence and expansion of indigenous flora species; and,
- Monitor for the occurrence of new weeds or the further spread of current weeds.

Performance Indicators

Key performance indicators for weed management include:

- Meeting the requirements of the CaLP Act in relation to control of listed noxious weeds within the study area;
- No new significant weed invasions occur in the study area;
- Establishment of photo-points throughout the site in consultation with Council so that changes in extent of weed infestation can be documented over time;
- Eliminate (<1% cover) noxious, High threat and woody weeds;
- Control cover of Moderate threat weeds (≤2%); and,
- No increase in the cover of Low threat weeds within the study area.

Table 2. Weed control targets

Scientific Name	Common Name	Control Method	Timing	Threat Level	Control Priority	Current Cover	Goal
Rubus fruticosus	Blackberry	CP,SS,HP,SL		High	High	1%	Eliminate
Cirsium vulgare	Spear Thistle	CP, SL	CP: All year round	Moderate	High	2%	Eliminate (<1%)

Scientific Name	Common Name	Control Method	Timing	Threat Level	Control Priority	Current Level	Goal
Agapanthus sp.	Agapanthus	SS, HP	SS: All year around HP:	Low (outside of plantings)	Moderate	2%	Control (2%)

Notes: CP = Cut and Paint; SS = Spot Spray; HP = Hand Pull; SL = Slash/Brushcut.

4.1.5 Pest Animals

Management options and procedures are provided below for two common pest species, European Rabbit and European Red Fox. The management options provided below should be considered as contingency measures to be incorporated should pest animals appear in the future.

4.1.5.1 European Rabbit

An evaluation of management measures commonly adopted to control European Rabbits in Victoria is provided below (Table 3). European Rabbits commence breeding in autumn and continue until vegetation dries off, which generally occurs in early summer. Rabbit mortality is particularly high during summer months due to disease, lack of food and water, and high temperatures. Late summer and early autumn is therefore the best time to control rabbits as populations are naturally low.

Table 3. Feasibility assessment of European Rabbit control methods

Method	Comments
Baiting (Pindone)	Although an antidote exists for domestic pets which have ingested Pindone (Vitamin K1), the risks associated with the poisoning of domestic and native animals is considered unreasonable. Additionally, consultation with qualified pest controllers indicated that pindone poisoning may not be successful, as rabbits are unlikely to feed on introduced bait if an abundance of existing food sources are present.
Warren fumigation	The site inspection identified very little evidence of warrens across the site. In the event that significant warren networks become established, this method is considered suitable for control.
Warren ripping	As above. In order to avoid impacts on native vegetation communities, ripping would be constrained to areas of maintained exotic grassland and other non-native vegetation.
Long netting and night netting	Night netting is an effective method, particularly in situations where rabbits are leaving bushland harbour to feed in areas of open space.

4.1.5.2 Red Fox

An evaluation of management measures commonly adopted to control Red Foxes in Victoria is provided below (Table 4). The most effective fox control is achieved during late winter and spring. At this time foxes are less mobile, they are rearing young and food demands are high. At other times there are more young animals to move into vacated territories. Fumigation and den destruction is most effective during August and September, within 10 weeks of cubs being born. Vixens are only likely to be killed through fumigation when they are confined to the den, within the first three weeks after the birth of cubs.

Table 4 Feasibility assessment of Red Fox control methods

Method	Comments
Baiting	The risks of poisoning domestic and native animals is considered unreasonable. Additionally, the costs of baiting would exceed the available resources for pest animal management in ELP.

Method	Comments
Fumigation and den destruction	If completed at appropriate times, fumigation and den destruction can be effective in reducing fox numbers.
Shooting	Owing to the high recreational use of the site, shooting is not considered a feasible option.
Trapping	Jawed traps and cage traps can be used to control Red Foxes, however the success of trapping is relatively low, as foxes are known to be extremely trap-shy. Based on the trapping effort required and low likelihood of success, trapping is not considered a feasible control option.

Actions

- Continually monitor for the presence of pest animal fauna; and,
- Where appropriate, undertake preferred control methods as summarised above.

Performance Indicators

Key performance indicators for pest animal management include:

- Meeting the requirements of the CaLP Act in relation to control of listed fauna within the study area;
- Presence of pest fauna does not increase above current levels of occurrence;
- Achieving control of key fauna species within the study area within the specified management timeframe; and,
- No new significant pest fauna invasions occur in the study area.

4.1.6 Domestic Animals

Domestic pet management in accordance with Colac Otway Shire:

In accordance with section 25 of the Domestic Animal Act 1994, all domestic pets are to be contained to their owner's property; and yards are to be fenced so pets cannot jump, go through or under.

However, due to the nature of the proposed development (Year 9 campus), it is unlikely that domestic animals will be housed within the study area.

4.1.7 Erosion

To mitigate against erosion, ensure that best practice sedimentation and pollution control measures are undertaken at all times, in accordance with Environment Protection Authority guidelines (EPA 1991; EPA 1996; Victorian Stormwater Committee 1999) to prevent offsite impacts to waterways and wetlands.

An erosion management overlay (EMO1) also applies to the study area, which aims to protect areas prone to erosion, landslip or other land degradation processes by minimising land disturbance and inappropriate development.

5 RESPONSIBLITIES AND TIMEFRAMES

5.1 Responsibilities

The relevant landowners are responsible for all management actions described in this plan.

5.2 Timeframes

A timetable for the above management actions is provided below (Table 5).

Table 5. Timetable of management actions

Year	Management action	Timing of action	Report reference
0	Install protective fencing.	Prior to commencement of construction activities.	Section 4.1.2
1	Implement weed control for High Priority weeds.	In accordance with Table 2.	Section 4.1.4
2	Implement weed control for Moderate Priority weeds.	In accordance with Table 2.	Section 4.1.4
	Ongoing weed control for High Priority weeds.	In accordance with Table 2.	Section 4.1.4
	Implement pest animal control, as required.	As required.	Section 4.1.5
3	Implement weed control for Low Priority weeds.	In accordance with Table 2.	Section 4.1.4
	Ongoing weed control for High Priority weeds.	In accordance with Table 2.	Section 4.1.4
	Ongoing weed control for Moderate Priority weeds, as required.	In accordance with Table 2.	Section 4.1.4
4	Ongoing weed control for High, Moderate and Low Priority weeds, as required.	In accordance with Table 2.	Section 4.1.4
	Implement pest animal control, as required.	As required.	Section 4.1.5
5	Ongoing weed control for High, Moderate and Low Priority weeds, as required.	In accordance with Table 2.	Section 4.1.4
6	Ongoing weed control for High, Moderate and Low Priority weeds, as required.	In accordance with Table 2.	Section 4.1.4
	Implement pest animal control, as required.	As required.	Section 4.1.5
7	Ongoing weed control for High, Moderate and Low Priority weeds, as required.	In accordance with Table 2.	Section 4.1.4
8	Ongoing weed control for High, Moderate and Low Priority weeds, as required.	In accordance with Table 2.	Section 4.1.4
	Implement pest animal control, as required.	As required.	Section 4.1.5
9	Ongoing weed control for High, Moderate and Low Priority weeds, as required.	In accordance with Table 2.	Section 4.1.4
10	Ongoing weed control for High, Moderate and Low Priority weeds, as required.	In accordance with Table 2.	Section 4.1.4
	Implement pest animal control, as required.	As required.	Section 4.1.5

REFERENCES

DELWP 2015. *Flora and Fauna Guarantee Act 1988* – Action Statement No. 266 Soil erosion and vegetation damage and disturbance in the alpine regions of Victoria caused by cattle grazing.

DELWP 2019a. Native Vegetation Information Management Tool [www Document]. URL: <https://nvim.delwp.vic.gov.au/>. Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DELWP 2019b. Ecological Vegetation Class (EVC) Benchmarks for each Bioregion [www Document]. URL: <http://www.depi.vic.gov.au/environment-and-wildlife/biodiversity/evc-benchmarks#bioregionname>. Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DELWP 2019c. Planning Maps Online [www Document]. URL http://services.land.vic.gov.au/landchannel/jsp/map/PlanningMapsIntro.jsp. Victoria Department of Environment, and Primary Industries.

DoEH 2004. Protecting our Wildlife: Responsible pet ownership. Department of the Environment and Heritage, Canberra, ACT.

DPI 2008. Declared Noxious Weeds – Listed by Common Name. Landcare Notes. Department of Primary Industries, East Melbourne, Victoria.

Ecology and Heritage Partners 2019. Biodiversity Assessment: 45 Old Iluka Access and 5835 Great Ocean Road, Yuulong.

FIGURES

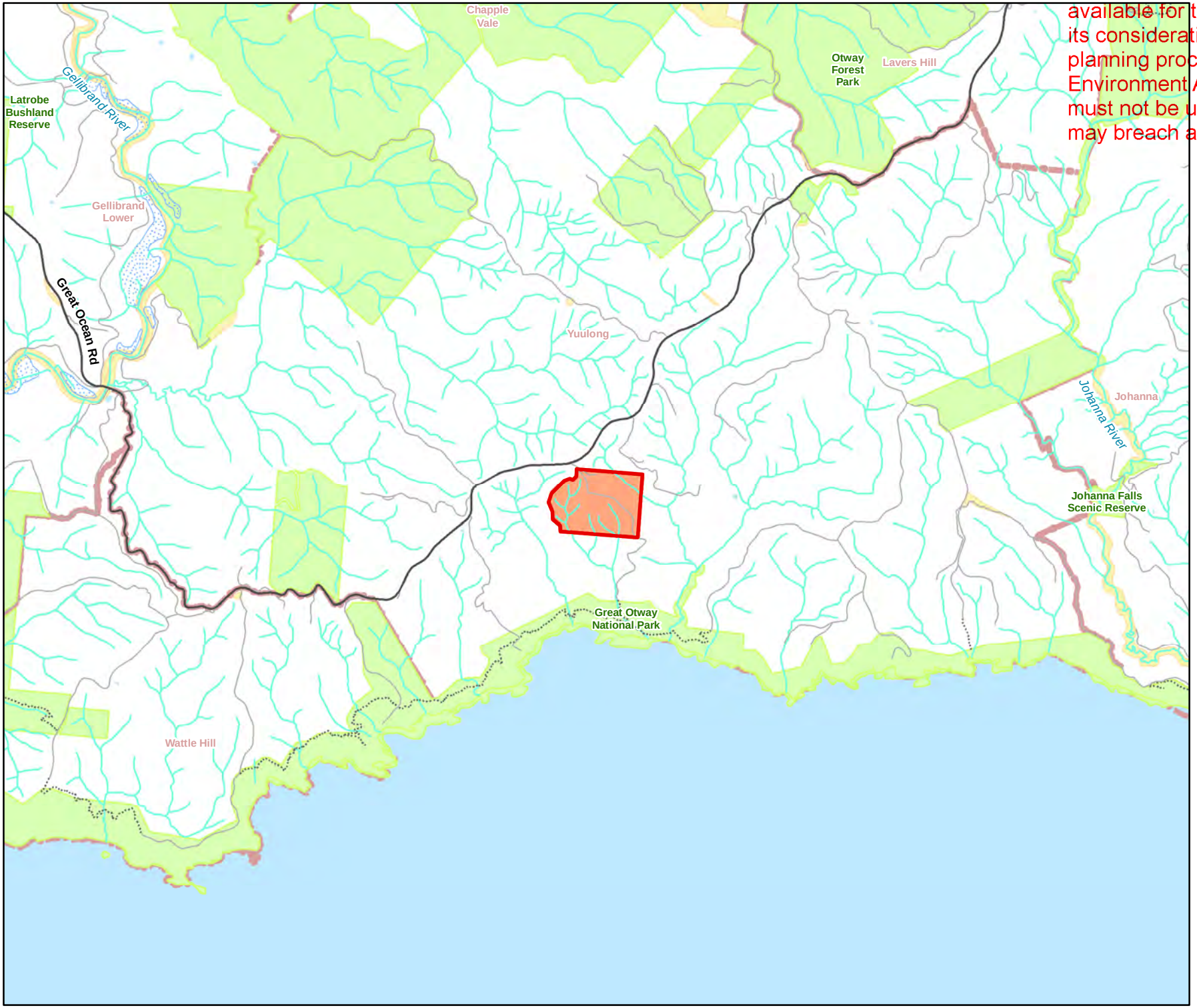


Figure 1

Location of the study area

Biodiversity Assessment for 5835 Great Ocean Road, Yuulong, Ballarat Clarendon College Campus

ecology & heritage partners

Legend

- Study Area
- Tree to be removed

Proposed development plan

- Bushfire shelter
- Commons and student accomodation
- Staff accomodation

Ecological Vegetation Class

- Shrubby Wet Forest (EVC 201)
- Impacted vegetation

Figure 2

Ecological features

Biodiversity Assessment for 5835 Great Ocean Road, Yuulong, Ballarat Clarendon College Campus

N

0 50 100

Metres

ecology & heritage partners

APPENDIX 1: WEED CONTROL MEASURES

Weed control measures identified in Table 2 are described in detail below. Weed control measures (including type of herbicide) should follow the guidance of an experienced contractor for the control of the weed species identified above.

Herbicides

Spot spraying and Rig-spraying

The application of herbicides is an effective and efficient control technique for a range of woody, herbaceous and grass weeds. The correct use and application of herbicides can provide targeted control of a range of species, however it must be stressed all use of herbicides must be used in accordance with the manufacturer's specifications and occupational health and safety policies.

Application methods for herbicides include spot spraying with a knapsack for small or sensitive areas, or for targeted species. Rig spraying is best used in larger areas which are not sensitive to high volume application of herbicide and there is limited potential for off-target damage. Dabbing of species with foam tipped application device, with the herbicide applied from an attached bottle, should be used in sensitive areas or in areas where weed control is targeted to a small number of plants, especially bulbs or tuberous plants.

Timing of intervals, plant age and growth seasons, plant stress levels and climatic factors all need to be considered when develop methodologies for the application of herbicides to ensure successful outcomes. Problems exist with ongoing unsuccessful herbicide treatments, which may result in weeds developing herbicide resistance, or the build-up of chemicals in the soil. Surrounding plants' susceptibility to herbicides and ongoing uses of the treated areas should also be considered when choosing the right herbicide to be used in a weed control program, as some herbicides are residual and may persist within the soil for varying durations.

Drill and Fill

Drill and fill, also known as direct injection, is a method where the selected herbicide (usually Glyphosate) is injected though a device into a hole that has been made into the targeted plant (i.e. woody species). The hole is usually made through the use of a drill but sometimes a tomahawk or saw may be used to put small nicks into the targeted plant. It is essential that the hole or nick must always be lower than the first branch containing foliage (i.e. ideally, the lowest possible point on the plant) and also the herbicide is applied into the hole as quick as possible. The general rule of thumb is that the herbicide must be applied within 30 seconds. Holes are scattered around the main trunk at 50 millimetre intervals, depending on the diameter of the trunk and also branches or angle of the trunk. It is essential that a complete ring around the trunk of the plant be made of this herbicide filled holes to ensure plant death, as large gaps may allow sections of the target tree to survive. Generally, the holes or nicks do not need to be deeper than 20 millimetres, but do need to be deep enough to penetrate the outer cambium layer of the tree. This allows the phloem to carry the herbicide into the roots, which will kill the plant over a number of weeks, depending on conditions.

The benefits of this method include: the retention of standing material for habitat, no costs for the removal of the plant from the site; no dragging of material across sensitive areas; and, speed, as the method is fast to execute (i.e. drill and fill, and move on).

The drawbacks of this method are that if it is not executed correctly, trees may re-grow, particularly as accessing the base of the trunk of spiny plants such as Hawthorn and African Box-thorn can be difficult. However if the application is successful, dead standing vegetation can become a fire hazard and look aesthetically displeasing to the community.

Cut and Paint

The cut and paint method of control requires the cutting of the target species at the very base, under any foliage, and the immediate application of herbicide (usually a glyphosate, dependent on the target species). The application can be done through a 'dabber' bottle or paint brush. Care should be undertaken during application, to avoid splash of herbicide causing non-target damage. Once cut down, the biomass of the target species may sometimes be left on the ground, but usually requires removal. This is particularly necessary if it bears fertile seeds or has the potential to re-shoot from contact with moist ground (i.e. Salix sp.), or covers native vegetation.

Many herbicides are available that are very effective in the control of woody weed species. Typically these herbicides are applied to the stem, trunk or roots of the target plant by 'drill and fill', 'cut and paint' or 'frilling' methods of application. These herbicides can be more effective than manual removal alone, as the chance of the plant re-sprouting is significantly reduced.

Mechanical Removal

Mechanical removal by machine may include grooming of woody weed infestations by a tractor-mounted groomer (slasher/mulcher), which is quite effective on Gorse, African Box-thorn and Hawthorn infestations. The excavation of Spiny Rush has been used in areas of dense infestations where other means of eradication may be a slow process due to difficult access.

Manual Removal

Some weed species are resilient against other methods of eradication, such as herbicides, and should be targeted by manual removal. Infestations of species such as African Box-thorn, Fennel, Serrated Tussock and Toowoomba Canary-grass should be combated by manual removal techniques.

Additionally, manual removal is a crucial technique when used in conjunction with herbicides for the control of both woody and herbaceous weed species. This combination of weed eradication is advised for almost all weed species.

Ring-barking

Ring-barking is a viable technique for use when eradicating large woody shrubs and trees. The technique involves the use of a large knife, tomahawk or axe to make a continuous cut around the trunk of the plant. The cut should be 5-10 centimetres wide and deep enough to penetrate the heart-wood (Muyt 2001). This technique should not be used when removing species which can reproduce by suckering.

Mowing

While it has been found that mowing may enhance the survival of many weed species, in some instances mowing can be used to control their spread. Areas located in close proximity (500 metres – 1 kilometre) to sites of ecological significance that are currently mown, should undergo an intensive mowing regime (every week), particularly in spring. This method of weed control is only effective against species which are prevalent within mown areas. It will prove most effective in controlling the spread of grass species such as Chilean Needle-grass, Serrated Tussock and Toowoomba Canary-grass.

Mulching

It is advised that mulching be used in areas of revegetation which were previously dominated by exotic vegetation. Mulching can be a very effective technique in suppressing species which may invade, particularly from mown areas.

In areas of native vegetation, mulch should be used very carefully. Only people who have an in-depth knowledge and long history of the specific site should advise the use of mulch in these areas to ensure native species (particularly rare and threatened species) are not affected by the use of mulch.

Soil Scalping

Soil scalping involves the removal of a thin layer of topsoil in areas of extremely high weed cover abundance. Care must be taken in order to ensure that enough soil is removed to eliminate the possibility of re-colonisation from the soil seedbank. If soil scrapping is to be undertaken, a minimum of depth of 10cm of soil needs to be removed to be effective. Soil scalping cannot be undertaken in areas of native vegetation nominated for retention and protection.

It is important that this process is directly followed by high density revegetation and mulching in order to reduce the migration of other weeds into these areas. This process is only favoured in areas that are considered a major source population for weed species of high threat to agriculture, heritage or areas of conservation significance.

ST. QUENTIN
Surveyors • Town Planners • Engineers

Geotechnical Assessment of Landslide Risk

5835 Great Ocean Road, Yuulong

September 2019

Prepared for:
Ballarat Clarendon College

Report Date:
16006G-LRA Rev2

DOCUMENT CONTROL DATA

ST. QUENTIN	St Quentin Consulting Pty Ltd 51 Little Fyans Street South Geelong 3220 P.O. Box 919 Geelong 3220 Tel: (03) 5201 1811 Fax: (03) 9524 8899 www.stqc.com.au	**Title**	16006G-LRA 5835 Great Ocean Road, Yuulong
		Author	C.FARRAR
		Reviewer	O.REYES
		Project Manager	C.FARRAR
		Synopsis	Geotechnical Report to aid design and construction of educational program for Ballarat Clarendon College

Reference: 16006G-LRA 5835 Great Ocean Road, Yuulong

Client: Ballarat Clarendon College

Revision Table

Rev	Description	Date	Authorised
0	Geotechnical Assessment of Landslide Risk 5835 Great Ocean Road, Yuulong	28/06/19	C.FARRAR
1	Geotechnical Assessment of Landslide Risk 5835 Great Ocean Road, Yuulong	23/09/19	C.FARRAR
2	Geotechnical Assessment of Landslide Risk 5835 Great Ocean Road, Yuulong	24/09/19	C.FARRAR

Distribution Table

Date	Revision	Distribution
3/07/19	0	Simon Loader, Tract Consultants Pty Ltd (1 Digital Copy)
3/07/19	0	Peter Williams and Tim Lang, Williams Boag (1 Digital Copy)
23/09/19	1	Simon Loader, Tract Consultants Pty Ltd (1 Digital Copy)
23/09/19	1	Peter Williams and Tim Lang, Williams Boag (1 Digital Copy)
24/09/19	2	Simon Loader, Tract Consultants Pty Ltd (1 Digital Copy)
24/09/19	2	Peter Williams and Tim Lang, Williams Boag (1 Digital Copy)

CONTENTS

SECTION **PAGE**

APPENDICES

EXECUTIVE SUMMARY

Our geotechnical landslide risk assessment has found there are possible landslide events, common to many sites in Yuulong and other areas in the Otway region, which may present risks to life and property.

Following our landslide risk assessment for the proposed development, we have judged the qualitative risk of property damage is "moderate to high" however subject to our recommendations and mitigation measures, we have judged the quantitative risk can be reduced to "tolerable" or less than 1 x 10^{-5} (landslide areas) subject to our recommendations and in accordance with guidelines published by the Australian Geomechanics Society (AGS) journal Volume 42 No 1 of March 2007, entitled "Landslide Risk Management".

Our analysis has demonstrated that whilst there are foreseeable risks associated with these hazards, the inherent low slope angle and distance to inferred landslide features is sufficient to maintain the risk below threshold for "tolerable" risk.

We have judged the critical landslide events relate to soil creep.

To reduce risk below tolerable levels, that is 1 x 10^{-5} (landslide areas) as defined by the AGS Guidelines, we recommend the following:

- **For the proposed Dorm Development and Bushfire Shelter, footings must be extended into (highly-moderately weathered) rock, at an estimated depth of about 4-4.5m to reduce the consequence to soil creep.**
- **New excavations be kept to a minimum where possible and not exceed 1m in height. Proposed cuts or fills must be supported with engineer designed retaining buildings and extended into higher strength rock.**
- **An appropriate founding depth for all footings should be verified by a qualified geotechnical engineer at time of construction.**
- **Construction of an appropriate engineer designed drainage system is required, so that water cannot pond or be directed near the edge of buildings.**
- **A suitable effluent management system is required, preferred to be an evapotranspiration system, Refer 16006G-LCA**

The above requirements are essential in reducing & maintaining landslide risk below "tolerable" levels.

The risk of landslide will increase where inappropriate excavation or constriction is conducted.

1.0 INTRODUCTION

Landslides, erosion and other forms of earth / rock movements are common throughout the Otway Ranges and are a continual natural process of geomorphological shaping of the land.

Developments of sites in geologically active areas are potentially at risk of damage from natural soil or rock movements. Under certain conditions serious building damage, personal injury or even death may result from landslides.

Whilst the risks due to soil movement can usually be identified and steps often be taken to mitigate or reduce the risks to tolerable levels, it is not feasible to eliminate the risks of property damage or personal injury entirely.

2.0 SCOPE OF REPORT

St. Quentin Consulting was commissioned by the client to provide a Landslide Risk Assessment on the property to meet the requirements of the Colac Otway Shire: Erosion Management Overlay (EMO).

The principles used in assessing the landslide risk follow the guidelines published in the Australian Geomechanics Society (AGS) journal Volume 42 No 1 of March 2007, entitled “Landslide Risk Management”.

The purpose of the assessment is to identify possible landslide hazards on the subject site near the proposed development location and to provide guidance and options for possible risk mitigation.

3.0 DEVELOPMENT DESCRIPTION

The proposed development is the construction of educational program facility to be owned and solely operated by Ballarat Clarendon College. The facility will replace an existing program that has been operating for many years in King Island.

Supplied plans indicate that the development will incorporate two main development areas, including staff accommodation buildings, that will be constructed on a prominent ridgeline and close to an existing homestead building and shed and a second development on a separate site, but similarly close to a ridgeline that will accommodate a student commons and dorm facility. Linking the two areas is an existing vehicle track (known as Hornes Road). A bushfire shelter is also proposed approximately adjacent to Hornes Road and positioned north of an existing shearing shed and positioned close to the ridgeline. Plans and elevations prepared by the designer are considered an accurate representation of the proposed works (refer Appendix G for Geotechnical Declaration with drawing references and Appendix I for complete drawing set).

4.0 TESTING PROGRAM AND FINDINGS

4.1 Data gathering – desk top studies and previous investigations

There have been many of private and published landslide risk assessment reports conducted in the Otway Ranges (refer references). These reports suggest that landslide hazards are common in some areas and that inappropriate development can result in and may contribute to slope failure.

We acknowledge other investigation and reporting on or near the subject site. In preparation of our field investigation of the site, preliminary data was gathered from the following sources:

- Colac Otway Shire – landslide details and website information: inventory of known major landslides within the Shire developed by A.S. Miner Geotechnical and Dahlhaus Environmental Geology Pty Ltd.
- Corangamite Catchment Management Authority – ‘CCMA’ published landslide details, susceptibility mapping, field guide and information on its website.
- Department of Primary Industries – GeoVic website: details on geological features and mapping and the Victorian Resources Online website: information about soil properties.
- Aerial photos and maps published by Nearmap.com & Google Earth.
- Previous investigations and reports by us and other consultants, published and unpublished.
- Plans and elevations prepared by the client
- Historic Aerial Photographs.
- Digital terrain modelling from data supplied by Elvis (Elevation.fsdf.org.au)

4.2 Field investigations

4.2.1 Site inspection and mapping

A thorough geomorphological appraisal of the site was conducted, identifying the main features of the site and the surrounding area to identify evidence of slope instability and past slope failures. Slope angles were measured with an inclinometer.

A plan showing the approximate borehole location and plan showing main geomorphic features is presented in Appendix A. A schematic cross section view of the site with a geological hazard model is presented in is presented in Appendix B.

4.2.2 Site description and geomorphology

The subject site is on the south side of Great Ocean Road on an area of uplifted and deeply dissected spurs and ridges. A terrain view (Google Earth) showing geomorphology is presented in Figure 1. Interpretation of landslide features on and near this site are included in Appendix E.

Gill (1975) suggests that the Otway Region geomorphology was formed by uplift of previously flat non-marine deposits that was dominated by lakes and swamps over 100 million years ago. Subsequent uplift and high rainfall have shaped the current landscape with extensive water course incision and large to very large landslide activity. Some of these landslide features cover several hundred metres. Landslide inventory mapping indicates widespread landslide activity across the Yuulong area as indicated by the mapping presented in the Figure 2: Department of Primary Industries Otway Shire Landslide Inventory Mapping (A.S. Miner Geotechnical and Dahlhaus Environmental Geology Pty Ltd, Wangerrip Landslide Inventory overlay. More detailed mapping and landslide interpretation is presented in Appendix E.

Figure 1: Aerial Map: Google-Earth Terrain View, Google Earth 2019 (Image date: 17/8/19).

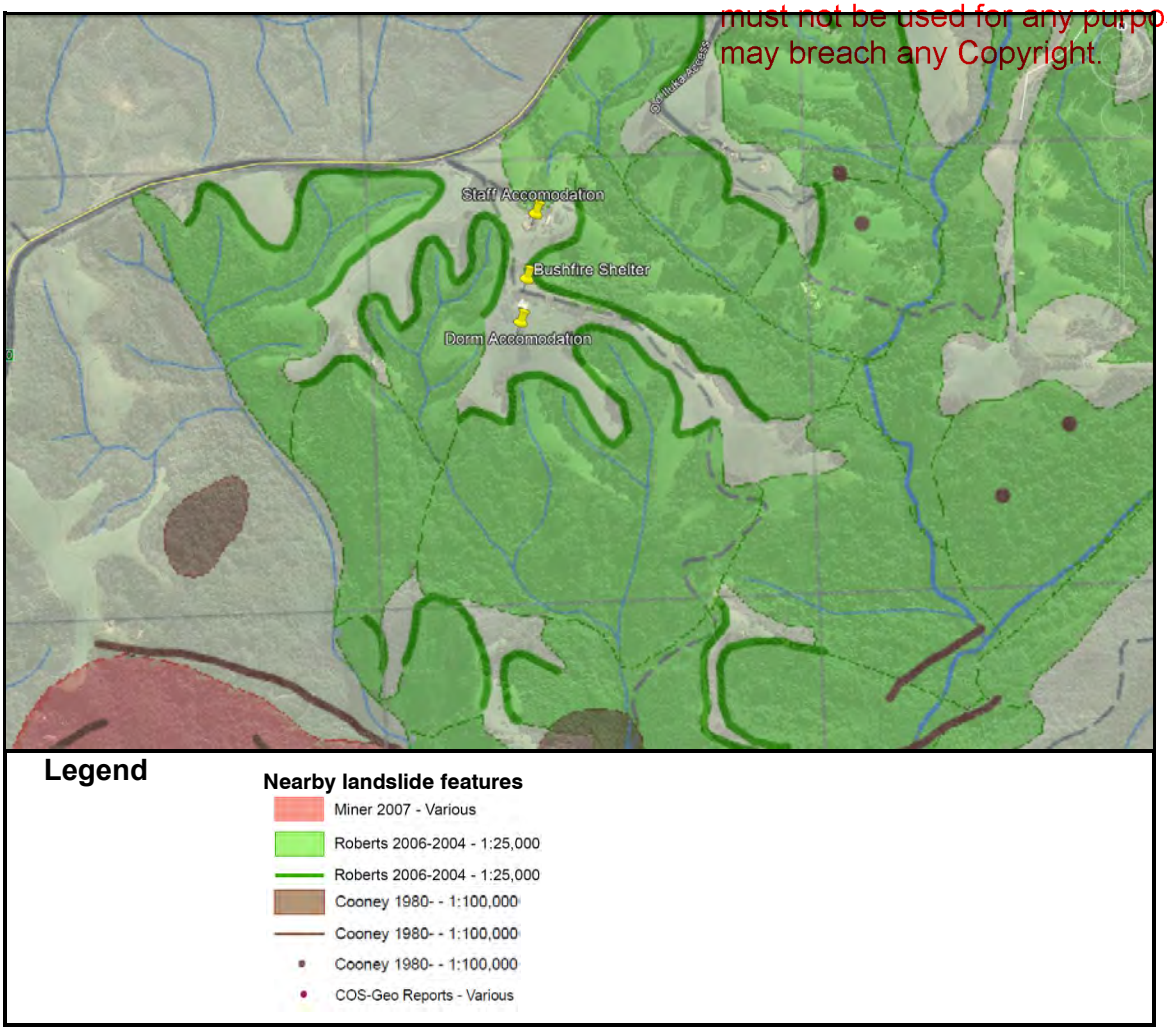


Figure 2: Extract from overlay from Department of Primary Industries Otway Shire Landslide Inventory Mapping (A.S. Miner Geotechnical and Dahlhaus Environmental Geology Pty Ltd)

4.2.3 Sub-surface conditions & test results

The soil conditions in the region are characterised as residual soils overlying sandstones and interbedded mudstones and coal layers. Large areas of colluvium (landslide debris) are common, particularly in steep and lower slopes close to the coast. It is generally accepted that high rainfall, inferred low rock strength and coastal erosion have resulted in extensive landslide activity over several thousand years to present. No evidence landslide debris was encountered in the immediate proposed development area.

Eleven boreholes were performed using a trailer-mounted drill rig with boreholes performed to a maximum depth of 4.5m and shallower boreholes performed using a hand auger apparatus on steeper slopes due to access constraints. Our exploratory drilling program has revealed that the soil profile comprises soils overlying low strength (generally extremely to highly weathered) rock and deeper high strength (moderately weathered) rock at about 3-4m or so. The composition of the soil layers in and near the proposed development area indicates the soil are “residually” derived. Disturbed soil samples were continuously collected logged and hand classified by an experienced and qualified geotechnical engineer. A description of the soil types observed in the boreholes is shown in Appendix C.

Exposed rock cuttings were measured to ascertain dip and strike angles over a wide area including adjacent road reserve cuttings of the Great Ocean Road and exposed cliff faces along the headland of Milanesia Beach between Cape Volney to Bowker Point.

Measurements indicate a dominant SEE trending bedding direction (8-18°), likely influenced by the nearby Moonlight Head (Crowes) Anticline. Variable bedding direction was recorded at the exposed cliff at the base of the Cape Volney to Bowker Point suggests evidence of large to very large-scale landslide events, likely influenced by coastal erosion.

Refer to the following section for more details and description of previous nearby movements. Photographs showing exposed rock is shown in Appendix D & E.

4.2.5 Groundwater conditions

Limited published bore data is available for permanent / transient water table for the Yuulong area. Historic groundwater bore information was searched using the VVA website. This revealed a single borehole

performed by the Rural Water Commission to a depth of about 115m in 1965, described as a 'drought relief' bore. No water table depth was described on the report.

During our investigation numerous springs and an inferred perched table was noted in gullies/incised water courses. We expect these are perennial surface drainage courses that are more active during seasonally wet conditions. It is important to note that intermittent perched water table have been associated with significant landslide activity in the Otway Region that results in weakened shear strength on over consolidated clays (Miner 1999) that can trigger landslide events. We suggest that similar conditions (inferred intense and prolonged rainfall) has resulted in similar conditions in this area, informed by the extensive landside activity in the area. Without drainage management, these conditions can continue to impact stability of slopes.

Perched water table may prove problematic if construction is commenced after wet periods with potential collapse of deep excavations. For these reasons, it is important upslope cut-off drains are provided to prevent/reduce transient water flows near the construction and effluent area. More details on drainage are provided in Section 8.2.

4.3 Previous landslide movements

There are multiple landslide features in the Yuulong locality, some affecting a large expanse of the area. Significant landslide features have been identified on 'Wangerrip' and 'Cape Volney' Colac-Otway Shire Landslide Inventory Mapping (collated by A.S. Miner Geotechnical and Dahlhaus Environmental Geology Pty Ltd). Notable features have been mapped by Roberts most likely via aerial interpretation. Our investigation has revealed some additional features and differing boundaries not noted by Roberts. Additional landslide features have been also identified by Miner (2007) and are included on the Landslide Inventory Mapping.

There are several interpretations of landslide feature progression in the region. It has been noted that higher ocean levels existed during the last interglacial period, about 125,000 years ago (Williams et al.) and that when the sea retreated, cut platforms were covered by colluvium (Gill 1975). Evidence of very large landslide emanating from coastal edge suggest these were influenced by a higher ocean level, about 125,000 year ago, that were" around 7 metres higher than present."[1] However, it is generally accepted that most of the very large distinct featured landslides in the region are estimated to be about 5000-6000 years old and occurred after sea levels again rose after the last glacial period. It has been postulated that some features are potentially much younger however very few features have been investigated in detail to confirm. Two very recent landslides (occurring in 1952) have been studied by Cooney (1980), in Lake Elizabeth and Wild Dog Road. Cooney found these occurred following very high rainfall and inferred saturated toe of the landslides. We suggest that similar scale events could occur under similarly high rainfall evented and promoted from tidal under-cutting and similarly saturated toe that occurs at the coastal edge. Projected ocean rises will undoubtedly increase the risk of landslides near the coastal edge.

Most of the landslide features in the vicinity of development area were assessed as fossil landslides, based on the well-rounded geomorphology that generally didn't indicate significant evident of recent landslide activity movement. However, we have judged larger scale translational slope failures (2000-20,000m^3) noted in the area indicate more defined (steeper and hummocky) feature set. The location of these features indicates they are within the boundary of previous very large features, however, have been influenced by particular hydraulic conditions (springs and drainage courses), which have results in more severe and more recent slope movements. The most notable is a cluster of large features observed between the existing residence and existing shearing shed. A notable feature was mapped existing close to the alignment of Hornes Road (that we have denoted as the Hornes Road Landslide) which is probably critical in terms of the Bushfire Shelter Development and a small area of the Hornes Road access.

There are several very large-scale landslide features in the local area. A very large and active landslide feature exists at Moonlight Head, Rosengren (1984) estimated this to be about 600m wide and extends about 500m inland that is "considered to be possibly the largest single landslip on the Victorian coast"[2]. Similar scale large to very large landslide features have been identified above Milanesia beach by Miner (2007) and the author during our investigation which were photographed and presented in Appendix D. Inferred prominent Landslide Polygons of Milanesia Beach are presented in Appendix E.

Milanesia Beach rock outcrops revealed exposed sandstone (inferred fossil earth-slide) with obvious shear zones. Invertebrate fossil burrows that are known to occur "under very shallow water or on the surfaces of emergent sand bars. A rare fossil theropod dinosaurs. footprint discovery at Milanesia Beach (Rich et al. 2010) further support previous saturated surface environment that infers very wet and poorly drained seasonal conditions that is hypothesised during the formation of Cretaceous soils. Concretions (rounded concentrated carbonates) were noted in the coastal cliff face and continued inland for at least 100m, where trace boulder to cobble size concretions were found amongst irregular bedded sandstone.

Several very recent and active large landslide features were noted in the cliff face and measured to be up to 50m wide x 40m high and at least 5000m^3. We estimate these have occurred with the last 6 months (refer Appendix D).

[1] Peter Dahlaus & Anthony Miner, A Geomorphic Approach to Estimating the Likelihood of Landslides in the South West Victoria, Australia

[2] Neville Rosengren, Sites of Geological and Geomorphological Significance in the Shire of Otway

4.4 Historical aerial photographs

A historic search of aerial photographs was conducted to assist in interpreting previous landslide near the site. Four (4) aerial photograph dates from 1945, 1977, 1983 and 2003 were selected and reviewed to assess site feature and the land use activities onsite and surrounding area. Two (2) additional sources were used, from Google Earth and Digital Elevation Model (DEM) using data from Foundation Spatial Data Framework and historic imagery (from 2003, 2008, 2014 and 2019). We conducted an appraisal of both the proposed development area as well as the coastal edge to ascertain landslide features and changes to these features that may suggest any landslide activity over this period. Copies of these aerial photographs are presented in Appendix E.

Key events relevant to the site are summarised in Table 1 below.

Table 1: Historical Aerial Photograph Summary

Year	Source	Information
1945	Aerial Photograph - Yuulong Landata	Poor quality image: black and white. Poor image stitching. Shows existing vegetation predominately in gullies. Ridgeline evident with an existing building (near location of proposed staff accommodation). Geomorphology difficult to determine. However, features evident, including local landslides east of development site (in gully area) and adjacent to future Hornes Roads alignment (denoted Hornes Roads Landslide)
1977	Aerial Photograph - Yuulong Landata	Good image quality: black and white. Significant vegetation removal. Existing dwelling and shed noted on site. Geomorphology of gullies (inferred landslide features) is clear. Significant erosion (and inferred slope movement) noted in gully south of the existing dwelling. Distinct featured toe and scarp, north of proposed Bushfire Shelter site and directly adjacent to Hornes Road access (denoted as a large volume (estimated 20,000m^2 Hornes Road Landslide). Inferred recent regression of this pre-existing feature. With toe of resultant debris flow can be seen impacting alignment of the lower drainage course to the east.
1983	Aerial Photograph - Yuulong Landata	Fair image quality: black and white. Vegetation increased in gullies. Additional building noted (near existing dam). No obvious change to landslide features.
1945	Aerial Photograph - Milanesia Beach Landata	Good quality image: black and white. Shows numerous large to very large landslide features extending approximately 500m from the existing vegetation predominately in gullies.
1983	Aerial Photograph - Milanesia Beach Landata	Fair image quality: black and white. Vegetation increased. No obvious change to landslide features.
2003	Aerial Photograph - Milanesia Beach Google Earth	Good image quality: colour. Significant increase in vegetation. No obvious change to landslide features.
2008	Aerial Photograph - Landata	Good image quality: colour. Significant increase in vegetation. No obvious change to landslide features.
2014	Aerial Photograph - Yuulong Google Earth	Google Earth: good image quality: colour. No significant change to large Hornes Road landslide features (compared to oldest 1945 and 1977 image)
2019	Aerial Photograph - Yuulong and Milanesia Beach Google Earth/DEM overlay	Google Earth: good image quality: colour. DEM: Excellent image quality, incomplete data set. Indicates clear geomorphology of landslide features. No significant change to very large landslide features (compared to oldest 1945 image)

5.0 GEOTECHNICAL STATEMENT REQUIRED BY EMO SCHEDULE 1
In accordance with Colac Otway Shire Planning Scheme, Erosion Management Overlay (EMO) 44l04 we provide the following information.

5.1 Practitioner details
The author of this report is Cameron Farrar, a professional geotechnical engineer with a Bachelor of Engineering and is registered member of the Institute of Engineers and Australian Geomechanics Society. The author has more than 20 years of experience in geotechnical engineering and management of slope instability issues and landslip risk management.

5.2 Currency
This report is based on field measurements made less than 12 months ago.

5.3 Site description
Refer to section 4.2.2.

5.4 Site assessment plans
Appendix A & B show slope and contour details of the development site area.

5.5 Sub-surface conditions
Borelogs, presented in Appendix C and section 4.2.3 describe the site's subsurface features.

5.6 Natural slope failure
Past failures and were identified on and near the site. Refer to section 4.3.

5.7 Site investigations
A site investigation was conducted to examine and sample the soil profile in order to assess the geotechnical/geological model. Details of the soil conditions revealed are included in this report (Appendix C) and are described in item 4.2.3 above.

5.8 Sub-surface investigation
Geological soil and rock samples were recovered from four test locations for examination by a professional geotechnical engineer.

5.9 Landslide risk
Subject to our recommendations, the risks for slope instability hazards identified are of a tolerable risk level and will remain so over the design life of the proposed development (as presented in development plans).

5.10 Development suitability
The subject lot is suitable for the proposed development and the proposed development can meet the tolerable risk criteria, as defined in the EMO schedule.

5.11 Special conditions and inspections
In our opinion and subject to our recommendations for engineer designed retaining walls, no other special geotechnical conditions are required for approval of the development and a program of periodic inspections is not required.

6.0 RISK ESTIMATION FOR PROPOSED DEVELOPMENT SITE

We have judged there are four significant and conceivable landslide events (modes of failure) that may affect the proposed development site and individuals on the site. Each site has unique failure modes and therefore we have developed individual risk analysis for each site. We have conducted detailed analysis for possible landslides associates with the relevant and most prominent landslide features or possible landslide event in several directions.

Explanation of likelihood of each possible event is described below, based on 'best estimates' using derived frequency in accordance with the AGS 2007 Guidelines Section 5.4.2 Estimation of Annual Probability (Frequency) ($P_{(H)}$) of Each Landslide.

We have determined annual probability of each event in context with our developed geotechnical model with consideration of the proximity to past failures (including landslide inventory), geomorphology, degree of weathering and borehole information performed on this and nearby sites.

In terms of landslide dimensions and volumes, the following estimations have been assumed, based on Roads and Maritime Services (2014) V4.0.

Landslide Size	Volume of Failure Range (m^3) (RMS V4.0*)	Typical dimension (L x W x D)	Individual Block Size (RMS V4.0*)
Very Large	20,000	50 x 100 x 10	Individual blocks >1.0m minimum dimension (e.g. one rock 1 x 1 x 2m)
Large	2,000 to 20,000	25 X 60 X 7	Individual blocks of 0.5-1.0m minimum dimension
Medium	200 to 2,000	10 X 25 X 4	Individual blocks of 0.2 to 0.5m minimum dimension
Small	20 to 200	5 x 10 x 2	Individual blocks of about 0.2m minimum dimension
Very Small	2 to 20	2 X 4 X 1.2	Individual blocks of 0.1 m minimum dimension
Extremely Small	<2	1 X 3 X 0.3	-

*(RMS V4.0): Roads and Maritime Services (2014) Guide to Slope Risk Analysis, Version 4, Roads and Maritime Services, North Sydney, NSW.

Conceivable landslide events (hazards) affected the proposed develops are:

1. **Gradual, down-slope creep of the upper shallow soil layers.** This is a common form of "landslide" throughout the Otway region which involves slow speed creep of the soil layers down the slope. As previously suggested creep incidence is usually noted well before any serious property damage occurs and is generally insignificant. Signs creep incidence are usually noted well before any serious damage or personal injury results and therefore the consequence to property or life is insignificant.

   During our inspection we observed evidence of bent/distorted trunks and terracettes as presented in Appendix D. Furthermore, the convex landform unit suggests creep may have occurred, and on this basis, we have judged creep (Hazard 1) is **'likely'** to occur on all subject development areas over the design life of the buildings.

   The upper 1.0-2.0m (approximately) of residual soil/extremely weathered rock, above the moderately to slightly weathered rock should be regarded as mobile and is likely to be subject to ongoing creep.

2. **Very small-small rotational or translational failure**
   We have observed several recent very to small failures near the site, ranging between 2-200m^3 in edges of steep drainage courses (inferred landslide features). Very small to small features were also evident on broader slopes, particularly at angles of about 14-15° or greater. This infers a critical angle at which similar failures may occur. On the basis of the high frequency of this scale of failure, similar scale (very small to small) failures are considered **'likely'**. However, we have judged that the location of these failures would generally be limited below about 14-15°.

3. **Medium size rotational or translational failures of the existing cut slopes on the site.**
   We have observed several instances of medium size rotational or translational slope failures (200-2,000m^3) and generally associated with regression of existing landslide features. Evidence of tension cracking near the edge of existing landslide features at about 5 metres from inferred landslide edges indicate that similar size failures are **'likely'** to develop (Hazard 3). Further this to, we have judged that the extent of regression would be limited due to the presence of higher strength rock (generally at about 3-4m deep). However, we have judged that the extent of regression could occur at shallow angles, estimated to be about 15°, based on similar features and hummocky landslide regions.

4. **Large rotational or translational failures of the slope.**
   Large to very large translational failures have been documented near the site (refer Figure 2 and Appendix A).

   However, it is postulated that the very large landslide features (>20,000m^3) have occurred during the last interglacial period, about 125,000 years ago (Williams et al.) and considered '**unlikely'.** Further to this, we have judged the only credible landslide of this size to affect the development would be reactivation of very large features below the proposed Dorm Development, given the dominant southern trend of similar features.

   We have judged that smaller scale features, including the cluster between the existing residence and shearing shed indicate more recent activity, given the strong geomorphology. We have judged these

features could be as recent as 20-200 years ago which would similarly place this scale of failure as **'likely'** in the vicinity of Hornes Road. However, importantly, we expect the extent of future regression (of similar scale) would be limited in direction and aperture, primarily due to the presence of higher strength rock noted in adjacent landslide exposure.

We expect the likelihood of similar size failures (near the Dorms area and Staff Accommodation) would be less likely given the gradual and shallow slopes noted. On this basis large failures in the vicinity if these regions are considered to be '**possible**', suggesting a reoccurrence interval of about 1000 years

6.1 Estimation of qualitative risk of damage to property

Based on our measurements and observations and using the procedure and terminology from the AGS Guidelines (2007), we have assessed the "level of risk to property" for the proposed development site as generally "**moderate**", with the exception of creep risk, which was determined to be **"high"**, without mitigation measures. For each of the events described, the risk to elements at risk can be summarised in corresponding tables, 2A Hornes Road access, 2B Dorms/Commons Area, 2C Staff Accommodation and 2D Bushfire Shelter.

Note that the proximity of the Hornes Road Landslide is critical to the Hornes Road Access however the inferred extent of damage is judged to be limited given the limited extent of regression expected.

a risk analysis for the proposed Bushfire Shelter was not performed and judged to be non-critical and **"low"** due to the very low slope angle and distance to inferred landslide features.

Table 2A. Hornes Road

Failure Mode (Element at Risk)	Likelihood of event occurring	Consequence of event occurring	Risk to Property
1. Slow speed soil creep (vehicles)	Almost Certain	Insignificant	Low-Moderate
2. Small translational failure below Hornes Rd (vehicles)	Likely	Insignificant	Low
3. Medium rotational failure below Hornes Rd (vehicles)	Likely	Minor	Moderate
4. Large rotational failure below Hornes Rd (vehicles)	Likely	Minor	Moderate

Table 2B. Dorms/Commons Area

Failure Mode (Element at Risk)	Likelihood of event occurring	Consequence of event occurring	Risk to Property
1. Slow speed soil creep (building)	Almost Certain	Minor	High
1.' Slow speed soil creep (building) with creep resistant footings embedded into slightly weathered rock	Almost Certain	Insignificant	Low-Moderate
2. Small rotational/translational failure below building envelope (building)	Likely	Insignificant	Low
3. Medium translational failure below building envelope (building)	Likely	Insignificant	Low
4A. Large translational failure below building envelope (building)	Possible	Insignificant	Very Low
4B. Very large translational failure below building envelope (building)	Unlikely	Major	Moderate

Table 2C. Staff Accommodation

Failure Mode (Element at Risk)	Likelihood of event occurring	Consequence of event occurring	Risk to Property
1. Slow speed soil creep (building)	Almost Certain	Insignificant	Low
2. Small rotational/translational failure below building envelope (building)	Likely	Insignificant	Low
3. Medium rotational/translational failure below building envelope (building)	Likely	Insignificant	Low
4.1. Large rotational/translational failure below building envelope (building)	Possible	Minor	Moderate
4.2. Large rotational/translational failure below building envelope (access road)	Possible	Medium	Moderate

Table 2D. Bushfire Shelter Structure

Failure Mode (Element at Risk)	Likelihood of event occurring	Consequence of event occurring	Risk to Property
1. Slow speed soil creep (Bushfire Shelter building)	Almost Certain	Minor	High
1.' Slow speed soil creep (Bushfire Shelter building) with creep resistant footings embedded into slightly weathered rock	Almost Certain	Insignificant	Low-Moderate
2. Small rotational/translational failure below building envelope, regression of Hornes Road Landslide, increased aperture with at least 20m^3 of movement (Bushfire Shelter building)	Likely	Insignificant	Low
3. Medium translational failure below building envelope, regression of Hornes Road Landslide, increased aperture with at least 200m^3 of movement (Bushfire Shelter building)	Likely	Insignificant	Low
4. Large translational failure below building envelope, regression of Hornes Road Landslide, increased aperture with at least 2,000m^3 of movement (Bushfire Shelter building)	Likely	Insignificant	Low

6.2 Estimation of quantitative risk of loss of life

AGS guidelines recommend that the "risk of loss of life" is calculated quantitatively to ensure that the value obtained does not exceed the value of "tolerable risk". Tolerable risk is defined as "the risk that society can live with" and has been denoted a value of 10^{-4} per annum (or a chance of 1 in 10,000) for an existing natural slope or 10^{-5} per annum (or a chance of 1 in 100,000) for an existing landslide area.

The qualitative risk of loss of life is calculated using the following formula:

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

Where R is the risk (the annual probability of loss of life)
$P_{(H)}$ is the annual probability of the hazardous event (the landslide)
$P_{(S:H)}$ is the probability of spatial impact by the hazard, given the event
$P_{(T:S)}$ is the temporal probability, given the spatial impact
$V_{(D:T)}$ is the vulnerability of the individual

For each of the conceivable events that may occur on this site as described above, the risk to life is calculated using the above-mentioned formula and summarised below in Table 3A, 3B, 3C and 3D.

Table 3A. Hornes Road

Failure Mode / Possible event	$P_{(H)}$	$P_{(S:H)}$	$P_{(T:S)}$	$V_{(D:T)}$	R
1. Slow speed soil creep (pedestrians)	10^{-1}	0.5	1.7×10^{-2}	0	0
2.1. Small rotational failure below Hornes Rd (individuals in vehicles)	10^{-2}	0.1	8.6×10^{-3}	0.05	4.3×10^{-7}
2.2 Small rotational failure above Hornes Rd, below the building envelope (pedestrians)	10^{-2}	0.1	1.7×10^{-2}	0.05	8.5×10^{-7}
3.1. Medium rotational failure below Hornes Rd (individuals in vehicles)	10^{-2}	0.1	1.7×10^{-3}	1.0	1.7×10^{-6}
3.2. Medium rotational failure below Hornes Rd (pedestrians)	10^{-2}	0.1	8.6×10^{-3}	1.0	8.5×10^{-6}
4.1. Medium rotational failure below Hornes Rd (individuals in vehicles)	10^{-2}	0.1	1.7×10^{-3}	1.0	1.7×10^{-6}
4.2. Medium rotational failure below Hornes Rd (pedestrians)	10^{-2}	0.1	8.6×10^{-3}	1.0	8.5×10^{-6}

Table 3B. Dorms/Commons Area

Failure Mode / Possible event	$P_{(H)}$	$P_{(S:H)}$	$P_{(T:S)}$	$V_{(D:T)}$	R
1. Slow speed soil creep (pedestrians)	10^{-1}	0.5	1.7×10^{-2}	0	0
2.1. Small rotational failure below building (individuals in residence)	10^{-2}	0.01	8.5×10^{-2}	0.05	4.3×10^{-7}
2.2 Small rotational failure below building (pedestrians)	10^{-2}	0.01	1.7×10^{-2}	1	1.7×10^{-6}
3.1. Medium translational failure below building (individuals in residence)	10^{-3}	0.01	8.5×10^{-2}	0.05	4.3×10^{-8}
3.2. Medium translational failure below building (pedestrians)	10^{-3}	0.01	1.7×10^{-2}	1.0	1.7×10^{-7}
4A.1. Large translational failure below building (individuals in residence)	10^{-3}	0.01	8.5×10^{-2}	0.05	4.3×10^{-8}
4A.2. Large translational failure below building (pedestrians)	10^{-3}	0.01	1.7×10^{-2}	1.0	1.7×10^{-7}
4B.1. Very large translational failure below building (individuals in residence)	10^{-4}	1	8.5×10^{-2}	1.0	8.6×10^{-6}
4B.2. Very large translational failure below building (pedestrians)	10^{-4}	1	1.7×10^{-2}	1.0	1.7×10^{-6}

Table 3C. Staff Accommodation

Failure Mode / Possible event	$P_{(H)}$	$P_{(S:H)}$	$P_{(T:S)}$	$V_{(D:T)}$	R
1. Slow speed soil creep (pedestrians)	10^{-1}	0.5	1.7×10^{-2}	0	0
2.1. Small rotational/translational failure below building (individuals in residence)	10^{-2}	0.01	8.5×10^{-2}	0.05	4.3×10^{-7}
2.2 Small rotational/translational failure below building (pedestrians)	10^{-2}	0.01	1.7×10^{-2}	1	1.7×10^{-6}
3.1. Medium rotational/translational failure below building (individuals in residence)	10^{-3}	0.01	8.5×10^{-2}	0.05	4.3×10^{-8}
3.2. Medium rotational/translational failure below building (pedestrians)	10^{-3}	0.01	1.7×10^{-2}	1.0	1.7×10^{-7}
4A.1. Large rotational/translational failure below building (individuals in residence)	10^{-3}	0.01	8.5×10^{-2}	0.05	4.3×10^{-8}
4A.2. Large rotational/translational failure below building (pedestrians)	10^{-3}	0.05	1.7×10^{-2}	1.0	1.7×10^{-7}

Table 3D. Bushfire Shelter Structure

Failure Mode / Possible event	$P_{(H)}$	$P_{(S:H)}$	$P_{(T:S)}$	$V_{(D:T)}$	R
1. Slow speed soil creep (pedestrians)	10^{-1}	0.01	4.10×10^{-3}	0	0
2.1. Small rotational failure below building (individuals in Bushfire Shelter)	10^{-2}	0.01	2.0×10^{-3}	0.05	1.0×10^{-8}
2.2 Small rotational failure below building (pedestrians)	10^{-2}	0.01	4.10×10^{-3}	1	4.1×10^{-7}
3.1. Medium translational failure below building (individuals in Bushfire Shelter)	10^{-2}	0.01	2.0×10^{-3}	0.1	2.9×10^{-8}
3.2. Medium translational failure below building (pedestrians)	10^{-2}	0.05	4.10×10^{-3}	1.0	2.1×10^{-6}
4A.1. Large translational failure below building (individuals in Bushfire Shelter)	10^{-2}	0.05	2.0×10^{-3}	0.1	1.0×10^{-7}
4A.2. Large rotational/translational failure below building (pedestrians)	10^{-2}	0.05	4.10×10^{-3}	1.0	2.1×10^{-6}

- A value of 0 has been adopted for soil creep events.
- A value of 0.05 has been adopted for small failure events affecting pedestrians and vehicles for roads.
- A value of 1.0 has been adopted for medium to large failure events affecting pedestrians and vehicles for roads.
- A value of 0.05 has been adopted for the small-scale failure events affecting buildings.
- A value of 0.10 has been adopted for the medium to large-scale failure events affecting the Bushfire Shelter.
- A value of 1.0 has been adopted for failure events affecting pedestrians near buildings.
- A value of 1.0 has generally been adopted for very large-scale event (possible total collapse / destruction of the building)

6.3 Explanation of qualitative risk to life calculations

The values presented in the above table are multiplied to achieve the estimated risk to life shown 'R' in the table. Note that these calculations refer to an individual inside the building, the risk to a person outside of the development area have not been considered.

$P_{(H)}$ and $P_{(S:H)}$ are derived from direct reading or estimation from Appendix C of the AGS 2007 Guidelines, a copy of this attached in Appendix I.

$P_{(T:S)}$ is calculated as follows:

annual occupancy of the residence: 10/12 months
daily occupancy of the residence: 20/24 hours
part of the building affected by the event: 1 (or 0.5 for half the building)
location of individual in the part of the residence: ¼

Where the whole building is affected by the event, the calculation for $P_{(T:S)}$ is:
$P_{(T:S)} = 10/12 \times 20/24 \times 1 \times 1/4 = 0.17$ or 1.7×10^{-1}

Where half of the building is affected by the event, the calculation for $P_{(T:S)}$ is:
$P_{(T:S)} = 10/12 \times 20/24 \times 1/2 \times 1/4 = 0.085$ or 8.5×10^{-2}

Where pedestrian is affected by the event, the calculation for $P_{(T:S)}$ is:
$P_{(T:S)} = 10/12 \times 1/24 \times 1 \times 1/2 = 1.7 \times 10^{-2}$

Where pedestrian on Hornes Road is affected by the event, the calculation for $P_{(T:S)}$ is:
$P_{(T:S)} = 10/12 \times 0.5/24 \times 1 \times 1/2 = 8.6 \times 10^{-3}$

Where vehicle on Hornes Road is affected by the event, the calculation for $P_{(T:S)}$ is:
$P_{(T:S)} = 10/12 \times 0.1/24 \times 1/2 \times 1 = 1.7 \times 10^{-3}$

Note that a reduced occupancy for the proposed Bushfire Shelter structure is assumed, due to infrequency of use, where:

annual occupancy of the residence during bushfire event: 3 days/365 days
daily occupancy of the residence: 24/24 hours
part of the building affected by the event: 0.5
location of individual in the part of the residence: 1/2

Where whole building is affected by the event, the calculation for $P_{(T:S)}$ is:
$P_{(T:S)} = 3/365 \times 24/24 \times 0.5 \times 1/2 = 2.0 \times 10^{-3}$

Where pedestrian is affected by the event, the calculation for $P_{(T:S)}$ is:
$P_{(T:S)} = 3/365 \times 24/24 \times 1 \times 1/2 = 4.1 \times 10^{-3}$

It is also fair to assume that required occupancy of the Bushfire Shelter would not normally be associated with a landslide event affecting multiple inhabitants, since that significant landslide event are usually associated with opposing climatic conditions i.e. very wet conditions as opposed to dry conditions usually required for bushfire events.

$V_{(D:T)}$ (the vulnerability of the individual) is derived from data collected from studies of landslide events in Hong Kong, for a person in a building. The relevant part of the study is reproduced below in Table 4:

Table 4, $V_{(D:T)}$ (the vulnerability of the individual)

Case	Range in Data	Recommended Value	Comments
If building collapses	0.9 - 1.0	1.0	Death is almost certain
If building is filled with debris and person buried	0.8 – 1.0	1.0	Death is highly likely
If debris strikes building only	0 – 0.1	0.05 (5×10^{-2})	Very high chance of survival

- A value of 0 has been adopted for soil creep events.
- A value of 0.05 has been adopted for the small--scale failure events.
- A value of 0.05 has been adopted for failure events affecting pedestrians and vehicles for roads.
- A value of 1.0 has been adopted for failure events affecting pedestrians for the accommodation buildings.
- A value of 1.0 has generally been adopted for very large-scale event (possible total collapse / destruction of the building)

6.4 Societal Risk

We have completed a preliminary assessment of Societal Risk due to the frequency of land users on the site. Societal Risk is discussed in Australian Geomechanics Society (AGS) Practice Note Guidelines for Landslide Risk Management 2007, where risk of multiple fatalities or injuries is conceivable. It states, "*Societal risk should be evaluated for buildings having high numbers of occupants, such as schools, hospitals, hotels or motels where many lives are at risk. This then addresses society's aversion to loss of many lives from single landslide events".*

Societal risk is directly related to the Importance Level of a building, that is presented below in Table 5.

Table 5, Importance level of structure

Importance Level of Structure	Explanation	Examples
1	Buildings or structures generally presenting a low risk to life and property (including other property).	• Farm buildings. • Isolated minor storage facilities. • Minor temporary facilities. Towers in rural situations.
2	Buildings and structures not covered by Importance Levels 1, 3 or 4.	• Low-rise residential construction. • Buildings and facilities below the limits set for Importance Level 3.
3	Buildings or structures that as a whole may contain people in crowds, or contents of high value to the community, or that pose hazards to people in crowds.	• Buildings and facilities where more than 300 people can congregate in one area. • Buildings and facilities with primary school, secondary school or day-care facilities with capacity greater than 250. • Buildings and facilities for colleges or adult education facilities with a capacity greater than 500. • Health care facilities with a capacity of 50 or more residents but no having surgery or emergency treatment facilities. • Jails and detention facilities. • Any occupancy with an occupant load greater than 5,000. • Power generating facilities, water treatment and waste-water treatment facilities, any other public utilities not included in Importance Level 4. • Buildings and facilities not included in Importance Level 4 containing hazardous materials capable of causing hazardous conditions that do not extend beyond property boundaries.
4	Buildings or structures that are essential to post-disaster recovery, or with significant post-disaster functions, or that contain hazardous materials.	• Buildings and facilities designated as essential facilities. • Buildings and facilities with special post-disaster functions. • Medical emergency or surgery facilities. • Emergency service facilities: fire, rescue, police station and emergency vehicle garages. • Utilities required as back-up for buildings and facilities of Importance Level 4. • Designated emergency shelters. • Designated emergency centres and ancillary facilities. • Buildings and facilities containing hazardous (toxic or explosive) materials in sufficient quantities capable of causing hazardous conditions that extend beyond property boundaries

Based on the above structure importance criteria and the intended occupancy (of no more than 40 persons), the proposed development structures are assessed as less than 3 (< 3) and therefore we have judged that a detailed societal risk calculation is not required.

7.0 SUMMARY OF RISKS AND CONCLUSION

Our assessment has identified possible risks of loss of life and damage to property on the site, due to conceivable landslide events. We have judged the qualitative risk of property damage is "moderate to high" in accordance with guidelines published by the Australian Geomechanics Society (AGS) journal Volume 42 No 1 of March 2007, entitled "Landslide Risk Management", subject to the following requirements.

We have judged the critical landslide events relate to soil creep. However, our analysis has demonstrated that whilst there are foreseeable risks associated with these hazards, the inherent low slope angle and distance to inferred landslide features is sufficient to maintain the risk below threshold for "tolerable" risk.

Subject to our recommendations and mitigation measures, including appropriately constructed footings, retaining buildings and effluent systems, the risk to life can be potentially reduced below the recommended "tolerable risk" limit defined as 1 x 10^{-5} (landslide areas) by the AGS Guidelines.

In summary, to reduce risk to a tolerable level, that is (1 x 10^{-5} (landslide areas) defined by the AGS Guidelines) we recommend the following:

- **Footings must be extended into (highly-moderately weathered) rock, at an estimated depth of about 4-4.5m to reduce the consequence to soil creep (for structures in Dorms area and Bushfire Shelter structure only). Staff accommodation structures may be founded on shallow footings, founded into naturally occurring stiff clay, estimated to be about 600-800mm.**

- **New excavations be kept to a minimum where possible and not exceed 1m in height. Proposed cuts or fills must be supported with engineer designed retaining buildings and extended into higher strength rock.**

- **An appropriate founding depth for all footings should be verified by a qualified geotechnical engineer at time of construction.**

- **Construction of an appropriate engineer designed drainage system is required, so that water cannot pond or be directly near the edge of buildings.**

- **A suitable effluent management system is required, preferred to be an evapotranspiration system, refer St. Quentin Report 16006G-LCA.**

The above requirements are essential in reducing landslide risk below 'tolerable' levels.

Appropriate construction of buildings/retaining buildings and drainage management are key factors in reducing landslide risk. The importance of these issues cannot be understated to maintain a tolerable risk for the life of the buildings (judged to be 50 years).

8.0 RECOMMENDATIONS and RISK MANAGEMENT PLAN

It is not feasible to remove all the risks of building on the site, but the risks can be reduced by appropriate engineering design, good hillside construction practices and by regular and frequent site maintenance.

We recommend all future servicing and infrastructure be carefully considered in context with active landslide features. We recommend further geotechnical advice be sort regarding functional design.

Additional advice on risk reduction is included in "General Recommendations" Section of our report and in the attached Appendices and Report Addendum. We recommend attention be paid to the attached AGS "Geoguides" that are presented in Appendix H.

Note that our assessment is limited to the proposed development areas and access between these areas. It is understood that pedestrian access to 'steep' landslide features would not be permitted, which would fall under school duty of care provisions. There are also foreseeable landslide risks associated with landslide events on undeveloped areas and the immediate beach and adjacent private/public land, however these areas are beyond the scope of our report. We recommend consulting relevant authorities with respect to public (societal) risk in public zones, particularly near steep and active landslide features near the coastal edge.

8.1 Site recommendations

The construction of an appropriately designed development may be possible, subject to our recommendations. The proposed development is considered appropriate for the site, provided drainage is improved and excavations are supported by and stabilised in accordance with AGS guidelines, see Appendix H Geoguide LR4.

Note that an increase in landslide risk can be expected if an inappropriate development is undertaken or if site maintenance is neglected. Maintaining the site drainage and monitoring the site and buildings for any evidence of soil or slope movement are very important aspects of the ongoing site maintenance requirements.

8.2 Drainage management

We recommend a qualified engineer be engaged to design stormwater detention system for this site. The engineer should be mindful not to design deep trenches or pipes near the clay rock interface that can potentially increase land risk potential due to subsurface waters. Careful attention to drainage is essential to reduce the landslide risk and surface water must therefore be prevented from ponding anywhere on or near the site.

Care must also be taken to ensure that all levelled areas (vehicle parking bays, recreation areas etc.) have a slight fall (≥2°) to prevent surface water from ponding or seeping into the ground and diverted away from the buildings.

Past research has identified rainfall and/or poor site drainage as a common trigger of landslide events (et al. Wood 1982, Cooney 1980). This is of importance given the recent bushfire activity and subsequent extremely wet season we have recently experienced. Whilst rainfall intensity cannot be controlled, careful site drainage management and design can reduce saturation of the soil layers associated with soil movement.

8.3 Effluent disposal

Effluent must be widely dispersed by an enclosed evapotranspiration system or alternatively terraced evapotranspiration beds, positioned laterally and supported with engineer designed retaining walls. Refer to separate land capability assessment report (ref: **16006G-LCA**).

8.4 Site vegetation

Suitable vegetation significantly improves the stability of a site by reducing the soil moisture content, minimising soil erosion and binding the soil building together. Large trees should be retained wherever possible. Where large tree removal is necessary to accommodate the proposed building, they should be cut off at ground level with the root buildings left intact.

8.5 Site excavations and fill batters

All site excavations and unsupported filled zones deeper than 1.0m must be retained by engineer-designed retaining walls, founded into naturally occurring rock with appropriate drainage features or be constructed with a flat batter angle ~ 30°.

When cut vertically, exposed faces will require protection via engineer designed retaining systems. Alternatively, soil nails / shotcrete may be considered.

The following soil parameters presented in Table 6 may be assumed in the design process.

Table 6. Retaining wall parameters

Soil parameter	Approx. value for clay*	Approx. value for extremely weathered rock *	Approx. value for highly weathered rock*	Approx. value for moderately weathered rock#
Wet density (γ)	1.70 t/m^3	2.00 t/m^3	2.10 t/m^3	2.40 t/m^3
Drained cohesion (c')	3kPa	5kPa	10kPa	100kPa
Angle of internal friction (φ')	15°	20°	30°	35°

*NOTE: estimated and derived from conservative yet 'typical' values from our previous experience and published information by others.

We highly recommend a suitably qualified geotechnical engineer verify the subsurface profile, during construction sequence.

We cannot over emphasise the need for extreme caution when conducting deep excavations or construction near unsupported fill batters in these soils due to the landslide risk and sensitivity of the area.

The construction of appropriately designed walls or battered slopes will reduce the risk of soil movement and the collapse of any proposed site excavations. Cut areas must have a slight fall (≥2°) away from cut interface to prevent surface water from ponding or seeping into the near the base of any site cut.

8.6 Site classification

Australian Standard AS2870-2011 provides a site classification for residential footing designs as presented in Table 7:

Table 7. Site Classification (AS2870-2011)

Site Classification	Foundation Type
A	**Most sand and rock sites with negligible ground movement from moisture change**
S	**Slightly reactive clay sites subject to slight ground movement from moisture change**
M	**Moderately reactive clay sites subject to moderate ground movement from moisture change**
H1/H2	**Highly reactive**
E	**Extremely reactive**
P	**Sites with environmental factors that may affect the performance of the building including trees, deep fill, recently removed building, abnormal moisture conditions, soft soils, landslide risk or erosion.**

NOTE 1: AS2870-2011 recommends a site inspection during excavation to confirm the soil profile.
NOTE 2: The above classification is made assuming that the site will not change significantly before construction of the proposed building. Site cuts greater than 500mm or the placement of addition uncontrolled fill is considered a significant change and the site may need to be re-classified.

We estimate the characteristic surface movement to range between 20-40mm, for climate category 1, where depth of suction change (Hs) is 1.5m

We have judged the site classification varies across the site, pertaining to relevant site conditions and constraints, however the following specific classification may be assumed for the proposed structures;

Staff Area
We have classified the soil profile as "M" in accordance with Section 2 of AS2870-2011 (Australian Standard on Residential Slabs and Footings).

Dorms Area
We have classified the soil profile as "P" in accordance with Section 2 of AS2870-2011 (Australian Standard on Residential Slabs and Footings), due to the landslide risk (clause 2.1.3 (d)).

Bushfire Shelter Area
We have classified the soil profile as "P" in accordance with Section 2 of AS2870-2011 (Australian Standard on Residential Slabs and Footings), due to the landslide risk (clause 2.1.3 (d)) and existing/proposed removal of trees (clause 2.1.3 (e)).

We recommend that an experienced engineer be commissioned to design footings, drainage systems and any retaining buildings for the proposed residence.

8.7 Pad footings
The following founding depth is judged to be appropriate for the corresponding development areas;

Staff Area
The use of engineer designed pad footings for a Class M classification is considered appropriate. The footing should be detailed as specified in Section 3 and constructed in accordance with Section 4, 5 & 6 of AS2870-2011. We recommend footing be founded a minimum of 100mm into naturally occurring clay. Table 3 details a suitable founding depth for pad and strip footings revealed during our investigation was found as follows:

Table 8: Minimum founding depths for raft slab footing systems

Borehole	Minimum Founding Depth	Founding Stratum	Minimum Allowable Bearing Capacity
	Strip/Pad		
5	600 mm	Stiff Silty Clay	100 kPa
6	800 mm	Stiff Silty Clay	100 kPa
7	600 mm	Stiff Silty Clay	100 kPa

NOTE: The above quoted depths were determined from surface level at the time of testing and may vary across the site or if the site is cut and/or filled. We recommend the footings penetrate the recommended "Founding Stratum" by at least 200mm.

Dorms Area & Bushfire Shelter Area
Our testing indicates that "'weathered rock" generally starts about 2.0m below surface however due to the variable rock strength and landslide risk, we recommend footings extent into highly to slightly weathered rock, at a depth of about 4-4.5m below the existing surface level. An allowable bearing capacity of at least 400kPa may be assumed for higher strength rock at about 4m below the existing surface level.

The above quoted depth to high strength rock is estimated from limited data and the depth to rock quality can vary significantly over short distances and, on this basis, we recommended an inspection by a suitability qualified geotechnical engineer at time of excavation to verify founding depth.

We recommend engineer-designed footings designed according to the principles of AS 2870-2011 Section 4 and constructed in accordance with Sections 5 & 6, capability of resisting mass soil movements.

Having all footings appropriately designed and founded will reduce the risk of damage due to soil movement or slope failures.

8.8 General recommendations

The satisfactory performance of buildings on this site depends on good engineering and building practice. This includes:

a) Design of an appropriate development for the site;

b) Use of flexible construction materials whenever possible which are “movement tolerant” (e.g. clad frame is preferable to brick and articulated brick or stone walls are preferable to non-articulated);

c) Minimisation of site excavations wherever possible and the provision of adequate retaining buildings and drainage for cut faces (or batter at an appropriate angle);

d) A re-vegetation program including planting suitable trees and shrubs (preferably indigenous) at an appropriate distance from the buildings to help support the soil and minimise erosion;

e) Appropriate site drainage to ensure surface water, excess roof water and building effluent does not pond or seep into the ground near building envelope;

f) Diversion on uncontained water around the building envelope area and be widely dispersed laterally well below the building site;

g) regular maintenance by the owner, including clearing of surface drains, sub-surface drains, repair of leaking plumbing, monitoring the site and buildings for any evidence of soil or slope movement and seeking immediate advice should any building distress become apparent.

Refer also to the attached Appendices for more general advice.

ST QUENTIN CONSULTING

Cameron Farrar
Geotechnical Engineer, MIE Aust (Reg No 4367740)

References

Australian Geomechanics Society, (2000) Landslide Risk Management Concepts and Guidelines, in Australian Geomechanics Vol 35, No 1, pages 49-92

Australian Geomechanics Society, (2007) Landslide Risk Management, in Australian Geomechanics Vol 42, No 1

Berkman, D.A., (Ed) (1989) Field Geologists Manual. Monograph Series No. 9, Australasian Institute of Mining and Metallurgy.

Cooney, A.M., (1980) Otway Range Landslide Susceptibility Study, first Progress Report. Victorian Department of Minerals and Energy, Unpublished Report No. 1980/76

Dahlhaus Environmental Geology Pty Ltd and AS Miner Geotechnical Pty Ltd, (2002) Coastal Community Revitalisation Project for Colac Otway Shire.

Dahlhaus Environmental Geology Pty Ltd and Yttrup P.J. and Associates Pty Ltd, (2001) Landslide Risk Management Final Report for Colac Otway Shire.

Douglas, J.G. and Ferguson, J.A., (1988) Geology of Victoria. Geological Society of Australia.

Fell, Robin. Landslides in Australia (1992), 6th International Conference on Landslides February 1992

Martin**,** Anthony J. A close look at Victoria's first known dinosaur tracks. Memoirs of Museum Victoria 74: 63–71 (2016) Published 2016

Miner, A.S., Geotechnical in association with The Department of Primary Industries, Landslide Mapping and Susceptibility Project, Report No: 477/02/10, 7th April 2010

Miner, A.S.& Dahlhaus, P A Geomorphic Approach to Estimating the Likelihood of Landslides in the South West Victoria, Australia, Unpublished Paper 2002

Rosengren, Neville, Sites of Geological and Geomorphological Significance in the Shire of Otway, 1984

State of Victoria, Aerial Photograph, VIC_1945, Aerial Photograph, VIC_1970, Aerial Photograph, VIC_1986

Google Earth Image 2008, accessed December 2018

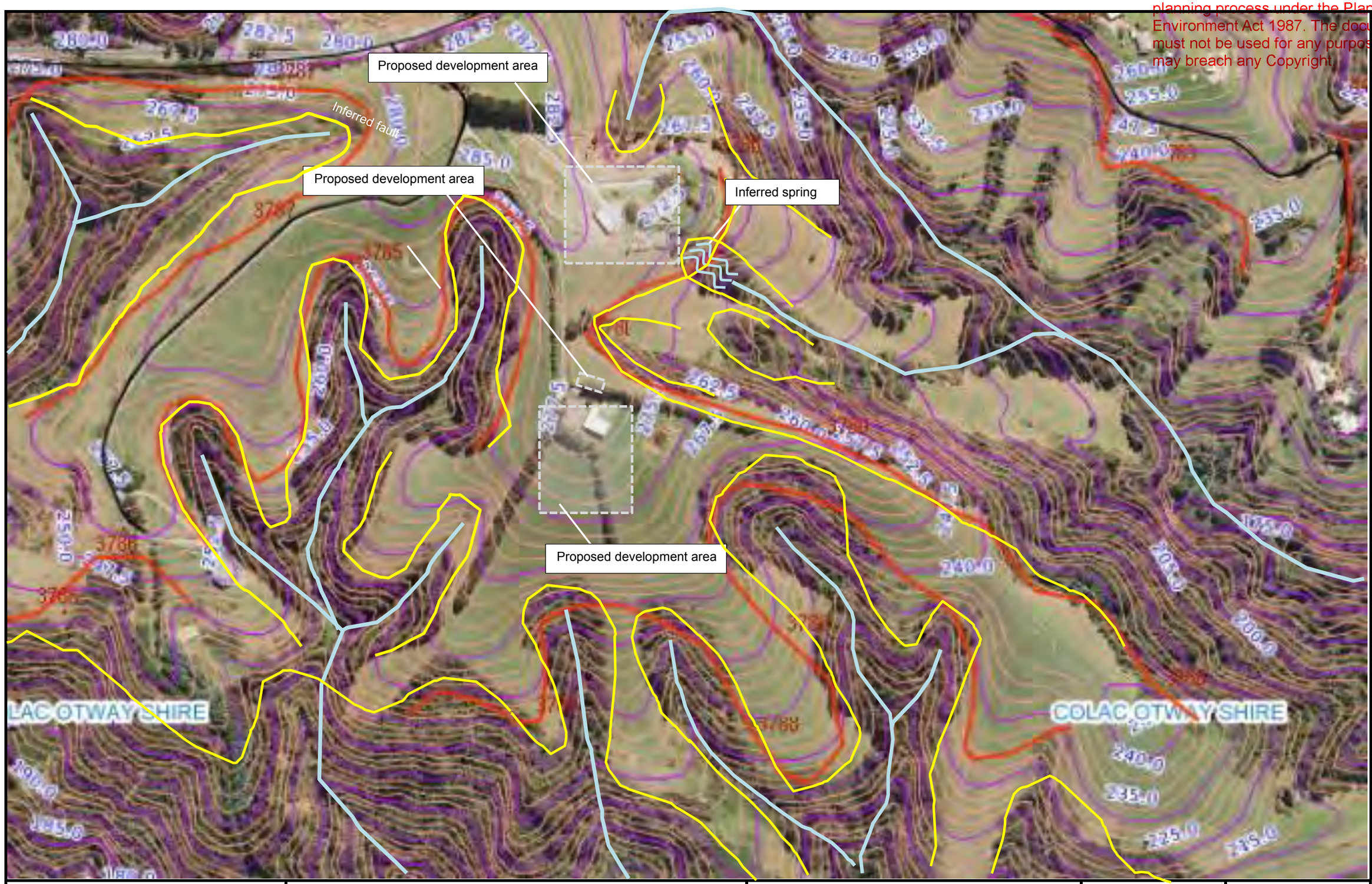
Nearmap Image November 2018, accessed December 2018

Varnes, D.J., (1978) Slope movement types and processes, in Landslides Analysis and Control Schuster and Krizek eds., Transportation Research Board Report 176.

Wood, P.D. (1982) Wild Dog Creek, Parish of Krambruk, Landslide Study. Geological Survey of Victoria, Unpublished Report No. 1982/85.

Appendix A

Geomorphological site plans



ST. QUENTIN
Surveyors · Town Planners · Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

Regional geomorphological plan with landslide inventory overlay (University of Ballarat):

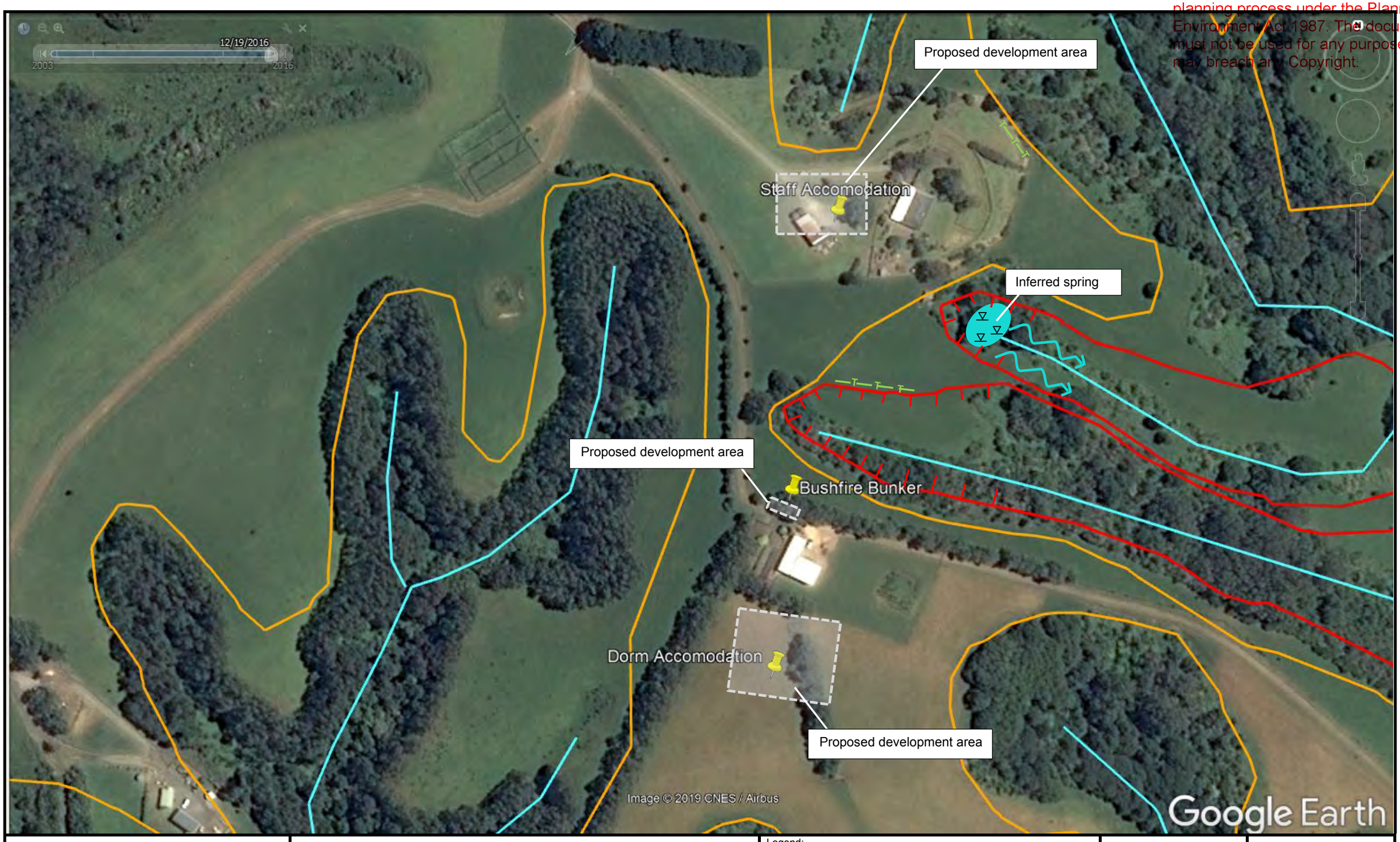
31-33 Great Ocean Road Yuulong

Legend:

Development area	Inferred landslide feature (Roberts)
Drainage course	Inferred landslide feature (Author)

Project Ref:16006G

N
mga zone 55



ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

Detailed geomorphological plan with landslide inventory overlay

31-33 Great Ocean Road Yuulong

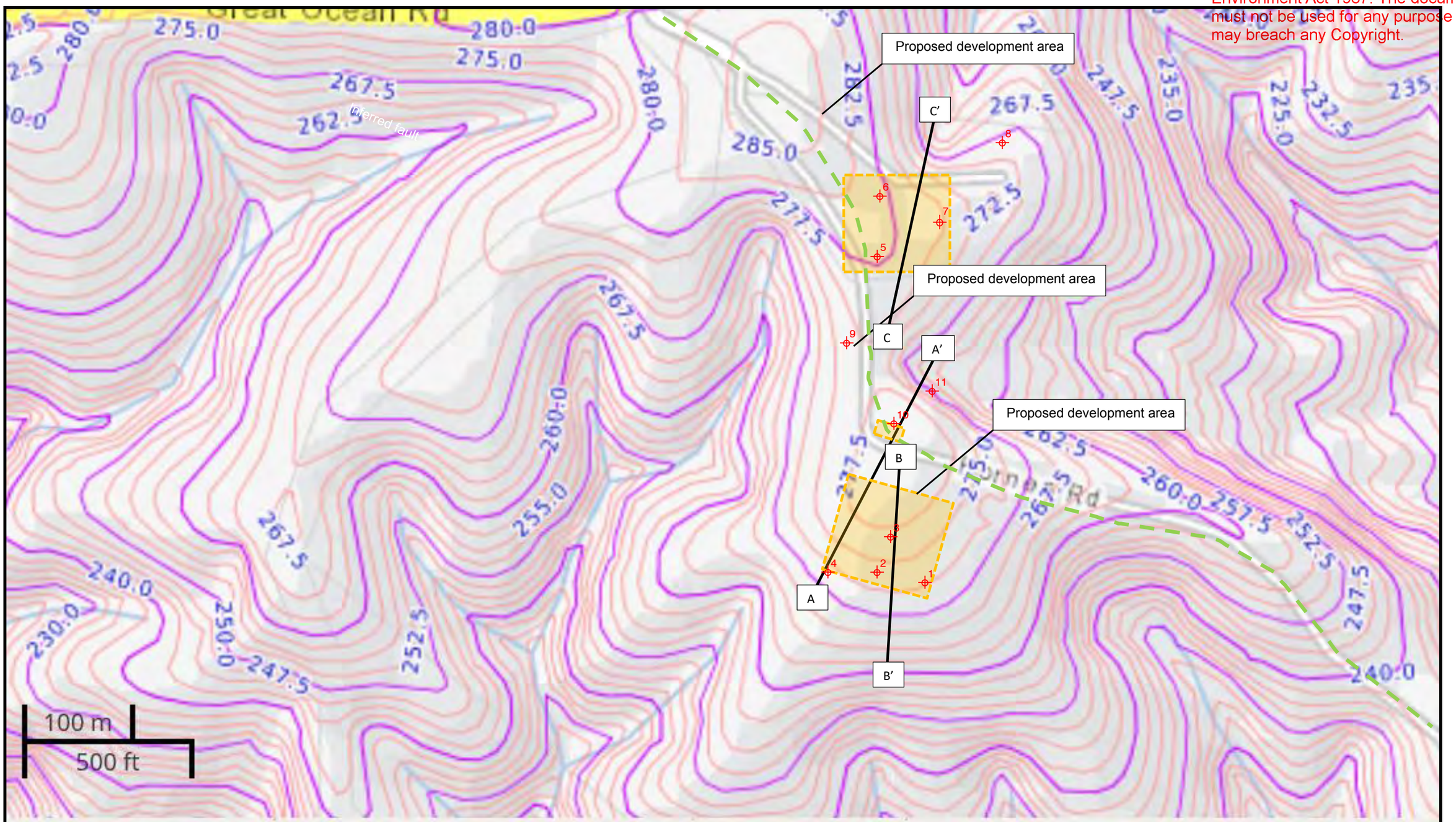
Legend:

	Recent landslide feature		Scarp
	Ancient landslide feature		Gully/Water course
	Tension crack		Standing Water

Project Ref:16006G

N

mga zone 55



ST. QUENTIN
Surveyors ·Town Planners ·Engineers
51 LITTLE FYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5201 1811 FAX (03) 5229 2909

Site geomorphological plan and geological model section references:

31-33 Great Ocean Road Yuulong

Legend:

Test site	Ridgeline
Study area	Water/drainage course

Project Ref:16006G

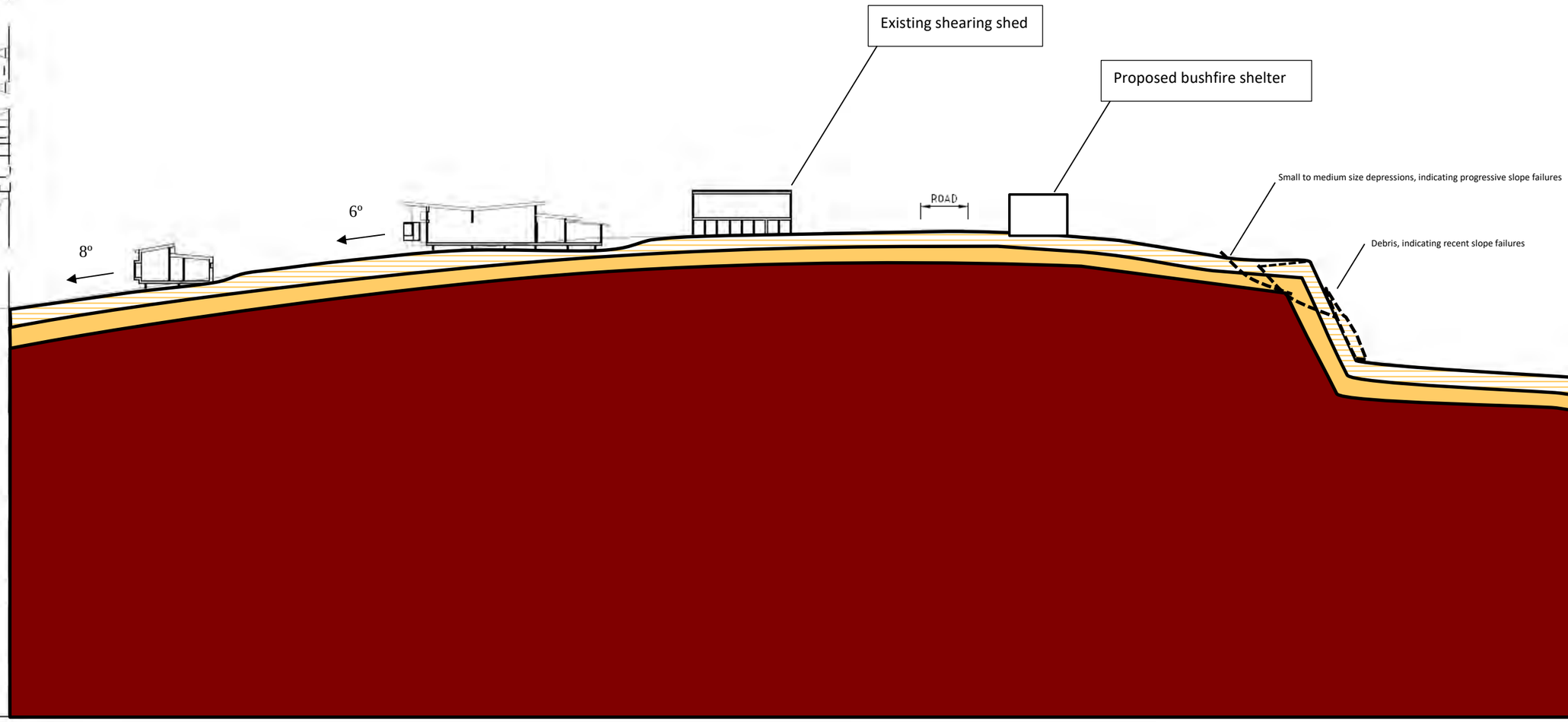
N

mga zone 55

Appendix B

Geological model, hazard modes

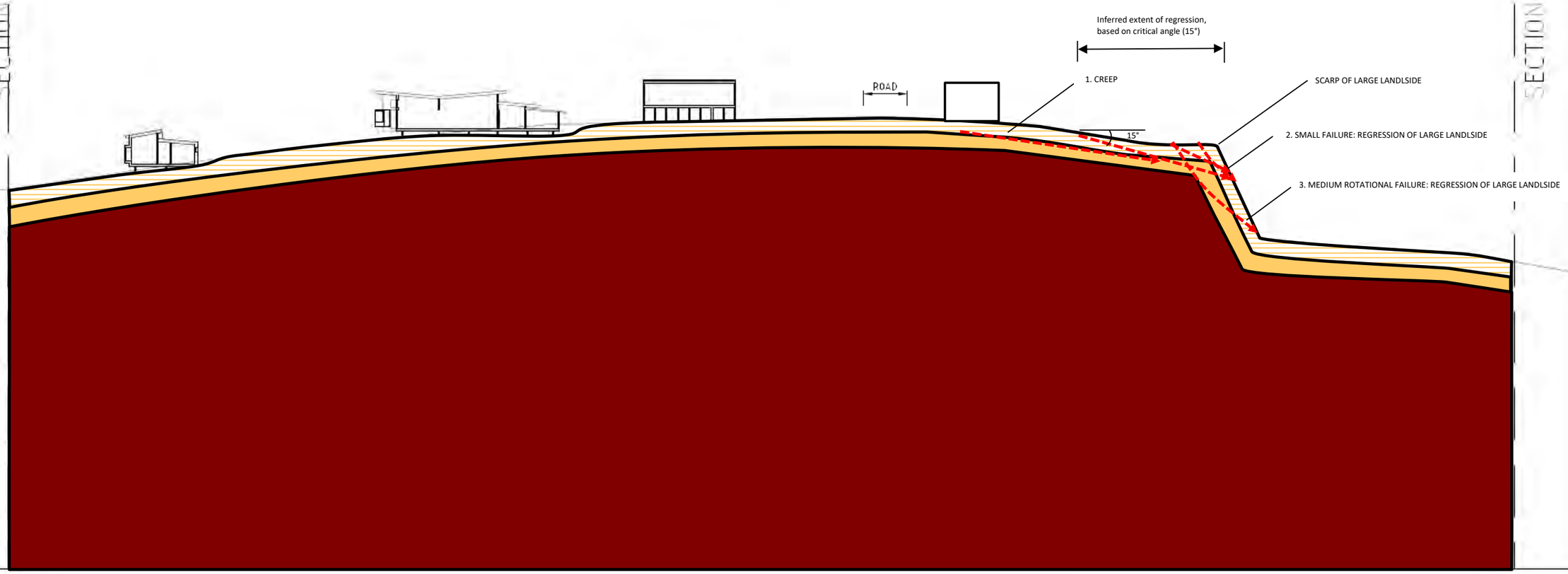
SECTION A-A



SECTION A-A

PROJECT NO: 15858G DATE: 19.06.19	5835 GREAT OCEAN ROAD YUULONG	ST. QUENTIN 51 LITTLE RYANS STREET, P.O. BOX 919, GEELONG 3220 TELEPHONE (03) 5221 7411 FAX (03) 5229 0909	Colluvium Residual Soil Inferred bedding angle	Extremely weathered rock Highly weathered rock Moderately weathered rock	SCALE 1:500
DRAWN BY: A.V APPROVED BY: C.F	CROSS SECTION A-A & GEOTECHNICAL MODEL				

SECTION A-A



SECTION A-A

PROJECT NO:	15858G
DATE:	19.06.19
DRAWN BY:	A.V
APPROVED BY:	C.F

5835 GREAT OCEAN ROAD
YUULONG

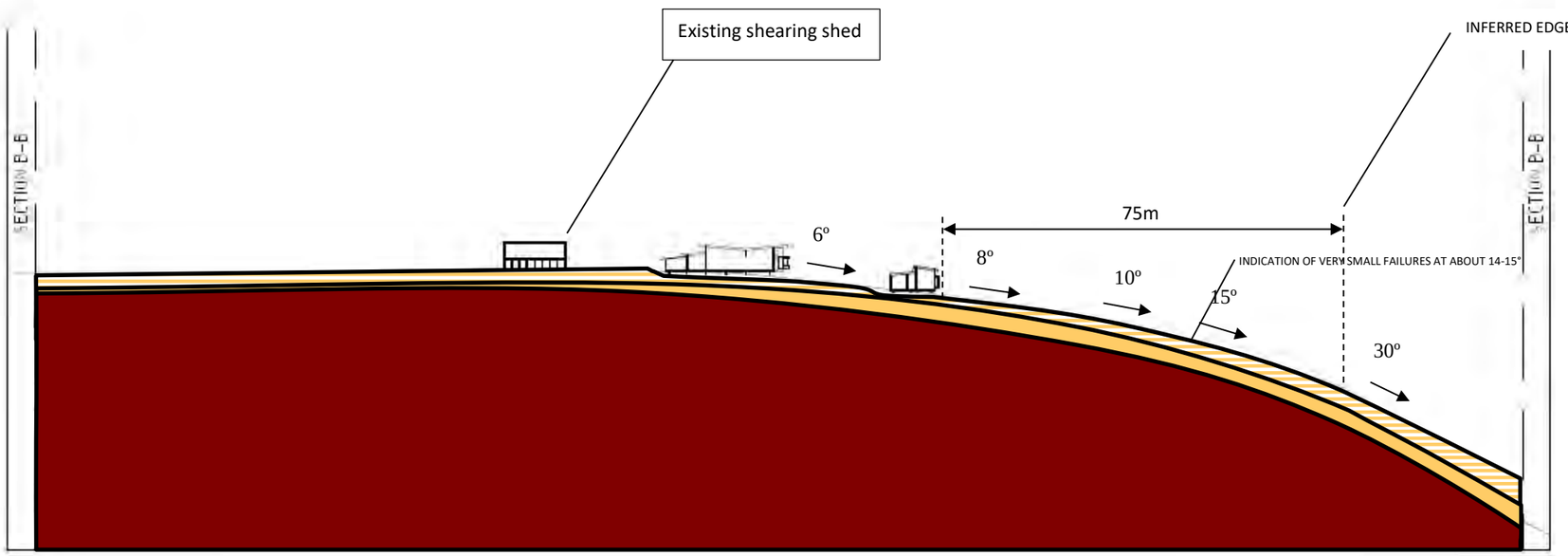
SECTION A-A'
FAILURE MODES

ST. QUENTIN
51 LITTLE RYANS STREET,
P.O. BOX 919, GEELONG 3220
TELEPHONE (03) 5221 7411 FAX (03) 5229 0909

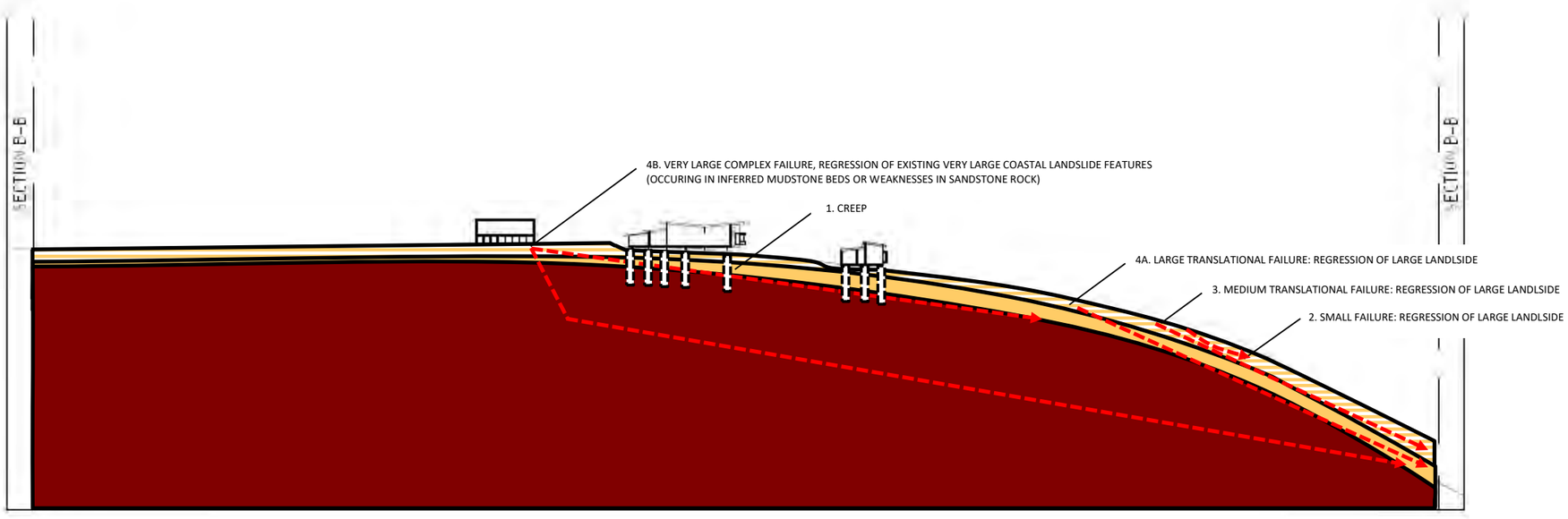
- Colluvium
- Residual Soil
- Inferred bedding angle
- Extremely weathered rock
- Highly weathered rock
- Moderately weathered rock

SCALE 1:500

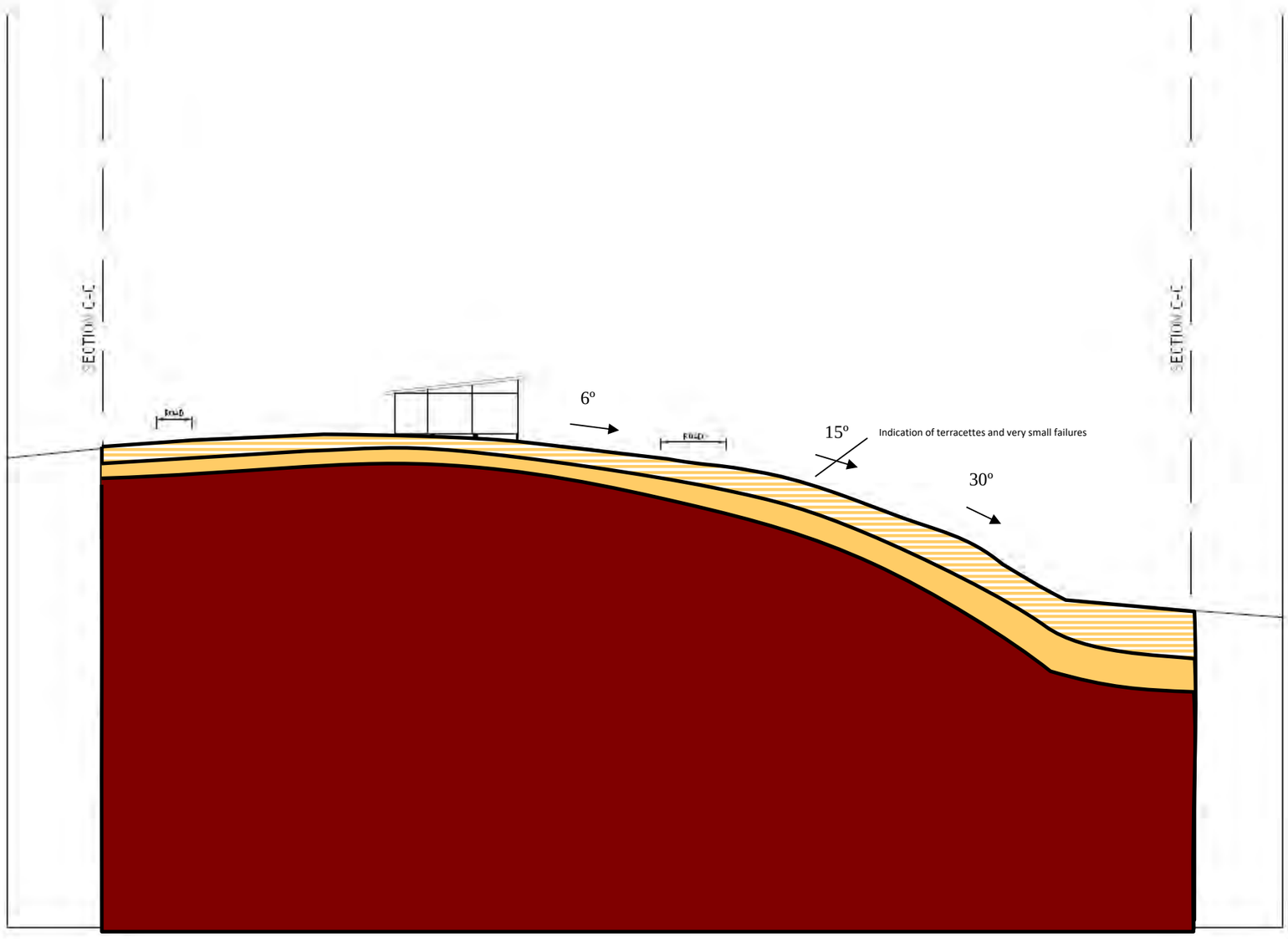
0 5 5 5 5m



PROJECT NO: 15858G DATE: 19.06.19	5835 GREAT OCEAN ROAD YUULONG	ST. QUENTIN 51 LITTLE FYANS STREET, P.O. BOX 919, GEELONG 3220 TELEPHONE (03) 5201 1011 FAX (03) 5229 2909	Colluvium Residual Soil Inferred bedding angle Extremely weathered rock Highly weathered rock Moderately weathered rock
DRAWN BY: A.V APPROVED BY: C.F	SECTION B-B' FAILURE MODES		SCALE 1:1000



PROJECT NO: 15858G DATE: 19.06.19	5835 GREAT OCEAN ROAD YUULONG	ST. QUENTIN 51 LITTLE FYANS STREET, P.O. BOX 918, GEELONG 3220 TELEPHONE (03) 5201 1011 FAX (03) 5229 0909	Colluvium Residual Soil Inferred bedding angle	Extremely weathered rock Highly weathered rock Moderately weathered rock	SCALE 1:1000
DRAWN BY: A.V APPROVED BY: C.F	SECTION B-B' FAILURE MODES				



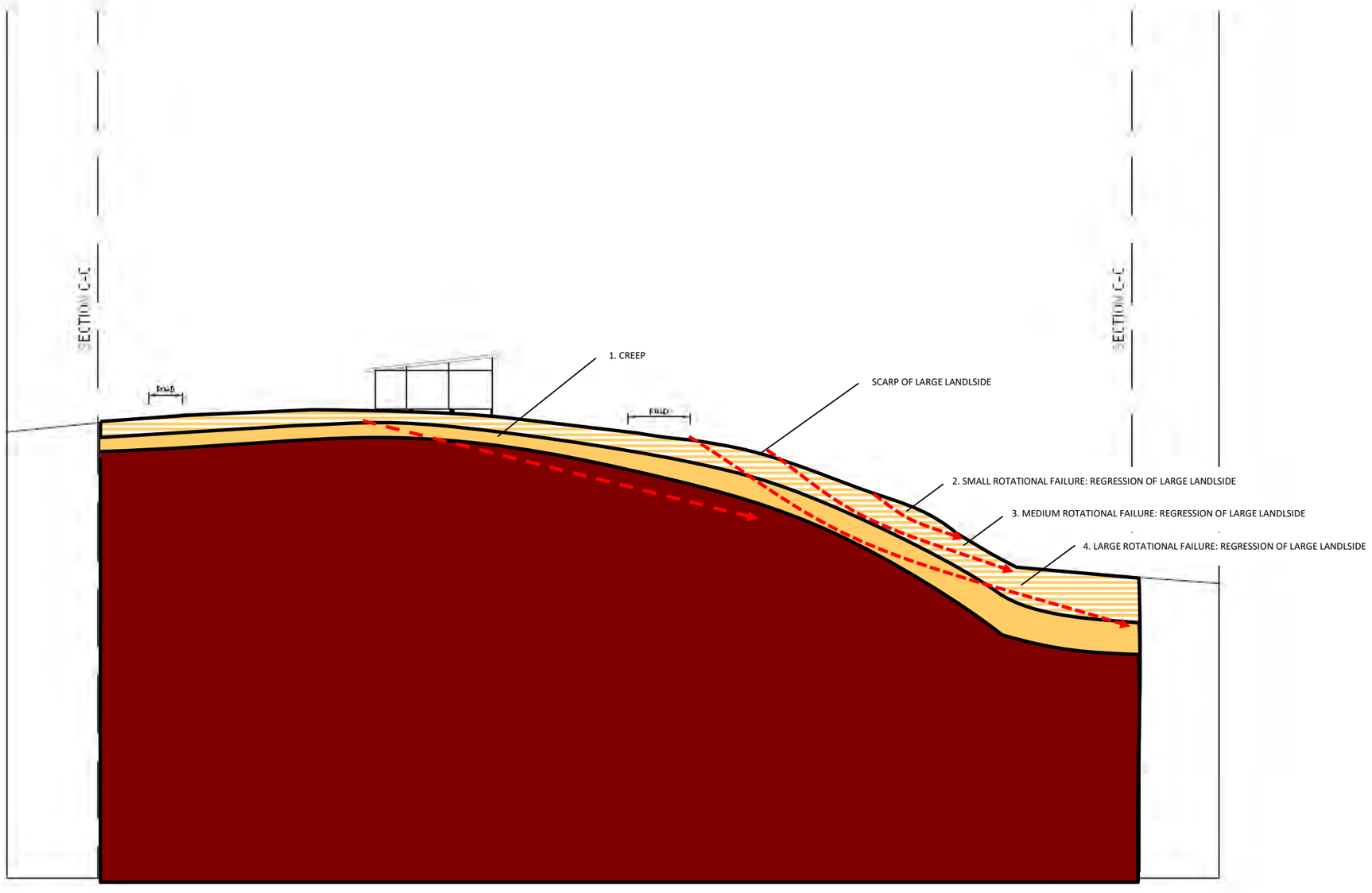
PROJECT NO: 15858G	5835 GREAT OCEAN ROAD YUULONG
DATE: 19.06.19	
DRAWN BY: A.V	CROSS SECTION B-B & GEOTECHNICAL MODEL
APPROVED BY: C.F	

ST. QUENTIN
Surveyors · Town Planners · Engineers
51 LITTLE FYANS STREET,
P.O. BOX 916, GEELONG 3220
TELEPHONE (03) 5201 1811 · FAX (03) 5229 0909

- Colluvium
- Residual Soil
- Inferred bedding angle
- Extremely weathered rock
- Highly weathered rock
- Moderately weathered rock

SCALE 1:500

0 2.5 5 7.5 10 12.5m



PROJECT NO:	15858G
DATE:	19.06.19
DRAWN BY:	A.V
APPROVED BY:	C.F

5835 GREAT OCEAN ROAD
YUULONG

SECTION C-C'
FAILURE MODES

ST. QUENTIN
Surveyors · Town Planners · Engineers
51 LITTLE FYANS STREET,
P.O. BOX 916, GEELONG 3220
TELEPHONE (03) 5201 1811 · FAX (03) 5229 0909

- Colluvium
- Residual Soil
- Inferred bedding angle
- Extremely weathered rock
- Highly weathered rock
- Moderately weathered rock

SCALE 1:500

0 .5 5 .5 0 .5m

Appendix C

Borelogs

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 1
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3	0.50	Silty Clay / Clayey SILT (Clay Loam) Grey Moderately structured Firm, slightly moist	CL	Mo	F	SM			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6 0.9 1.2 1.5	1.50	Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.8	2.00	Silty CLAY/ XW Rock (Clay Loam) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
2.1 2.4 2.7 3.0	3.00	HW Rock (Siltstone/Sandstone) Brown to yellow Strongly structured Moderate to high strength, Hard, slightly moist	LC	Str	H	SM			
3.3		Borehole 1 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 2
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.5	0.60	Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.9	1.20	Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.4 1.8 2.3 2.7 3.2 3.6	4.00	Silty CLAY/ XW Rock (Mudstone) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
4.1 4.5	4.50	HW Rock (Siltstone) Brown to yellow Strongly structured Moderate to high strength, Hard, slightly moist	LC	Str	H	SM			
5		Borehole 2 terminated at 4.5m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 3
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3		Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6	0.60								
0.9		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.2									
1.5									
1.8									
2.1									
2.4	2.50								
2.7		Silty CLAY/ XW Rock (Mudstone) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
3.0	3.00								
3.3		Borehole 3 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 4
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3		Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6	0.60								
0.9		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.2	1.20								
1.5		Silty CLAY/ XW Rock (Mudstone) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
1.8									
2.1									
2.4									
2.7									
3.0	3.00								
3.3		Borehole 4 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 5
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3		Clayey Sand FILL, with rock (Loam) Dark grey Weakly structured Medium dense, moist	CL	Mo	MD	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.40									
0.6		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
0.9									
1.2									
1.5									
1.8									
2.1									
2.4									
2.7									
3.0									
3.00		Borehole 5 terminated at 3m							
3.3									

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road
Yuulong, Victoria

Project No.: 16006G-LCA
Borehole No: BH 6
Inv. Date: 21/05/2019

Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3		Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6	0.60								
0.9		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.2									
1.5									
1.8									
2.1									
2.4									
2.7									
3.0	3.00								
3.3		Borehole 6 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 7
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3	0.40	Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6 0.9 1.2	1.20	Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.5 1.8 2.1 2.4 2.7 3.0	3.00	Silty CLAY/ XW Rock (Mudstone) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
3.3		Borehole 7 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 8
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.3	0.20	Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.6		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
0.9	1.00								
1.2		Silty CLAY/ XW Rock (Mudstone) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
1.5									
1.8									
2.1									
2.4									
2.7									
3.0	3.00								
3.3		Borehole 8 terminated at 3m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 9
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description (Type, Plasticity, Colour, Particle characteristics)	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.5		Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.60									
0.9		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.20									
1.4		Silty CLAY/ XW Rock (Mudstone) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
1.70									
1.8		Borehole 9 terminated at 1.7m							
2.3									
2.7									
3.2									
3.6									
4.1									
4.5									
5									

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road
Yuulong, Victoria

Project No.: 16006G-LCA
Borehole No: BH 10
Inv. Date: 21/05/2019

Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0		Silty Clay / Clayey SILT (Clay Loam) Dark grey Moderately structured Soft, moist	CL	Mo	S	M			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.40		Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
0.5									
0.9									
1.00		XW Rock (Mudstone) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
1.4									
1.50		Borehole 10 terminated at 1.5m							
1.8									
2.3									
2.7									
3.2									
3.6									
4.1									
4.5									
5									

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

Method:

- [x] Hand Auger
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

BOREHOLE LOG

ST QUENTIN
Surveyors • Town Planners • Engineers

Client: Ballarat & Clarendon College
Location: 5835 Great Ocean Road, Yuulong, Victoria
Project No.: 16006G-LCA
Borehole No: BH 11
Inv. Date: 21/05/2019
Sheet: 1 of 1
Logged by: S.L.
Checked by: C.F.

Depth (metres)	Graphic Log	Material Description Type, Plasticity, Colour, Particle characteristics	Soil Texture	Structure	Consistency / Density	Moisture	Sample / Test	Test Results	Geology and additional observations
0.4	0.50	Silty Clay / Clayey SILT (Clay Loam) Grey Moderately structured Firm, slightly moist	CL	Mo	F	SM			Geology: Cretaceous age sediments Eumeralla Formation (Koe)
0.8	0.80	Silty CLAY (Light Clay) Mottled orange and grey Strongly structured Stiff, moist	MC	Str	St	M			
1.2 1.6 2.0	2.00	XW Rock (Mustone) Orange to yellow Moderately structured Firm, dry	MC	Mo	F	D			
2.4 2.8	3.00	HW Mudstone Brown to yellow Strongly structured Moderate to high strength, Hard, slightly moist	LC	Str	H	SM			
3.2 3.6 4.0	4.00	MW-SW Rock (Siltstone/Sandstone) Brown to yellow Moderately to slightly weathered Moderate to high strength, hard, dry	LC	Str	H	SM			
4.4		Borehole 11 terminated at 4m							

moisture:

D	Dry
SM	Slightly Moist
M	Moist
W	Wet
Sat	Saturated

Degree of Weathering

RS	Residual Soil
XW	Extremely Weathered Rock
HW	Highly Weathered Rock
MW	Moderately Weathered Rock
SW	Slightly Weathered Rock
FR	Fresh Rock

Consistency/density:

VS	very soft	Fb	friable
S	soft	VL	very loose
F	firm	L	loose
St	stiff	MD	medium dense
VSt	very stiff	D	dense
H	hard	VD	very dense

Structure

Ma	Massive
SG	Single grained
We	Weak
Mo	Moderate
Str	Strong

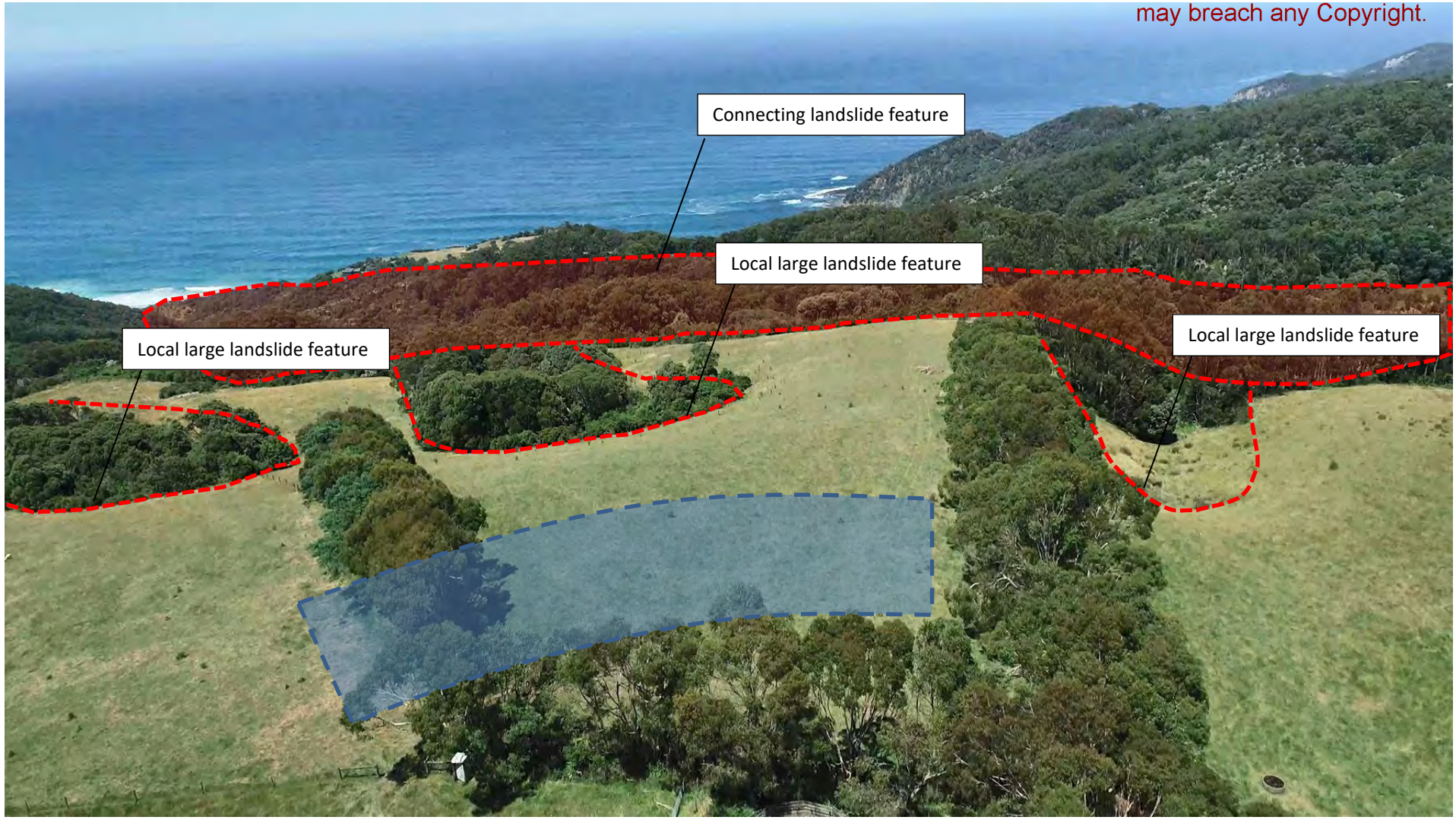
Method:

- [x] Hand Auger*
- [ ] Auger Drilling
- [ ] Roller/Tricone
- [ ] Washbore
- [ ] Non Destructive Digging

*(Exposure)

Appendix D

Site photographs



Aerial photograph of proposed dorm development area and inferred landslide

Aerial photograph of proposed dorm development area and inferred landslide features

Aerial photograph of proposed dorm development area west view

Aerial photograph of proposed staff accommodation development area north-east view

Aerial photograph of proposed staff accommodation development area and inferred landslide

Inferred fossil landslide

Inferred recent landslide

Aerial photograph of existing access (denoted as Hornes Road) and inferred adjacent landslides

Access Road (denoted as Hornes Road)

Proposed land application area (dorms)

Existing sheds and proposed accommodation area

South view from existing residence, note highlighted main scarp and more recent slope movement in foreground

Proposed Bushfire Shelter

Small landslide feature, Hornes Road landslide edge, downslope from proposed Bushfire Shelter

Hornes Road Landslide Feature (downslope from proposed Bushfire Shelter).
Note highly to slightly weathered rock in profile.

Hornes Road Landslide Feature (downslope from proposed Bushfire Shelter).
Note surface depressions, indicating regression of landslide features

Tension crack and highlighted main scarp

Existing spring (south of existing dwelling)

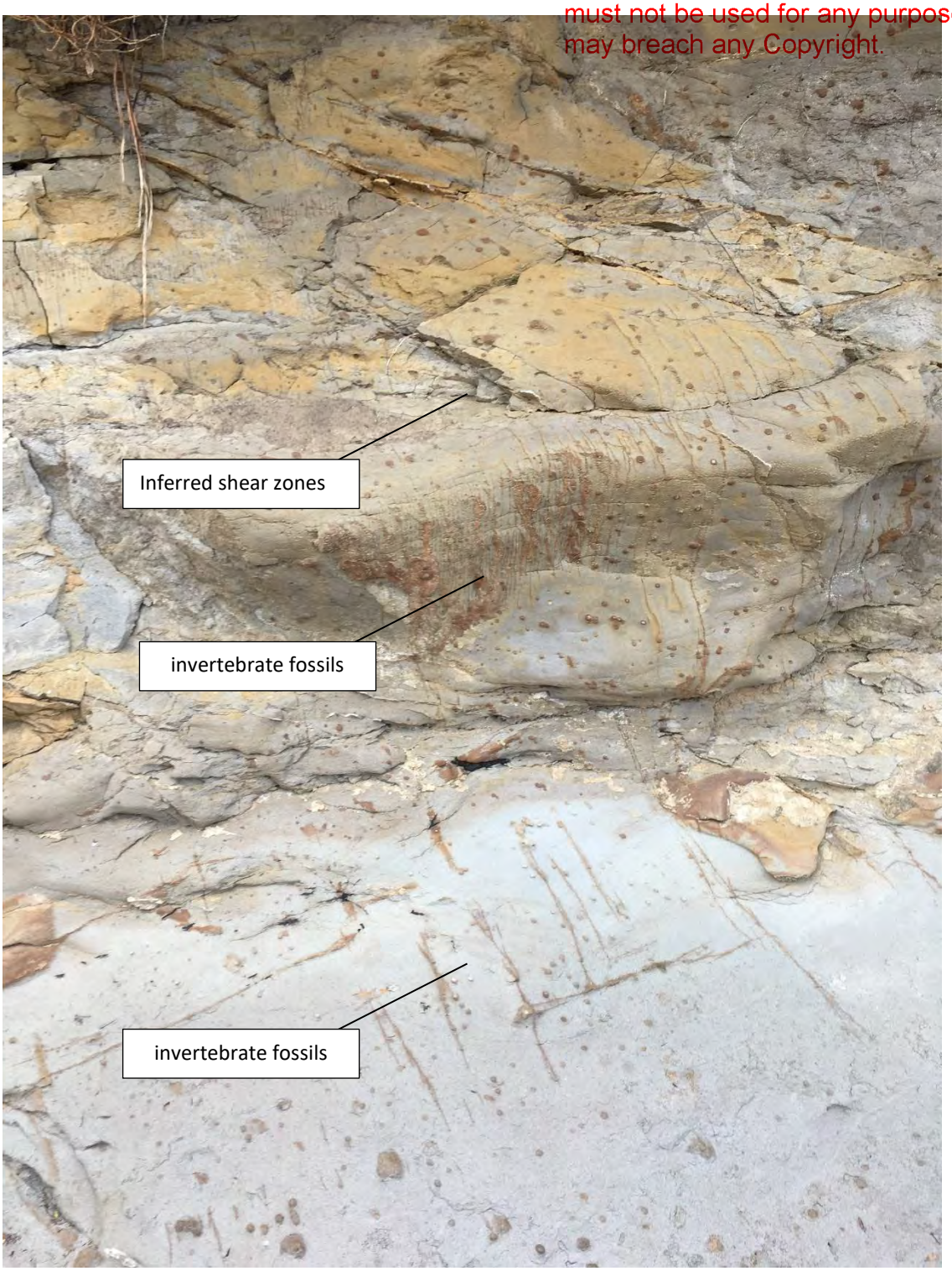
Evidence of recent fretting and slope movement in gully, edge of Hornes Road Landslide (south existing dwelling)

Evidence of recent fretting and slope movement in gully, edge of Hornes Road Landslide (south existing dwelling)-detail

Coastal cliff face concretions (hardened rock mass in cretaceous age sedimentary rock)

Coastal cliff face concretions (hardened rock mass in cretaceous age sedimentary rock)

Irregular bedding angles and embedded concretions indicating slope movement (approximately 100m inland)



Milanesia Beach, exposed sandstone (inferred fossil earth-slide) with inferred shear zones and invertebrate tunnel fossils

Recent large landslide feature head scarp: Milanesia Beach (40mx50m)

Large landslide feature with subsequent vegetation growth: Milanesia Beach (30mx40m)

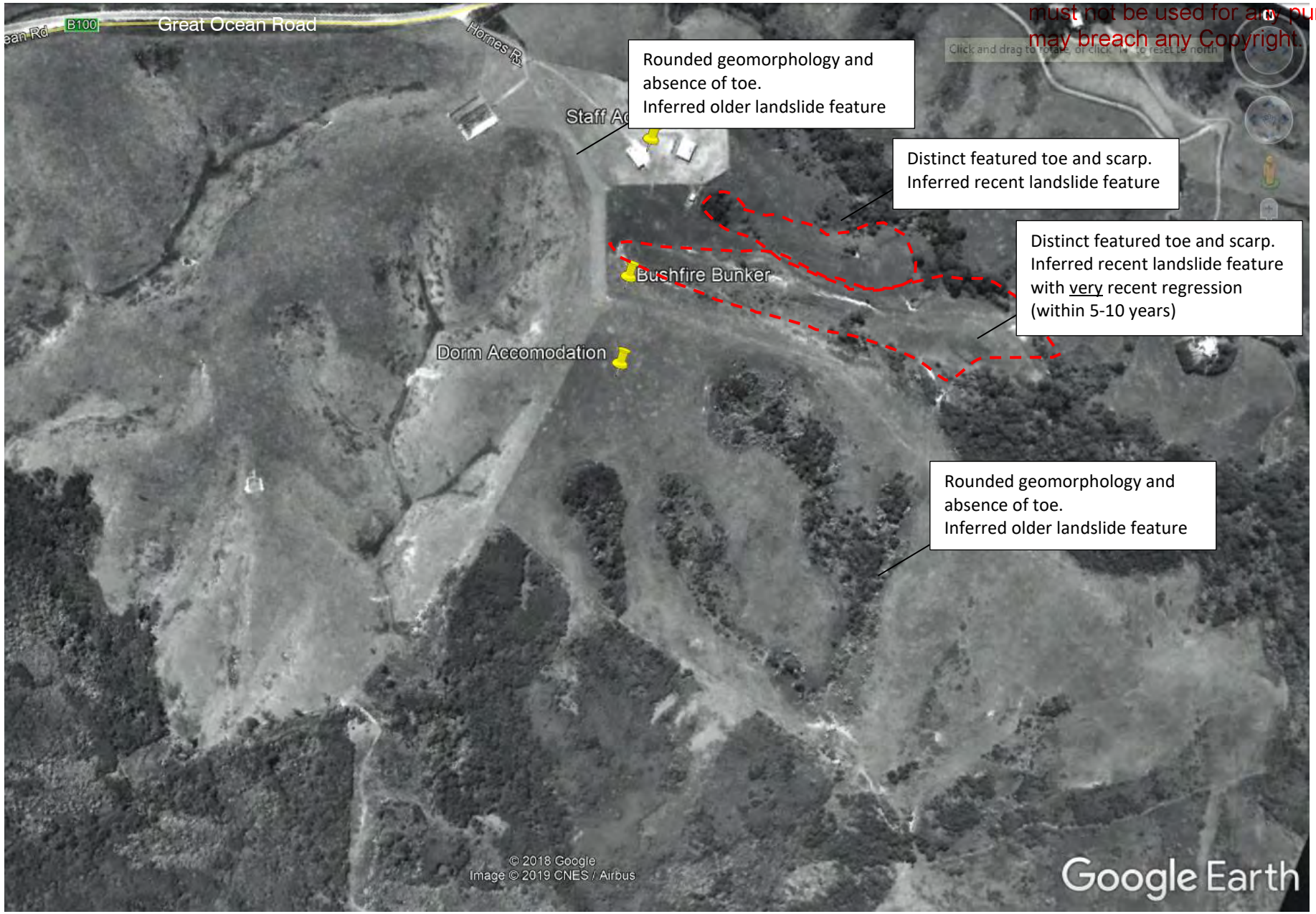
Typical soil/rock profile, (borehole 3)

Existing native trees in gully (landslide feature) east of existing shearing shed. Note bent trunks indicating signs of soil creep

Appendix E

Aerial photographs

5835 Great Ocean Road Yuulong: 1945



5835 Great Ocean Road Yuulong: 1977

5835 Great Ocean Road Yuulong: 1983

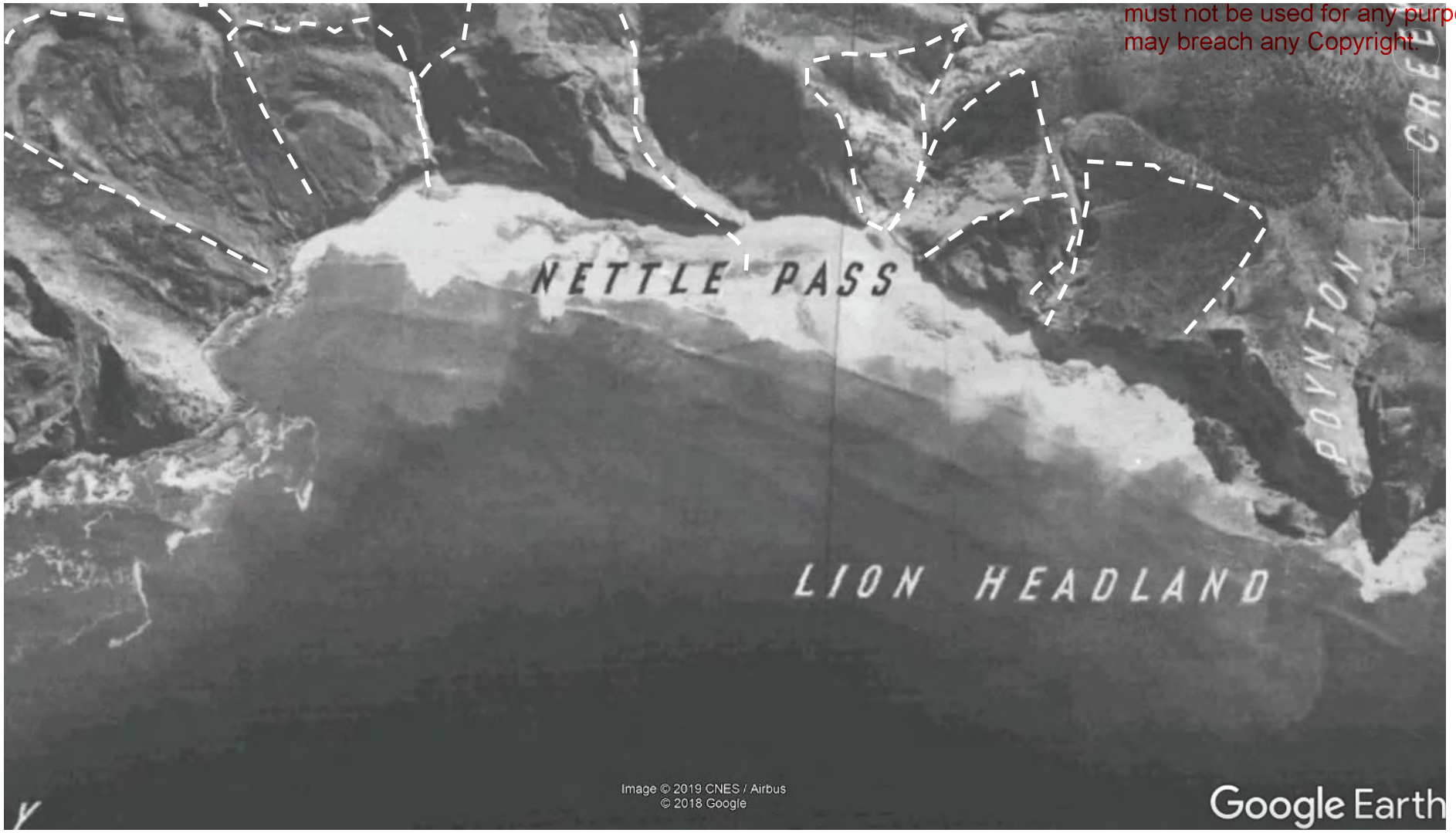
5835 Great Ocean Road Yuulong: 2003

5835 Great Ocean Road Yuulong: 2006

5835 Great Ocean Road Yuulong: 2014

5835 Great Ocean Road Yuulong: 2019

5835 Great Ocean Road Yuulong: 2019 with Wangerrip Landslide Inventory



Prominent Landslide Features Milanesia Beach 1945

Prominent Landslide Features Milanesia Beach 1983

Inferred prominent Landslide Polygons Milanesia Beach DEM, 2019

Inferred prominent Landslide Polygons Milanesia Beach DEM, showing approximate inland regression

Appendix F

Geotechnical Declaration: Form A

FORM	A	Geotechnical Declaration and Verification Development Application
Office Use Only		

To be submitted with planning application. It must accompany the Geotechnical Assessment and/or Landslip Risk Assessment. This form is essential to verify that the Geotechnical Assessment and/or Landslip Risk Assessment has been prepared in accordance with Cl 44.01 of the Colac Otway Planning Scheme and that the author of the Assessment/s is a geotechnical engineer or engineering geologist as defined by this clause.

Section 1	**Related Application**	
Planning Application Number (if known)		
DA Site Address	**5835 Great Ocean Road, Yuulong**	
DA Applicant	**Ballarat Clarendon College**	

Section 2	**Geotechnical Assessment and /or Landslip Risk Assessment**	
Details	Title: **Geotechnical Assessment of Landslide Risk at 5835 Great Ocean Road, Yuulong**	
	Author's Company/Organisation Name: **St Quentin Consulting**	Report Reference No: **16006G-LRA**
	Author: **Cameron Farrar**	Dated: **September 2019**

Section 3 Checklist

Geotechnical Requirements (Tick as appropriate) Yes	No	**Assessment and/or Landslip Risk Assessment. The report must also cover any additional matters required by Clause 44.01. This checklist must accompany each report. Each item is to be cross-referenced to the section or page of the Geotechnical Assessment and/or Landslip Risk Assessment which addresses that item.**
✓		A review of readily available history of slope instability in the site or related land as per: **Section 4.1 and 4.3**
✓		An assessment of the risk posed by all reasonably identifiable geotechnical hazards as per: **Section 6**
✓		Plans and sections of the site and related land as per: **Section 4.2.2** and **Appendix A & B**
✓		Presentation of a geological model as per: **Section 4.2.3** and **Appendix A & B**
✓		Photographs and/or drawings of the site as per: **Appendix A, B & D**
✓		A conclusion as to whether the site is suitable for the development proposed to be carried out as per: **Section 7**
		If any items above are ticked No, an explanation is to be included in the report to justify why.
		Subject to recommendations and conditions relevant to:
✓		Selection and construction of footing systems
✓		Earthworks
✓		Surface and sub surface drainage
✓		Recommendations for the selection of structural systems consistent with the geotechnical assessment of the risk
✓		Any conditions that may be required for the ongoing mitigation and maintenance of the site
	✓	Highlighting and detailing the inspection regime to provide adequate notification for all necessary inspections
✓		State Design life adopted: 50 years

NOTE: THIS FORM IS ADAPTED FROM: PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007
Australian Geomechanics Vol 42 No 1 March 2007

FORM	A	Geotechnical Declaration and Verification Development Application

Section 4 List of pertinent drawings and documents referenced in Geotechnical Report

Document	Description	Reference	Date
Site Location	WBa: Site Location	18-023 tp01-Rev 4	13.09.19
Site Masterplan	WBa: Site Masterplan	18-023 tp02-Rev 4	13.09.19
Site Masterplan w/Aerial Image	WBa: Site Masterplan w/Aerial Image	18-023 tp03-Rev 4	13.09.19
Site Plan: Commons & Student Dormitory	WBa: Commons & Student Dormitory Site Plan	18-023 tp04-Rev 4	13.09.19
Site Plan: Commons & Student Dormitory	WBa: Commons & Student Dormitory Site Plan w/Aerial Image	18-023 tp05-Rev 4	13.09.19
Site Plan: Commons & Student Dormitory	WBa: Commons & Student Dormitory Site Plan w/Aerial Image	18-023 Tp14-Rev 4	13.09.19

Section 5 Declaration

Declaration (Tick all that apply)				**I am a geotechnical practitioner as defined by the Schedule 1 to the Erosion Management Overlay and on behalf of the company below:**
Yes	✓	**No**		I am a geotechnical engineer or engineering geologist as defined by the Colac Otway Planning Scheme and on behalf of the company below
Yes	✓	**N/A**		I am aware that the Geotechnical Assessment and/or Landslip Risk Assessment I have either prepared or am technically verifying (referenced above) is to be submitted in support of a planning application for the proposed development site (referenced above) and its findings will be relied upon by the Colac Otway Shire Council in determining the planning application
Yes	✓	**N/A**		I prepared the Geotechnical Assessment and/or Landslip Risk Assessment referenced above in accordance with the Colac Otway Planning Scheme and the AGS Guidelines 2007as defined in the planning scheme.
Yes	✓	**No**		I technically verify that the Geotechnical Assessment and/or Landslip Risk Assessment referenced above has been prepared in accordance with the Colac Otway Planning Scheme and the AGS Guidelines 2007 as appropriate.
Yes		**No**	✓	I technically verify that the Geotechnical Assessment prepared for the planning application for the site confirms the land can meet the acceptable risk criteria specified in the schedule to Clause 44.01 of the Colac Otway Planning Scheme taking into account the total development and site disturbance proposed.
Yes	✓	**No**		I technically verify that the Landslip Risk Assessment prepared for the planning application for the site confirms the land can meet the tolerable risk criteria specified in the schedule to Clause 44.01 of the Colac Otway Planning Scheme taking into account the total development and site disturbance proposed.

Section 6 Geotechnical Engineer or Engineering Geologist Details

Company/ Organisation Name	**St Quentin Consulting**	
Name (Company Representative)	Surname: **Farrar**	Mr /Mrs /Other: **Mr**
	Given Names: **Cameron**	
	Chartered Professional Status: **Member Institute of Engineers**	Registration No: **4367740**
Signature		Dated: **25/09/2019**

Reference: AGS Guidelines 2007c "Practice Note Guidelines for Landslide Risk Management", Australian Geomechanics Society, Australian Geomechanics. V42. N1 March 2007.

Appendix G

AGS “Geoguides”

AUSTRALIAN GEOGUIDE LR4 (LANDSLIDES IN ROCK)

ROCK SLOPE HAZARD REDUCTION MEASURES

Removal of loose blocks - may be effective but, depending on rock type, ongoing erosion can result in more blocks becoming unstable within a matter of years. Routine inspection, every 5 or so years, may be required to detect this.

Rock bolts and rock anchors (Figure 5) - can be installed in the ground to improve its strength and prevent individual blocks from falling. Rock bolts are usually tightened using a torque wrench, whilst rock anchors carry higher loads and require jacking. Both can be designed to be "permanent" using stainless steel, or sheathing, to inhibit corrosion, but the cost can be up to 10 times that of the "temporary" alternative. You should inspect rock bolts and rock anchors for signs of water seepage, rusting and deterioration around the heads at least once every 5 years. If you notice any of these warning signs, have them checked by a geotechnical practitioner. It is recommended that you keep copies of design drawings and maintenance records (GeoGuide LR11) for the anchors on your site and pass them on to the new owner should you sell.

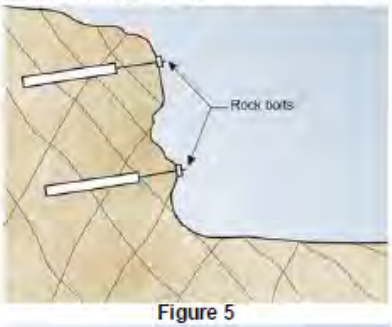


Figure 5

Rock fall netting, catch fences and catch pits (Figure 6) - are designed to catch or control falling rocks and prevent them from damaging nearby property. You should inspect them at least once every 5 years, and after major falls, and arrange for fallen and trapped rocks to be removed if they appear to be filling up. Check for signs of corrosion and replace steel elements and fixings before they lose significant strength.

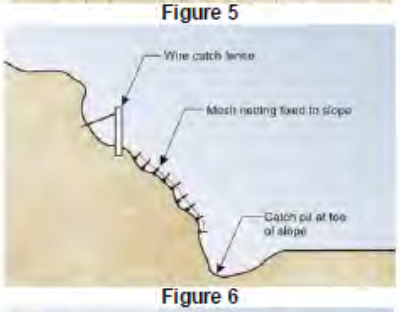


Figure 6

Cut-off drains (Figure 7) - can be used to intercept surface water run-off and reduce flows down the cliff face. Suitable drains are often excavated into the rock, or constructed from mounds of concrete, or stabilised soil, depending on conditions. Drains must be laid to a fall of at least 1% so they drain adequately. Frequent inspection is needed to ensure they are not blocked and continue to function as intended.

Clear trees and large bushes (Figure 7) - from slopes since roots can prize boulders from the face increasing the landslide hazard.

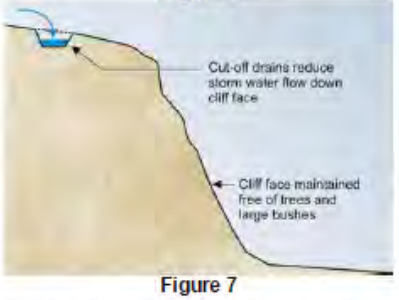


Figure 7

Natural cliffs and bluffs - often present the greatest hazard and yet are easily overlooked, because they have "been there forever". They can exist above a building, road, or beach, presenting the risk of a rock falling onto whatever is below. They also sometimes support buildings with a fine view to the horizon. Cliffs should be observed frequently to ensure that they are not deteriorating. You may find it convenient to use binoculars to look for signs of exposed "fresh" rock on the face, where a recent fall has occurred, or to go to the foot of the cliff from time to time to see if debris is collecting. A thorough inspection of a cliff face is often a major task requiring the use of rope access methods and should only be undertaken by an appropriately qualified professional. If tension cracks are observed in the ground at the top of a cliff take immediate action, since they could indicate imminent failure. **If you have any concerns at all about the possibility of a rock fall seek 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 LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR8 - Hillside Construction
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

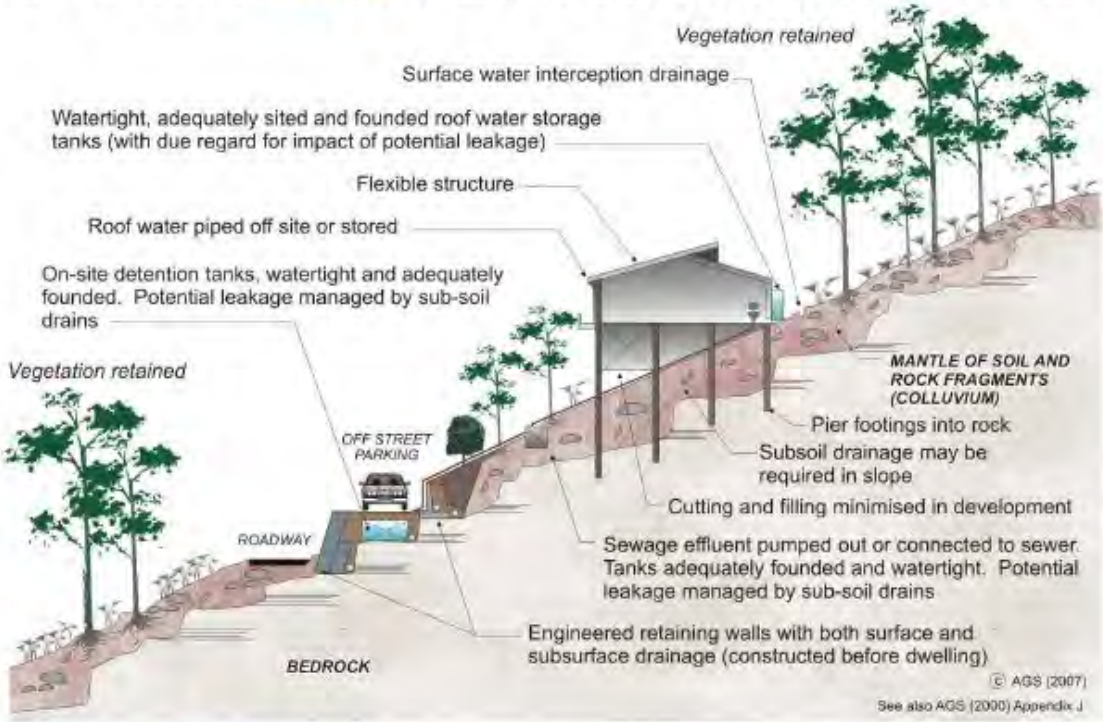
The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to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

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.

EXAMPLES OF GOOD HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES GOOD?

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

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.

APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

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

Appendix H

AGS Terminology in assessing risk

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

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

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

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

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

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

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

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

Appendix I

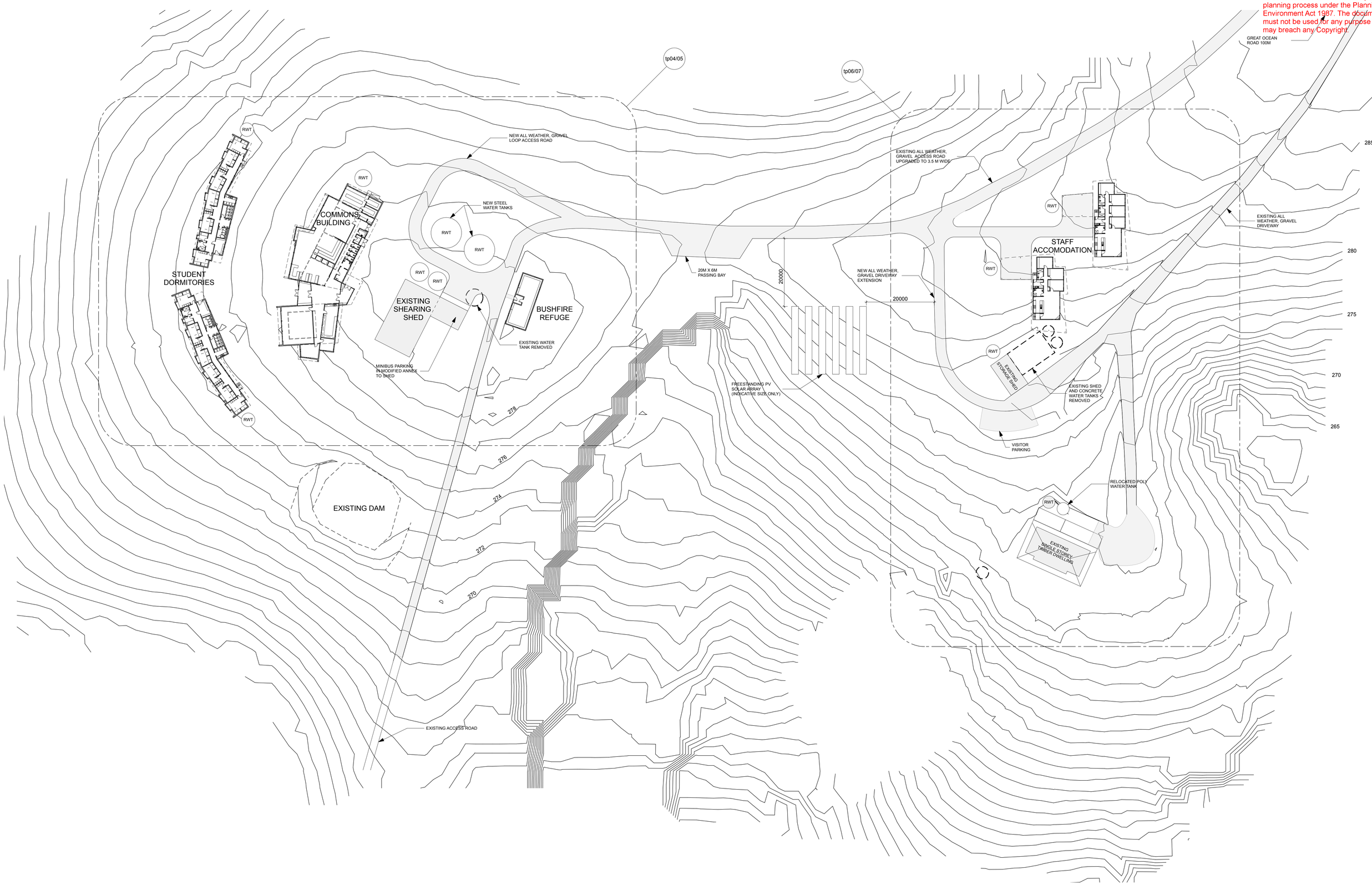
Architectural Drawings

GREAT OCEAN ROAD

Project	Project No.	Title	Status	Drawn	Date	Scale	Revision
BCC Year 9 Campus Yuulong	18-023	Plan - Site Location 5835 Great Ocean, Yuulong	Town Planning	SE	13-09-2019	1:2000@A1 1:4000@A3	4

WBa
Williams Boag Architects
51 Leicester Street **Carlton** 3053
Telephone 61.3 9388 6000 Facsimile 61.3 9388 6060
Email intray@williamsboag.com.au

Drawing No. tp01



Project BCC Year 9 Campus Yuulong	Project No. 18-023	Title Plan - Site Masterplan	Status Town Planning	Drawn SE	Date 13-09-2019	Scale 1:500@A1 1:1000@A3	Revision 4

WBa
Williams Boag Architects
51 Leicester Street **Carlton** 3053
Telephone 61.3 9388 6000 Facsimile 61.3 9388 6060
Email intray@williamsboag.com.au

Drawing No. tp02

Project BCC Year 9 Campus Yuulong	Project No. 18-023	Title Plan - Site Masterplan (with Aerial Image)	Status Town Planning	Drawn SE	Date 13-09-2019	Scale 1:500@A1 1:250@A3	Revision 4

WBa
Williams Boag Architects
51 Leicester Street **Carlton** 3053
Telephone 61.3 9388 6000 Facsimile 61.3 9388 6060
Email intray@williamsboag.com.au

Drawing No. tp03

STUDENT DORMITORIES (WEST)

RL 274.75 AHD

STUDENT DORMITORIES (EAST)

RL 274.25 AHD

COMMONS BUILDING
RL 278.25 AHD

EXISTING SHEARING SHED
FL 280.20 AHD

BUSH FIRE REFUGE
RL 279.20

NEW ALL WEATHER, GRADED TO FALL, COMPACTED GRAVEL LOOP ROAD.

CFA WATER SUPPLY

ALIGN CORNERS OF BUILDINGS

EXISTING OPEN SHED ORIENTATION REVERSED & ROOF EXTENDED TO PROVIDE GARAGE FOR 2 NO. MINI BUSES. REFER DWG. No.'s TP20 & TP21

EXISTING ACCESS ROAD TO ADJOINING PROPERTY.

RWT

tp08

tp10

01 tp18

02 tp18

27000

16000

15450

11545

17000

7200

3600

8000

R 8000

2400

268 269 270 271 272 272 272 273 274 275 275 274 274 275 276 277 278 279

Project	Project No.	Title	Status	Drawn	Date	Scale	Revision
BCC Year 9 Campus Yuulong	18-023	Plan - Commons & Student Dormitory Site Plan	Town Planning	SE	13-09-2019	1:200@A1 1:400@A3	4

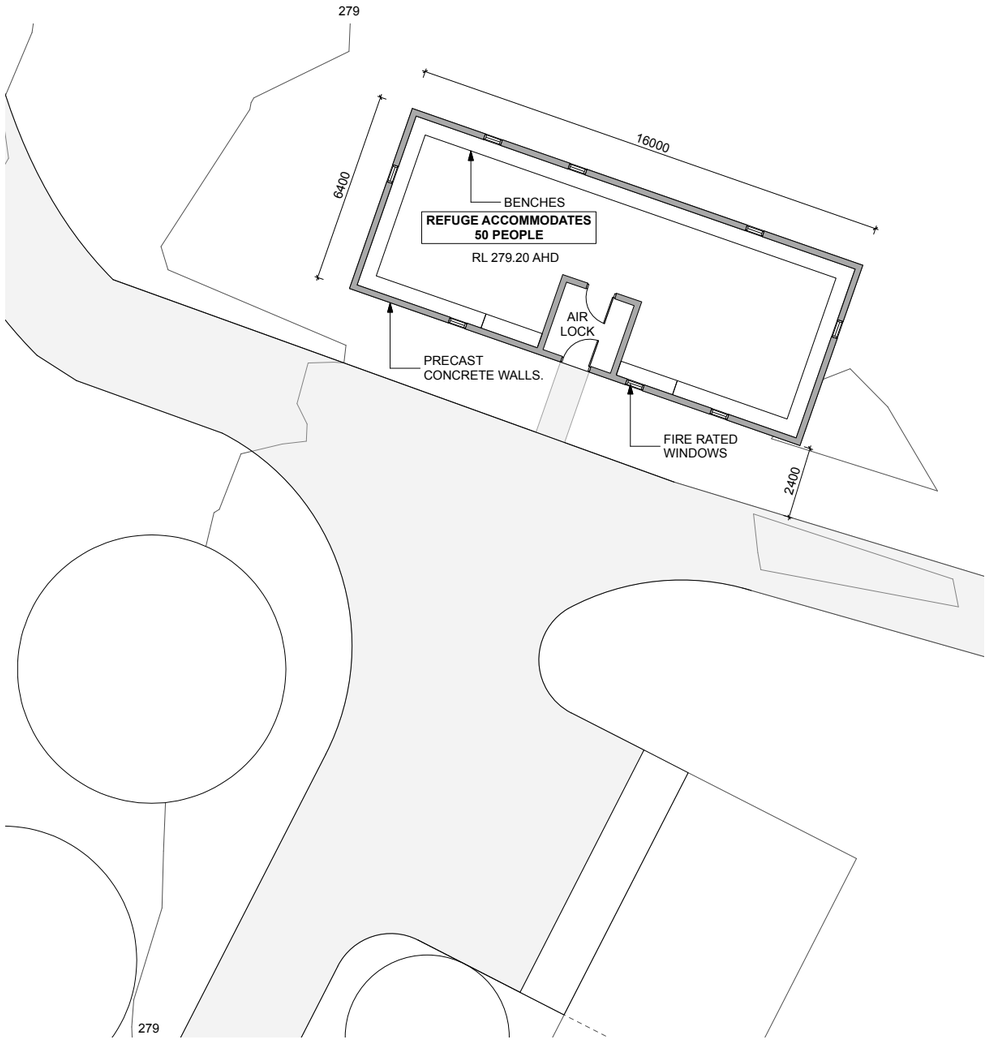
WBa
Williams Boag Architects
51 Leicester Street **Carlton** 3053
Telephone 61.3 9388 6000 Facsimile 61.3 9388 6060
Email intray@williamsboag.com.au

Drawing No. tp04

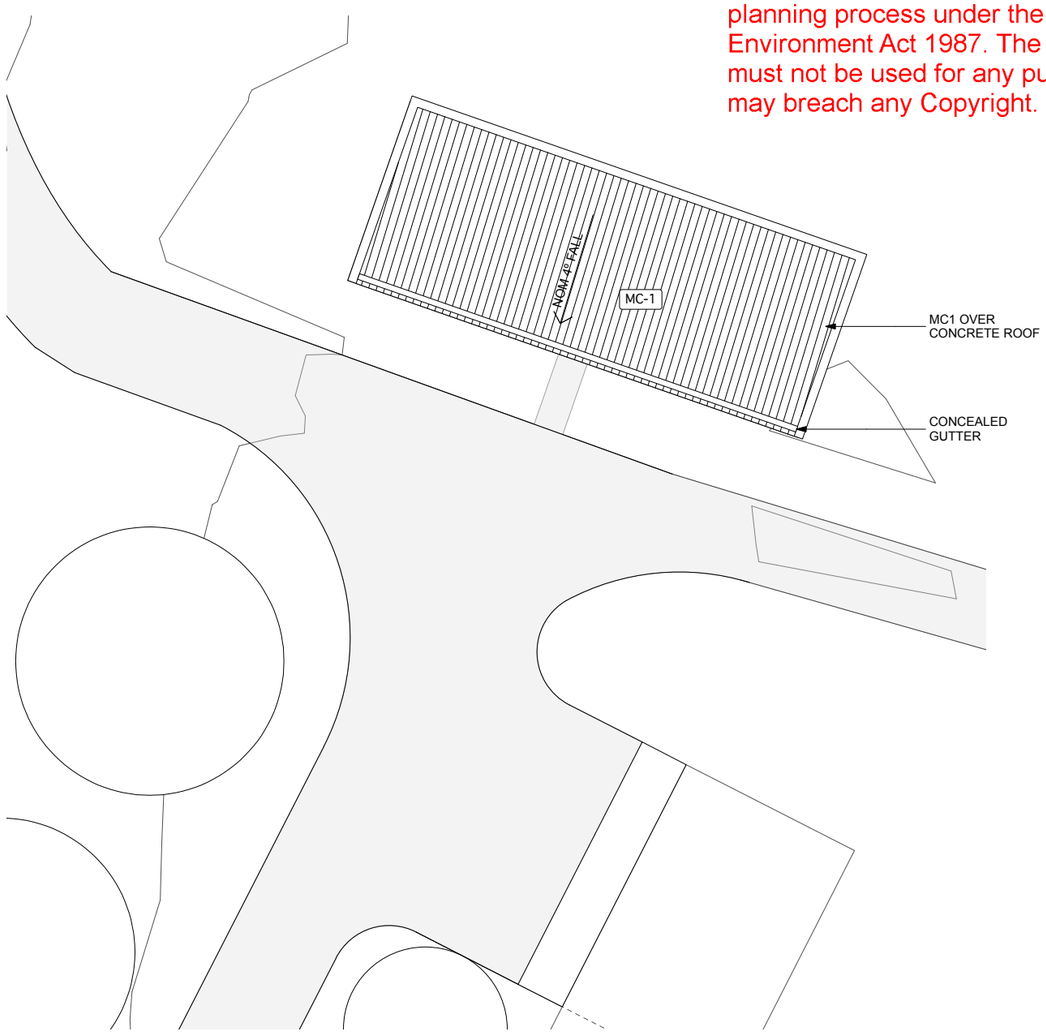
Project	Project No.	Title	Status	Drawn	Date	Scale	Revision
BCC Year 9 Campus Yuulong	18-023	Plan - Commons & Student Dormitory Site Plan (with Aerial Image)	Town Planning	SE	13-09-2019	1:200@A1 1:400@A3	3

WBa
Williams Boag Architects
51 Leicester Street **Carlton** 3053
Telephone 61.3 9388 6000 Facsimile 61.3 9388 6060
Email intray@williamsboag.com.au

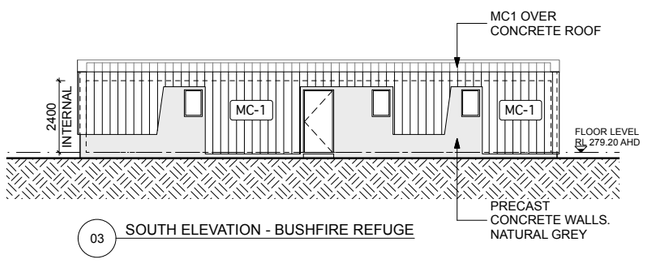
Drawing No. tp05



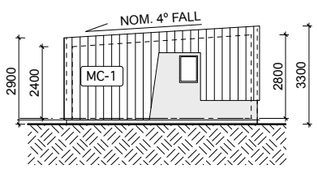
01 PLAN - BUSHFIRE REFUGE GROUND FLOOR



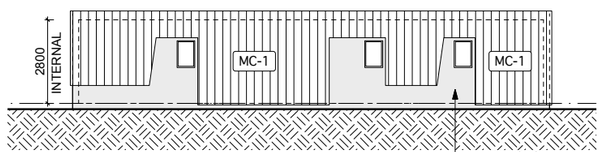
02 PLAN - BUSHFIRE REFUGE ROOF



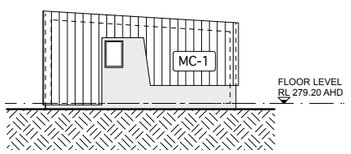
03 SOUTH ELEVATION - BUSHFIRE REFUGE



04 EAST ELEVATION - BUSHFIRE REFUGE



05 NORTH ELEVATION - BUSHFIRE REFUGE



06 WEST ELEVATION - BUSHFIRE REFUGE

Project BCC Year 9 Campus Yuulong	Project No. 18-023	Title Plan - Bushfire Refuge	Status Town Planning	Drawn PWo	Date 13-09-2019	Scale 1:100@A1 1:200@A3	Revision 5	Drawing No. tp14

WBa
Williams Boag Architects
51 Leicester Street **Carlton** 3053
Telephone 61.3 9388 6000 Facsimile 61.3 9388 6060
Email intray@williamsboag.com.au

GEOTECHNICAL INVESTIGATION ADDENDUM

TESTING PROGRAMME & REPORT

1. Report has been prepared by qualified persons and based on current available standards.
2. Recommendations are based on the assumption that limited test positions are representative of the sub-surface profile.
3. Whilst care has been taken to accurately report on the sub-surface conditions across the site it is not possible to anticipate unexpected sub-surface variations given the limited testing performed.
4. Changes in legislative policy may require report update or additional testing.

The purpose of this report is to conduct a limited and preliminary geotechnical investigation. Where any variation or anomalies are encountered, we recommend additional investigation and reporting by us to resolve any potential issues.

GENERAL COMMENTS

St Quentin Consulting does not accept responsibility for our report where it has been altered or not reproduced in full, including addendum.

Dimensions, slope, test locations are approximate only and must not be used for calculation of positioning.

Recommendations are based on information regarding the site and development type provided by the client or agent. If information supplied is not accurate or if significant changes are required, our report may be inappropriate. We cannot accept responsibility for significant changes and anticipate additional fees should further tests or report update be required.

Offset distance to any subsurface excavations must not exceed the minimum angle of repose for the in-situ naturally occurring soil. We estimate the maximum angle of repose for sand is 30 and 45 for clay soils. We do not recommend steeper angles unless competent rock is encountered.

ST. QUENTIN

Surveyors • Town Planners • Engineers

stqc.com.au

ratio:

Report
Prepared for
Ballarat Clarendon College

19 September 2019

Traffic Engineering

5835 Great Ocean Road & 45 Old Iluka Access, Yuulong

ratio:traffic

r:

ratio:consultants

8 Gwynne Street
Cremorne VIC 3121
ABN 93 983 380 225

Prepared for:
Ballarat Clarendon College
Our reference 16352T-REP01-F04

Version	Date	Reason for Issue	Prepare By	Check By
D01	19/07/19	Draft	C. Hogan	A. Walley
F01	24/07/19	Final	C. Hogan	A. Walley
F02	21/08/19	Final	C. Hogan	A. Walley
F03	22/08/19	Final	C. Hogan	A. Walley
F04	19/09/19	Final	C. Hogan	A. Walley

Directory Path	Y:\16000-16500\16352T - 5835 Great Ocean Road & 45 Old Iluka Access, Yuulon\Work\Reports\16352T-REP01-F04.docx

Table of contents:

1 Introduction:

1.1 Introduction

Ratio Consultants have been engaged by Ballarat Clarendon College to prepare a Traffic Impact Assessment Report for the proposed school campus proposed at 5835 Great Ocean Road & 45 Old Iluka Access in Yuulong.

2.1 Location and Environment

The subject site is located on the southern side of the Great Ocean Road in Yuulong and is approximately 10km southwest of the township Lavers Hill. The site is accessed via the intersection of the Great Ocean Road and Hornes Road.

Location of the subject site is shown in Figure 2.1.

Figure 2.1: Site's Locality Map

Source: www.online.melway.com.au

The subject site is zoned as Rural Conservation (RCZ) and is predominately farm land and includes a dwelling and a small number of outbuildings. Access to the site is currently provided via the rural unsealed Hornes Road which also provides access to a limited number neighbouring properties.

2.2 Road Network

The Great Ocean Road is an arterial road under the control of VicRoads. The Great Ocean Road runs along the coast of Victoria between Torquay in the east and Allansford in the west.

Within the vicinity of the site the Great Ocean Road comprises a carriageway of approximately 7 metres consisting of a single trafficable lane in each direction.

A posted speed limit 80 km/h applies to the Great Ocean Road within the vicinity of the site.

The view of the Great Ocean Road at the intersection with Horne Road, facing east and west, is shown in Figure 2.2 and Figure 2.3 respectively.

Figure 2.2: Great Ocean Road facing east

Figure 2.3: Great Ocean Road facing west

Hornes Road is an unsealed local Council road which extends generally from the Great Ocean Road in a southeast direction providing access to the subject site and neighbouring land to the west.

A view on Horne Road at the approach to the intersection with the Great Ocean Road is shown in Figure 2.4.

Figure 2.4: Hornes Road facing northwest

2.3 Existing Traffic Volumes

Traffic volumes acquired from the Vicroads website indicated that the average daily traffic volumes along the Great Ocean Road within the vicinity of the site are:

— Eastbound: 813 vehicles per day.
— Westbound: 955 vehicles per day.
— Two-way: 1,768 vehicles per day.

Of the total daily traffic volume approximately 9% was a result of heavy vehicles.

2.4 Great Ocean Road & Hornes Road Intersection

Description

The Great Ocean Road / Hornes Road intersection is located on the outside of a curve along the Great Ocean Road.

The intersection is configured as a simple T-intersection with priority to Great Ocean Road. No turn lanes or widened shoulders are provided.

Guard rail is installed along the north side of the Great Ocean Road carriageway for a distance either side of the intersection due to a sharp drop-off along the road edge.

Away from the intersection, the eastern Great Ocean Road approach is within a cutting, with embankments and significant vegetation close to both sides of the road carriageway. The western Great Ocean Road approach is along a ridgeline and is considerably more open.

There is no warning or advisory signage on either Great Ocean Road approach to advise of the presence of the intersection. A road name sign is located on the outside of the guard rail opposite the intersection to Hornes Road.

Views of the Great Ocean Road from Horne Road at the intersection, facing east and west, are shown in Figure 2.5 and Figure 2.6.

Figure 2.5: East view of Great Ocean Road from Hornes Road access

Figure 2.6: West view of Great Ocean Road from Hornes Road access

The view of the intersection from the east approach and west approach of the Great Ocean road is shown in Figure 2.7 and Figure 2.8, respectively.

Figure 2.7: East approach to intersection on Great Ocean Road

Figure 2.8: West approach to intersection on Great Ocean Road

Intersection Sight Distance

Austroads Guide to Road Design Part 4A details the desired Safe Intersection Sight Distance (SISD) for a given intersection.

SISD is defined as the minimum sight distance which should be provided on the major road at any intersection. SISD provides sufficient distance for a driver along the major road (Great Ocean Road) to observe moving into a collision situation and to decelerate to a stop before reaching the collision point.

The SISD is illustrated in Figure 3.2 and 3.3 of Austroads Guide to Road Design Part 4A and is reproduced in Figure 2.9 and Figure 2.10.

Figure 2.9: Safe Intersection Sight Distance

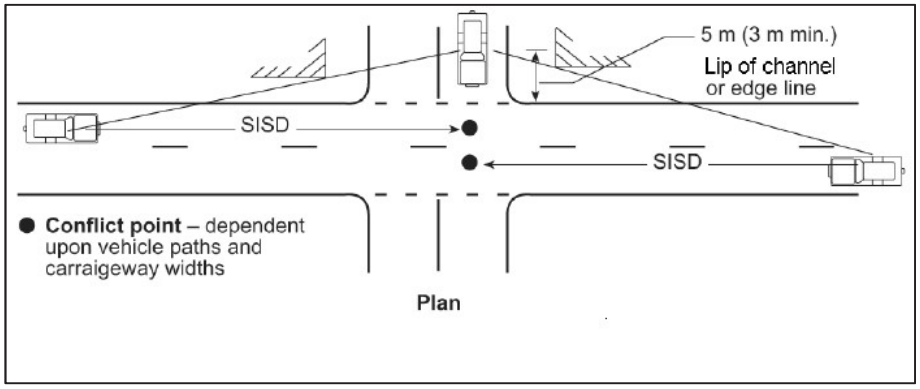
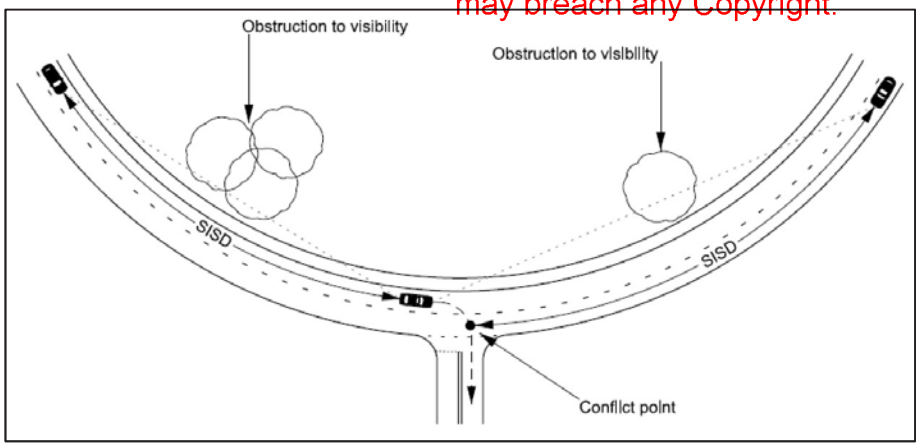


Figure 2.10: SISD for minor road intersecting on the outside of horizontal curve



Based on a speed limit of 80 km/h, and the parameters specified in Part 3 and Part 4A of Austroads Guide to Road Design, based on a standard reaction time and without accounting for grade, the SISD on approach to the intersection along Great Ocean Road is 181 metres.

The eastern approach is an upgrade of approximately 5 percent with the western approach relatively flat. Adjusting the above for these grades, the relevant SISD values are:

— East approach: 174 metres
— West approach: 181 metres

From inspection on-site the SISD on the west approach is in excess of 350 metres. To the east sight distance is marginally in excess of the requirement at 180 metres.

3.1 Proposed Development

It is proposed to develop the subject site for the purposes of a Year 9 campus for Ballarat Clarendon College.

Works on-site will include accommodation buildings for students and staff as well as the creation of new internal access roads and a number of parking areas for staff vehicles, limited visitors and school buses (limited to 24 seat Toyota Coaster buses). The existing dwelling will be repurposed as additional staff accommodation.

It is understood that the campus will operate as follows:

— The campus site will accommodate 40 students and 8 staff for approximately 8 and a half weeks.
— Students will be transported to the site via the use of two mini buses.
— Staff will be permitted to bring their own private vehicle.

We are advised that the campus may be used for small staff conferences outside of campus terms. We are also advised that the campus will not be available for third party use.

3.2 Parking and Access

The plans prepared by William Boag Architects show:

- 6 staff car parking spaces within 2 three-car car ports adjacent to the new staff accommodation buildings;
- 2 staff car parking spaces in proximity to the existing dwelling to be converted;
- An open visitor/staff car parking area capable of accommodating a further 5 cars; and
- A bus parking area of sufficient size to accommodate two 24 seat buses.

Vehicle access to the proposed campus will rely on the Hornes Road / Great Ocean Road intersection.

4.1 Car Parking Requirement – Clause 52.06

The statutory car parking requirements for a new development are set out within Table 1 of Clause 52.06 of the Colac Otway Planning Scheme.

The proposal is a campus for year 9 students. For secondary school uses, Table 1 at Clause 52.06 requires the following:

> *Secondary School*
>
> *1.2 car spaces to each employee that is part of the maximum number of employees on the site at any time*

For the maximum of 8 staff that would be on-site, this equates to a requirement for 9 spaces (rounded down to the nearest whole number).

Thirteen (13) car parking spaces are provided across the covered staff parking areas and open visitor/staff car parking area, in excess of the above requirement. Two (2) parking spaces are provided for the two school buses near the accommodation buildings. As such the on-site car parking provision complies with the applicable requirements of the Colac-Otway Planning Scheme.

On the basis of the above, it is our view that adequate car parking is provided on-site.

4.2 Bicycle Parking Requirement – Clause 52.34

The statutory car parking requirements for a new development are set out within Table 1 of Clause 52.34 of the Colac Otway Planning Scheme.

For secondary school uses the applicable bicycle parking requirements are:

> *Secondary School*
>
> *1 to each 20 employees; plus*
>
> *1 to each 5 pupils*

The above equates to a bicycle parking requirement for 8 spaces for students only.

The campus is remote from bicycle infrastructure and there is no expectation that students or staff will access the campus by bicycle.

As such no formal bicycle parking will be provided on-site, albeit that bicycles for student use within the campus grounds and organised events may be provided and stored on site.

In our view a reduction of the formal bicycle parking requirements is warranted in this circumstance.

4.3 Car Parking Arrangement and Vehicle Circulation

All formal car parking spaces are at least 3.0 metres wide, with the corresponding space length and effective access aisle meeting the requirements of the Clause 52.06 of the Colac Otway Planning Scheme.

Bus parking areas have been dimensioned appropriately to accommodate a 24 seat school bus.

Swept path diagrams have been prepared (refer to Appendix A) to demonstrate the layout and accessibility of car parking areas, general vehicle circulation, and the circulation and accessibility of the bus parking areas.

5.1 Traffic Generation and Impact

Traffic generated by the Campus during typical operation would be limited to:

— Staff and bus movements arriving / departing the campus site at the beginning and end of each campus term; and
— Occasional day to day staff and bus movements associated with external activities during the campus term;

Based on the operational aspects of the campus outlined in Section 3.1, we expect the following daily traffic movements for each of the above scenarios:

— Arrival/departure days: 10-20 vehicle movements per day
— Typical campus term days: 5-10 vehicle movements per day

Arrival//departure traffic will typically be limited to the first and last days of each campus term (8 days per year).

The above traffic movements will be spread across the day, albeit that there will be some periods of concentrated activity on arrival/departure days.

In the context of existing traffic on Great Ocean Road, and acknowledging that movements, the additional traffic generated on arrival/departure days and during the balance of the campus term will have no material impact on the road network.

The installation of advisory signage (discussed further in Section 5.2) on the eastern Great Ocean Road approach to this intersection would assist the legibility and safety of this intersection and would benefit both campus generated traffic and existing traffic on Great Ocean Road.

5.2 Great Ocean Road / Horne Road Intersection

Sight distance to the intersection on Great Ocean Road complies in both directions, albeit that the site distance from the east is only slight in excess of the SISD requirement.

From inspection, legibility of the Hornes Road intersection from the east is poor (see Figure 2.7) with the intersection location difficult to determine due to the presentation of the embankment and roadside vegetation along the southern side of Great Ocean Road.

Installation of an advanced warning sign on the eastern Great Ocean Road approach would significantly improve the legibility for approaching vehicles.

The Australian Standards AS 1742.2-2009 outlines the required traffic control signs used for various situations. Section 2.9.2.4 of AS 1742.2-2009 outlines the potential signs which could be used.

Considering the configuration of the Great Ocean Road / Horne Road intersection it is recommended, the appropriate signage would be the W2-9 (R) as shown in Figure 5.1. This sign should be installed on the southern side of the road, approximately 180 metres prior to the intersection.

Figure 5.1: Signage for side road intersection on outside of curve

6 Summary & Conclusions:

The subject site located at 5835 Great Ocean Road and 45 Old Iluka Access in Yuulong and is proposed to be developed to accommodate a school campus that will house for 40 students and 8 staff for extended stays of 8.5 weeks.

Access to the site is to be provided via Hornes Road which in turn is accessed from Great Ocean Road. Students will be transported to the site via two buses, staff may bring a private vehicle on-site.

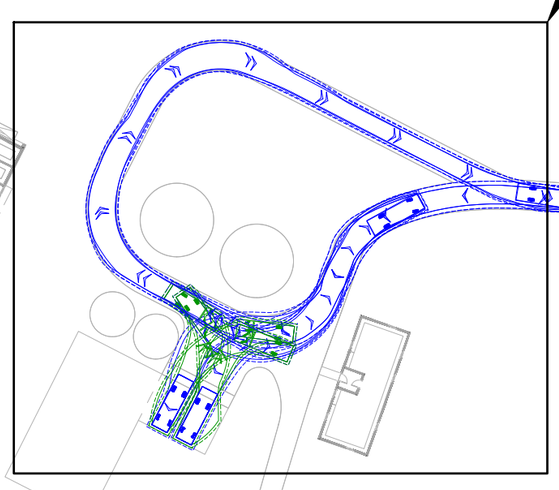
Based on the preceding it is our view that:

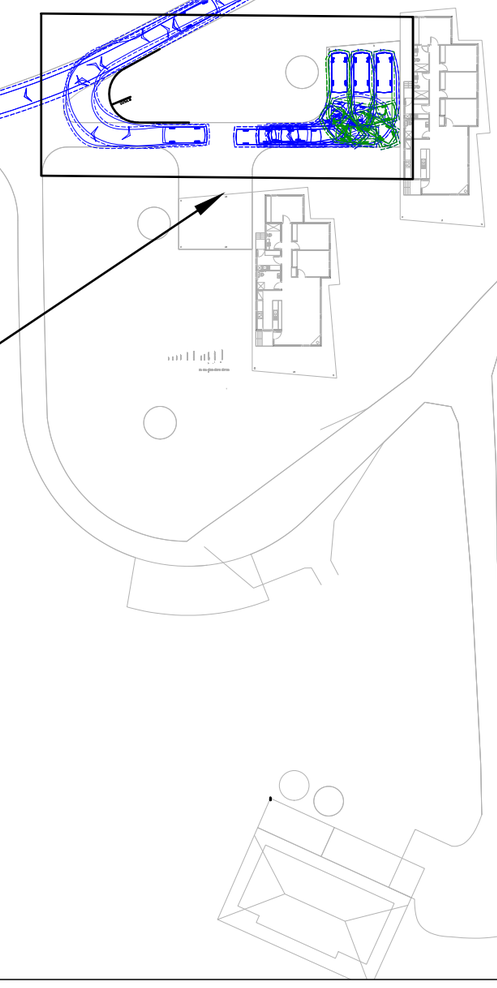
- Sufficient car parking is available on-site to cater for anticipated demands;
- The arrangement of on-site car parking complies with the relevant design standards. Access roads and vehicle circulation is appropriate for the vehicles expected to access the campus;
- Day to day traffic generated by the proposal will have no material impact on the Hornes Road / Great Ocean Road intersection and can be accommodated safely; and
- Whilst sight distance requirements are met, the visibility of the Hornes Road intersection could be improved by the installation of advanced warning signage on the eastern Great Ocean Road approach.

Appendix A Swept Path Diagrams

See sheets 2 – 4

See sheets 5 – 8.

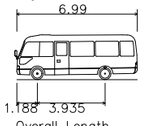




0 7.5 15

ratio:
RATIO CONSULTANTS PTY LTD
ABN 005 422 104
8 GWYNNE STREET
CREMORNE, VICTORIA 3121
TELEPHONE (03)9429 3111
FACSIMILE (03)9429 3011

Toyota Coaster



VEHICLE ENVELOPE (FORWARD)
500mm CLEARANCE (FORWARD)
VEHICLE ENVELOPE (REVERSE)
500mm CLEARANCE (REVERSE)

Overall Length	6.990m
Overall Width	2.095m
Overall Body Height	2.600m
Min Body Ground Clearance	0.276m
Max Track Width	1.750m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	7.200m

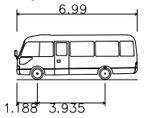
Proposed Residential Development
5835 Great Ocean Rd & 45 Old Iluka Access
Swept Path Assessment

NOTE:
1) Base Plan Supplied by Williams Boag Architects
2) Maximum Design Speed 10km/h

RATIO REFERENCE	SHEET No.	SCALE	DATE
16352T SK03/CLH	1 of 8	1:750@A3	19/09/2019

ratio:
RATIO CONSULTANTS PTY LTD
ABN 005 422 104
8 GWYNNE STREET
CREMORNE, VICTORIA 3121
TELEPHONE (03)9429 3111
FACSIMILE (03)9429 3011

Toyota Coaster



Overall Length	6.990m
Overall Width	2.095m
Overall Body Height	2.600m
Min Body Ground Clearance	0.276m
Max Track Width	1.750m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	7.200m

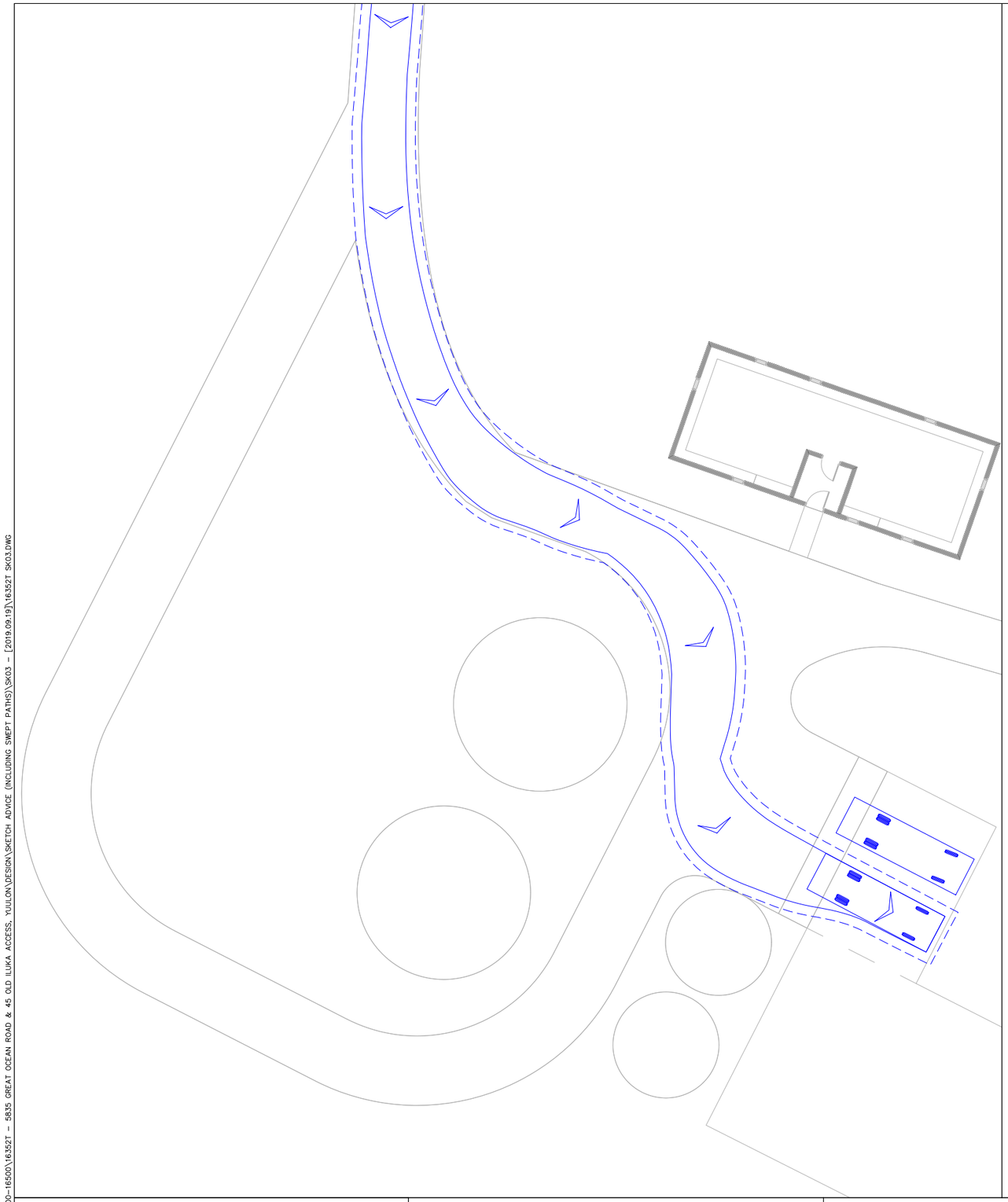
VEHICLE ENVELOPE (FORWARD)
500mm CLEARANCE (FORWARD)
VEHICLE ENVELOPE (REVERSE)
500mm CLEARANCE (REVERSE)

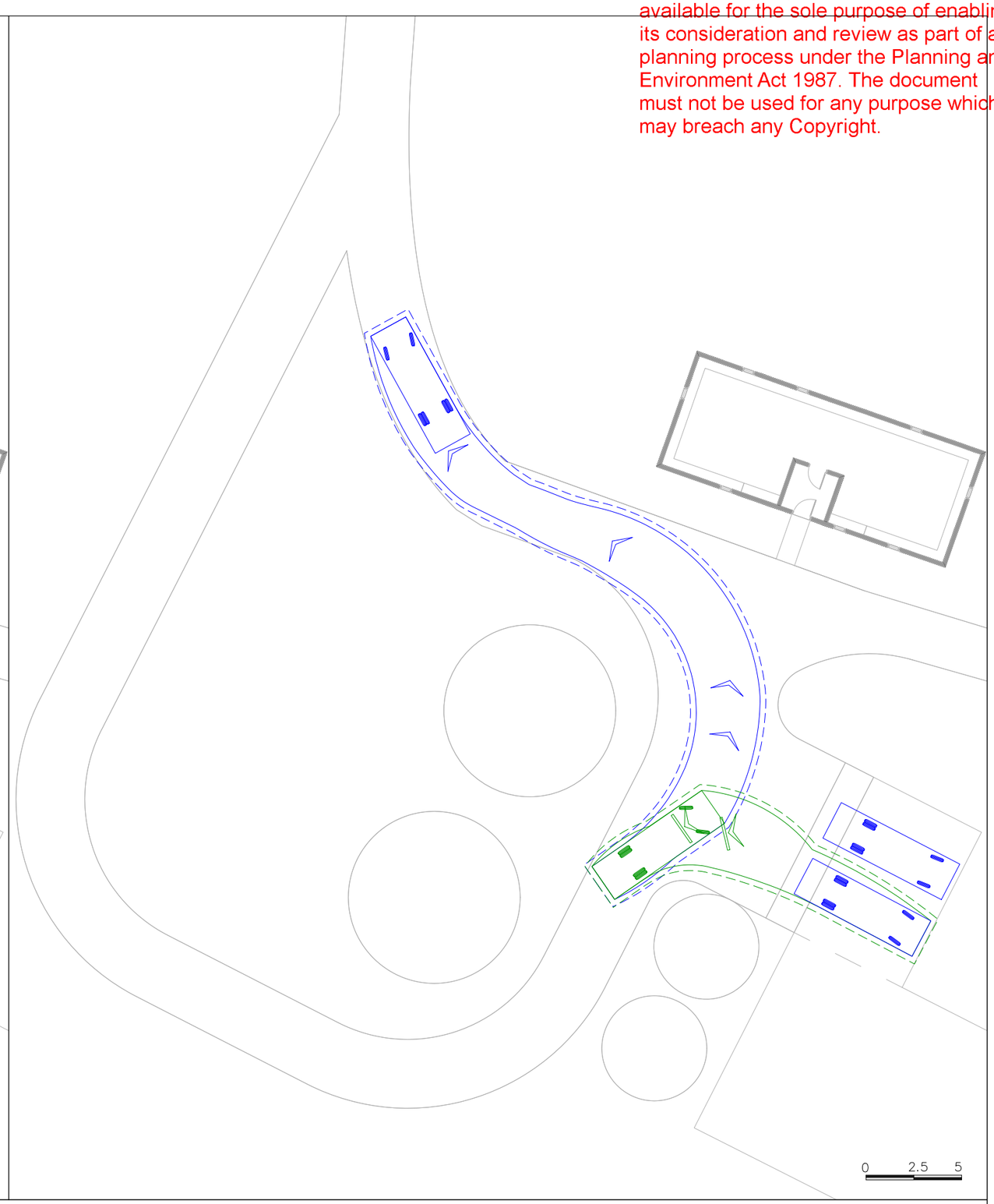
0 2.5 5

Proposed Residential Development
5835 Great Ocean Rd & 45 Old Iluka Access
Swept Path Assessment

NOTE:
1) Base Plan Supplied by Williams Boag Architects
2) Maximum Design Speed 10km/h

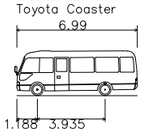
RATIO REFERENCE	SHEET No.	SCALE	DATE
16352T SK03/CLH	2 of 8	1:250@A3	19/09/2019





ratio:
RATIO CONSULTANTS PTY LTD
ABN 005 422 104
8 GWYNNE STREET
CREMORNE, VICTORIA 3121
TELEPHONE (03)9429 3111
FACSIMILE (03)9429 3011

Toyota Coaster



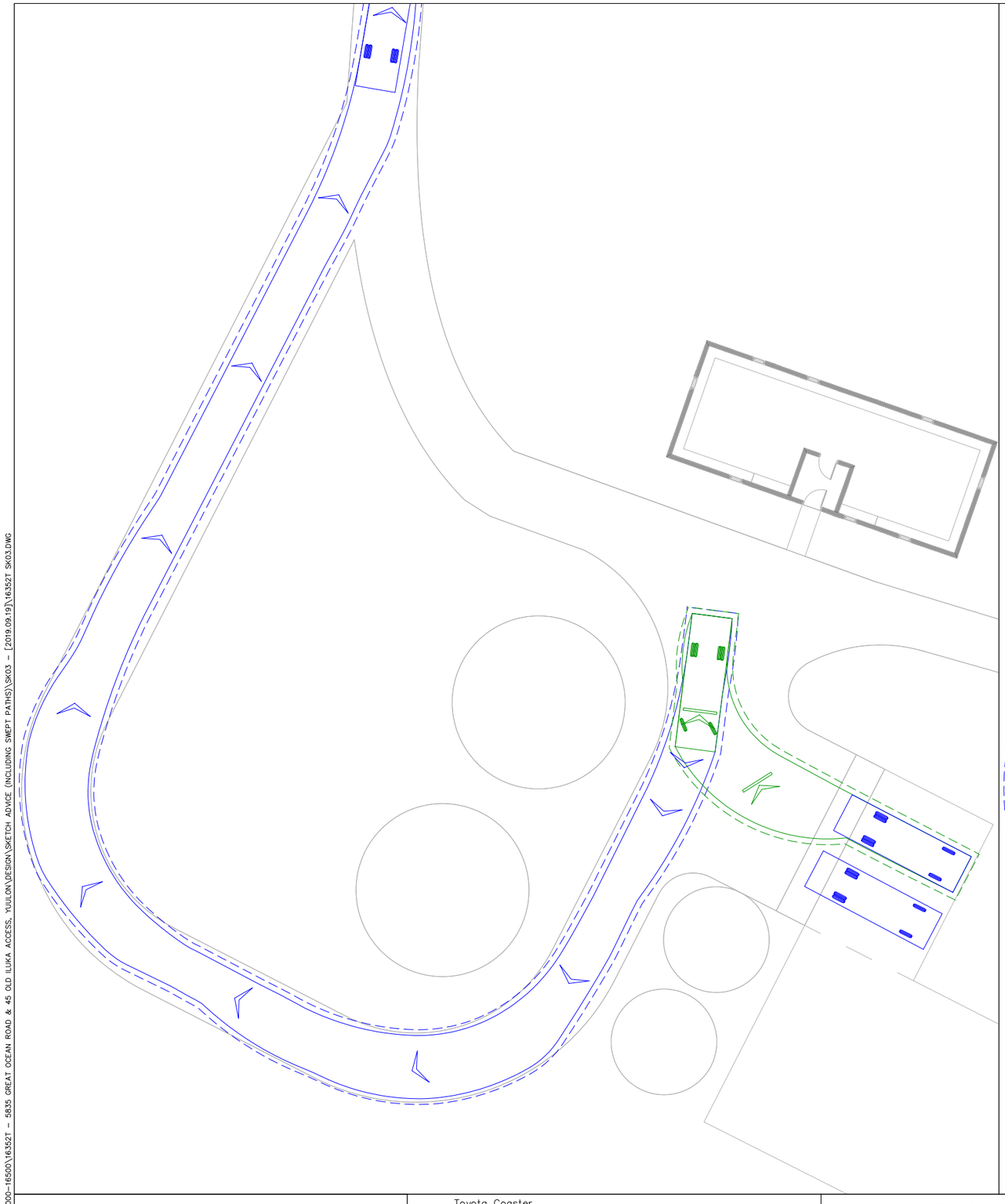
Overall Length	6.990m
Overall Width	2.095m
Overall Body Height	2.600m
Min Body Ground Clearance	0.276m
Max Track Width	1.750m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	7.200m

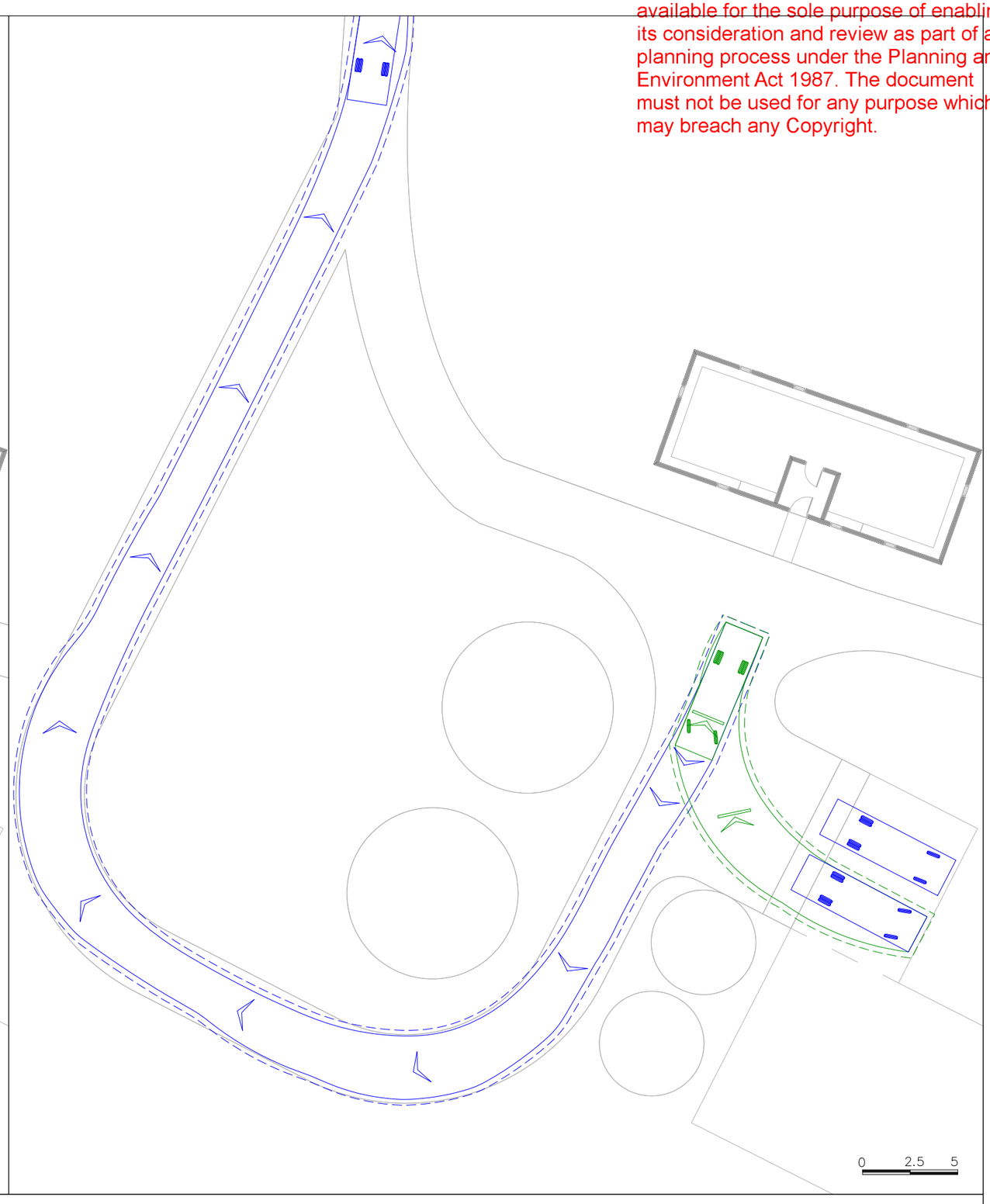
VEHICLE ENVELOPE (FORWARD)
500mm CLEARANCE (FORWARD)
VEHICLE ENVELOPE (REVERSE)
500mm CLEARANCE (REVERSE)

Proposed Residential Development
5835 Great Ocean Rd & 45 Old Iluka Access
Swept Path Assessment

NOTE:
1) Base Plan Supplied by Williams Boag Architects
2) Maximum Design Speed 10km/h

RATIO REFERENCE	SHEET No.	SCALE	DATE
16352T SK03/CLH	3 of 8	1:250@A3	19/09/2019



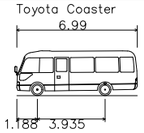


0 2.5 5

Y:\16000-16500\16352T - 5835 GREAT OCEAN ROAD & 45 OLD ILUKA ACCESS, YUILON\DESIGN\SKETCH ADVICE (INCLUDING SWEPT PATHS)\SK03 - [2019.09.19]\16352T SK03.DWG
19/09/2019 1:28:48 PM

ratio:
RATIO CONSULTANTS PTY LTD
ABN 005 422 104
8 GWYNNE STREET
CREMORNE, VICTORIA 3121
TELEPHONE (03)9429 3111
FACSIMILE (03)9429 3011

Toyota Coaster



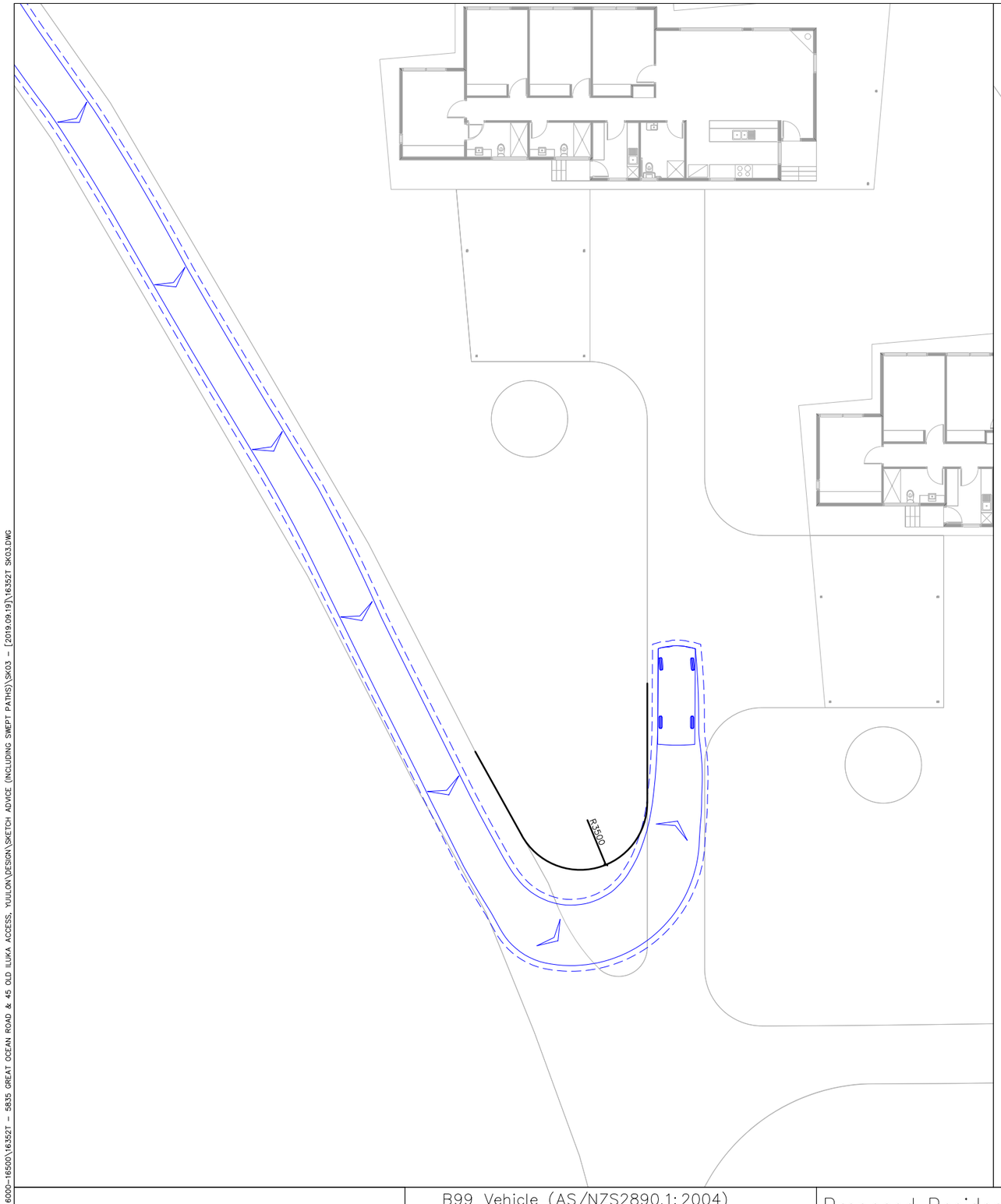
VEHICLE ENVELOPE (FORWARD)
500mm CLEARANCE (FORWARD)
VEHICLE ENVELOPE (REVERSE)
500mm CLEARANCE (REVERSE)

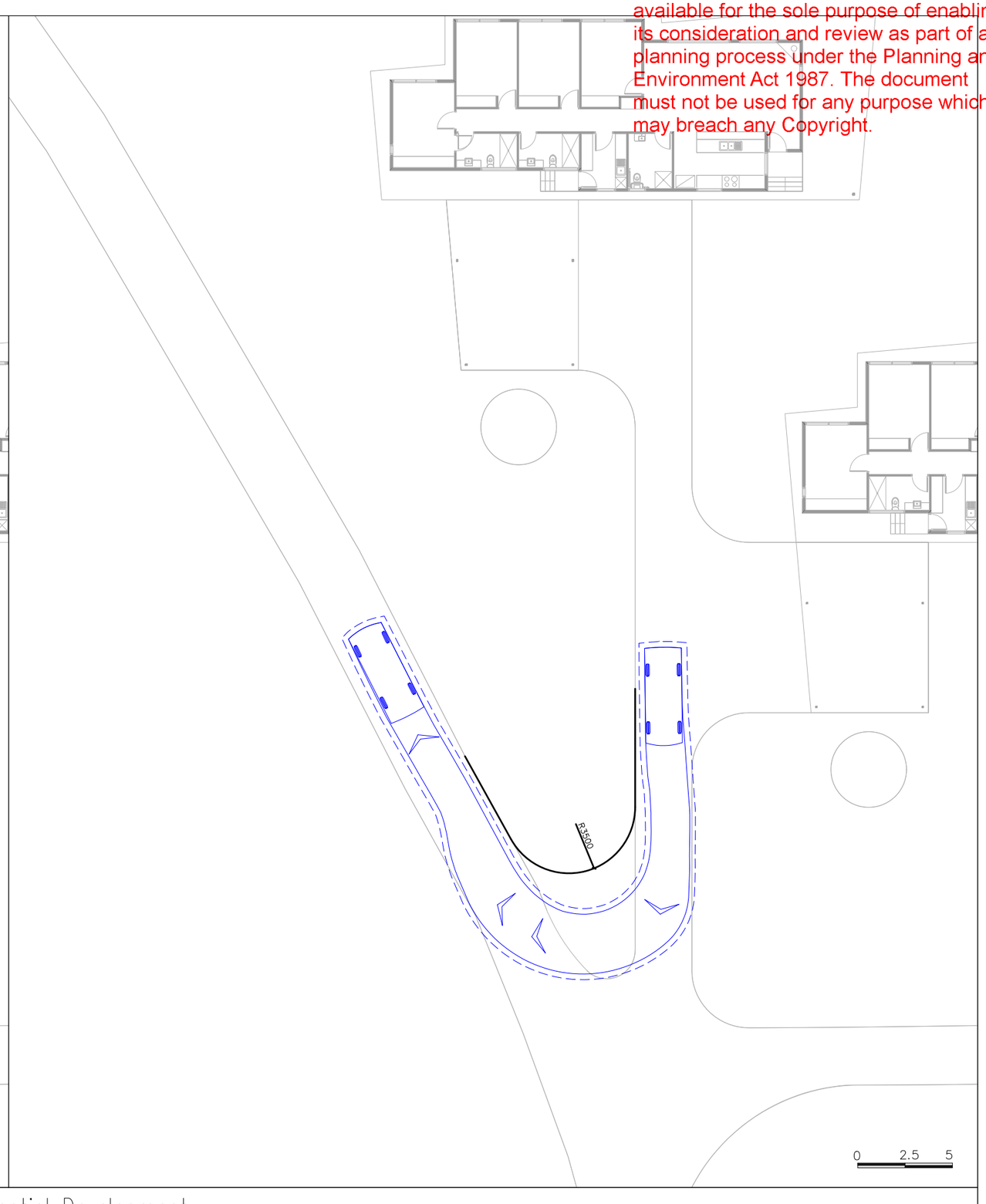
Overall Length	6.990m
Overall Width	2.095m
Overall Body Height	2.600m
Min Body Ground Clearance	0.276m
Max Track Width	1.750m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	7.200m

Proposed Residential Development
5835 Great Ocean Rd & 45 Old Iluka Access
Swept Path Assessment

NOTE:
1) Base Plan Supplied by Williams Boag Architects
2) Maximum Design Speed 10km/h

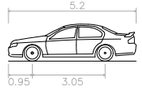
RATIO REFERENCE	SHEET No.	SCALE	DATE
16352T SK03/CLH	4 of 8	1:250@A3	19/09/2019





ratio:
RATIO CONSULTANTS PTY LTD
ABN 005 422 104
8 GWYNNE STREET
CREMORNE, VICTORIA 3121
TELEPHONE (03)9429 3111
FACSIMILE (03)9429 3011

B99 Vehicle (AS/NZS2890.1:2004)



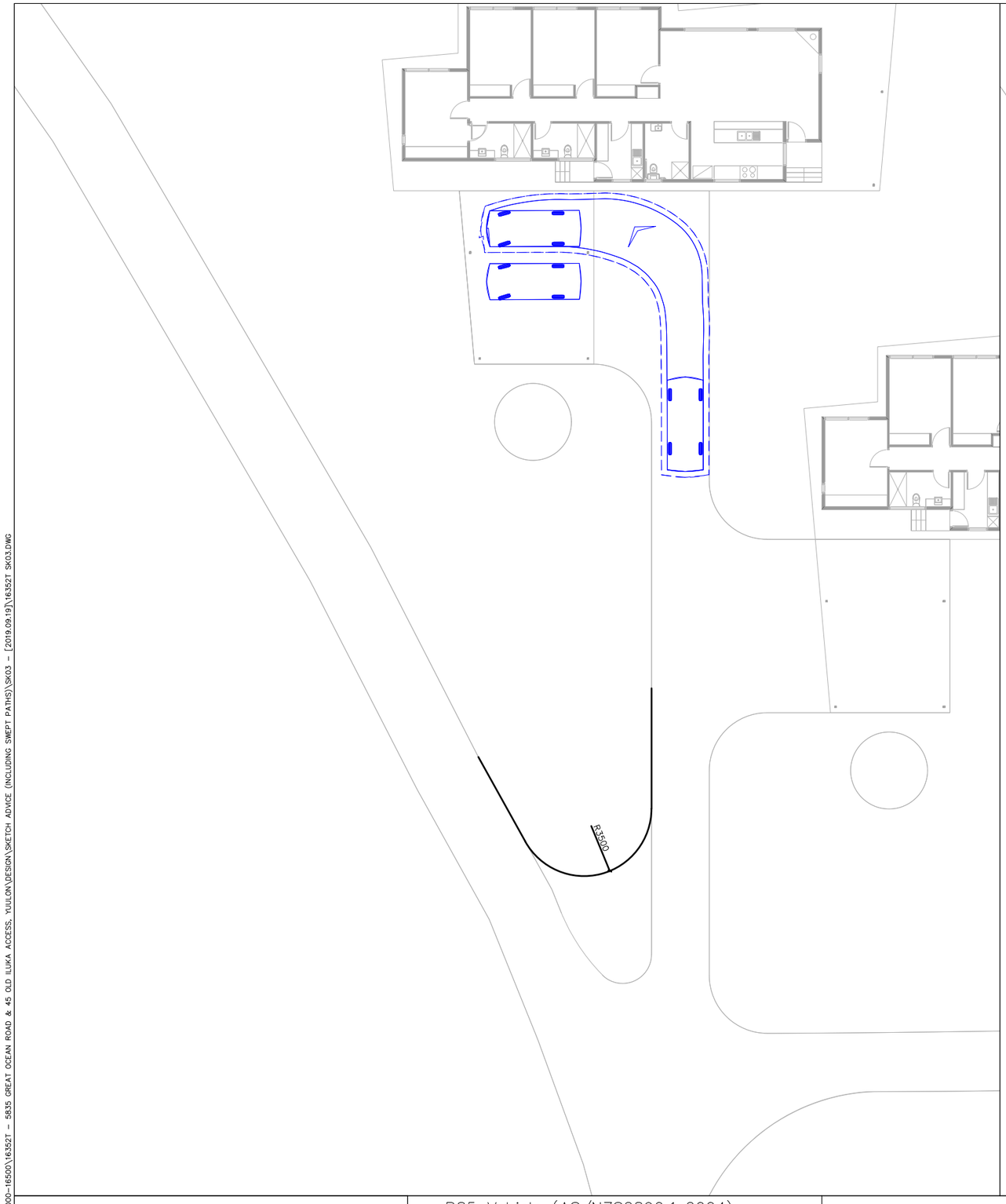
VEHICLE ENVELOPE (FORWARD)
300mm CLEARANCE (FORWARD)
VEHICLE ENVELOPE (REVERSE)
300mm CLEARANCE (REVERSE)

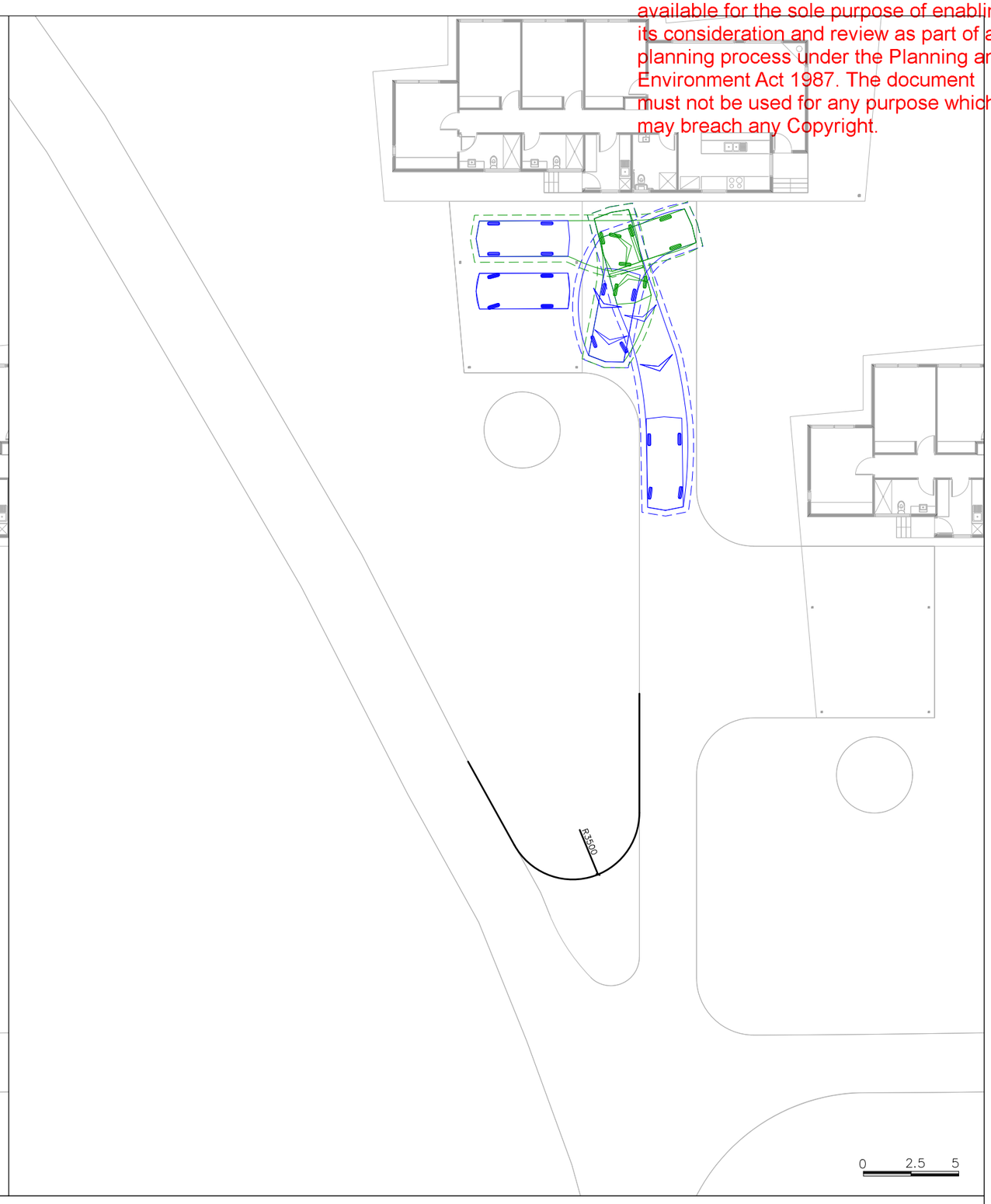
Overall Length	5.200m
Overall Width	1.940m
Overall Body Height	2.200m
Min Body Ground Clearance	0.312m
Track Width	1.840m
Lock to Lock Time	4.00 sec
Curb to Curb Turning Radius	6.30m

Proposed Residential Development
5835 Great Ocean Rd & 45 Old Iluka Access
Swept Path Assessment

NOTE:
1) Base Plan Supplied by Williams Boag Architects
2) Maximum Design Speed 10km/h

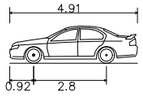
RATIO REFERENCE	SHEET No.	SCALE	DATE
16352T SK03/CLH	5 of 8	1:250@A3	19/09/2019





ratio:
RATIO CONSULTANTS PTY LTD
ABN 005 422 104
8 GWYNNE STREET
CREMORNE, VICTORIA 3121
TELEPHONE (03)9429 3111
FACSIMILE (03)9429 3011

B85 Vehicle (AS/NZS2890.1:2004)



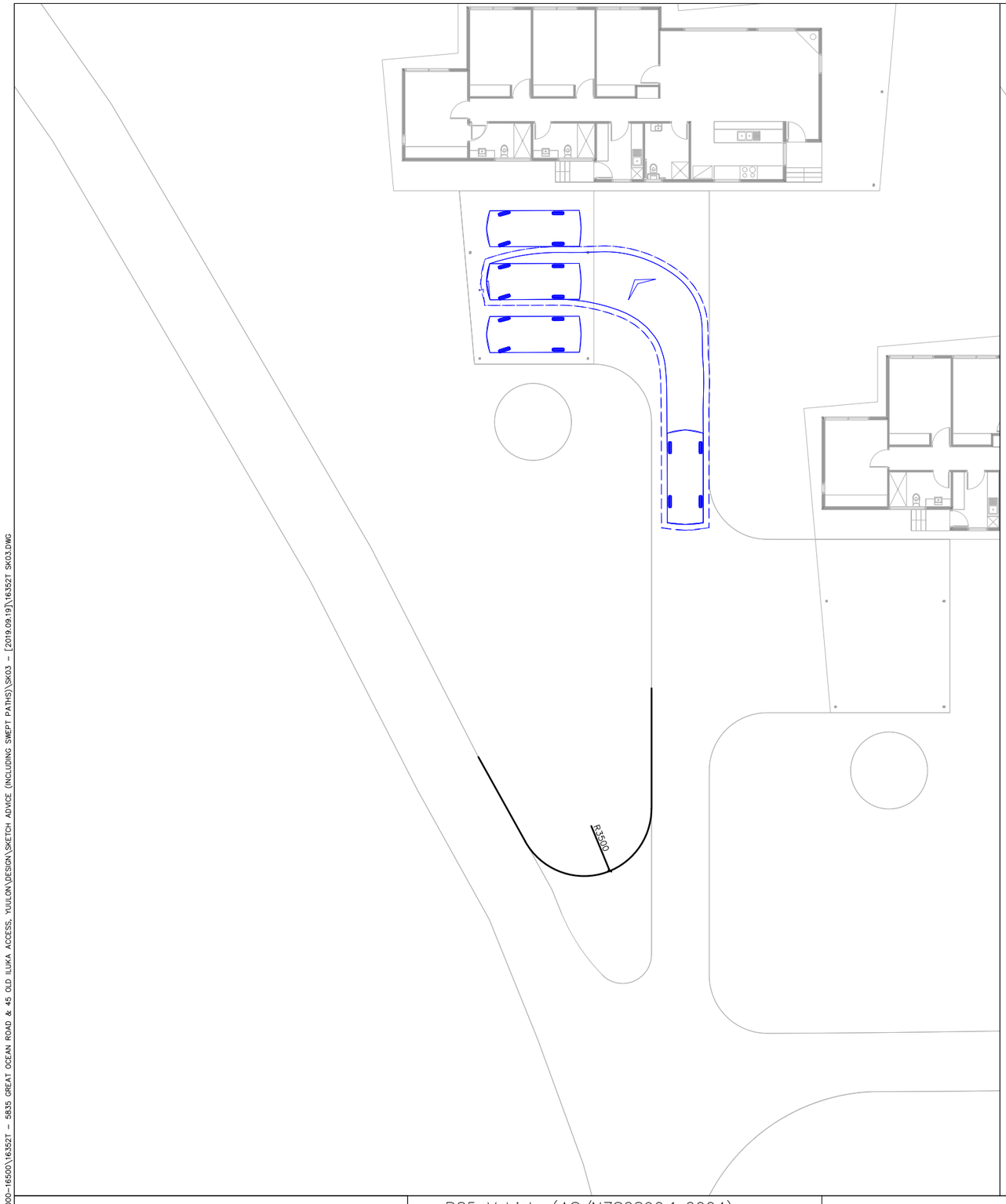
VEHICLE ENVELOPE (FORWARD)
300mm CLEARANCE (FORWARD)
VEHICLE ENVELOPE (REVERSE)
300mm CLEARANCE (REVERSE)

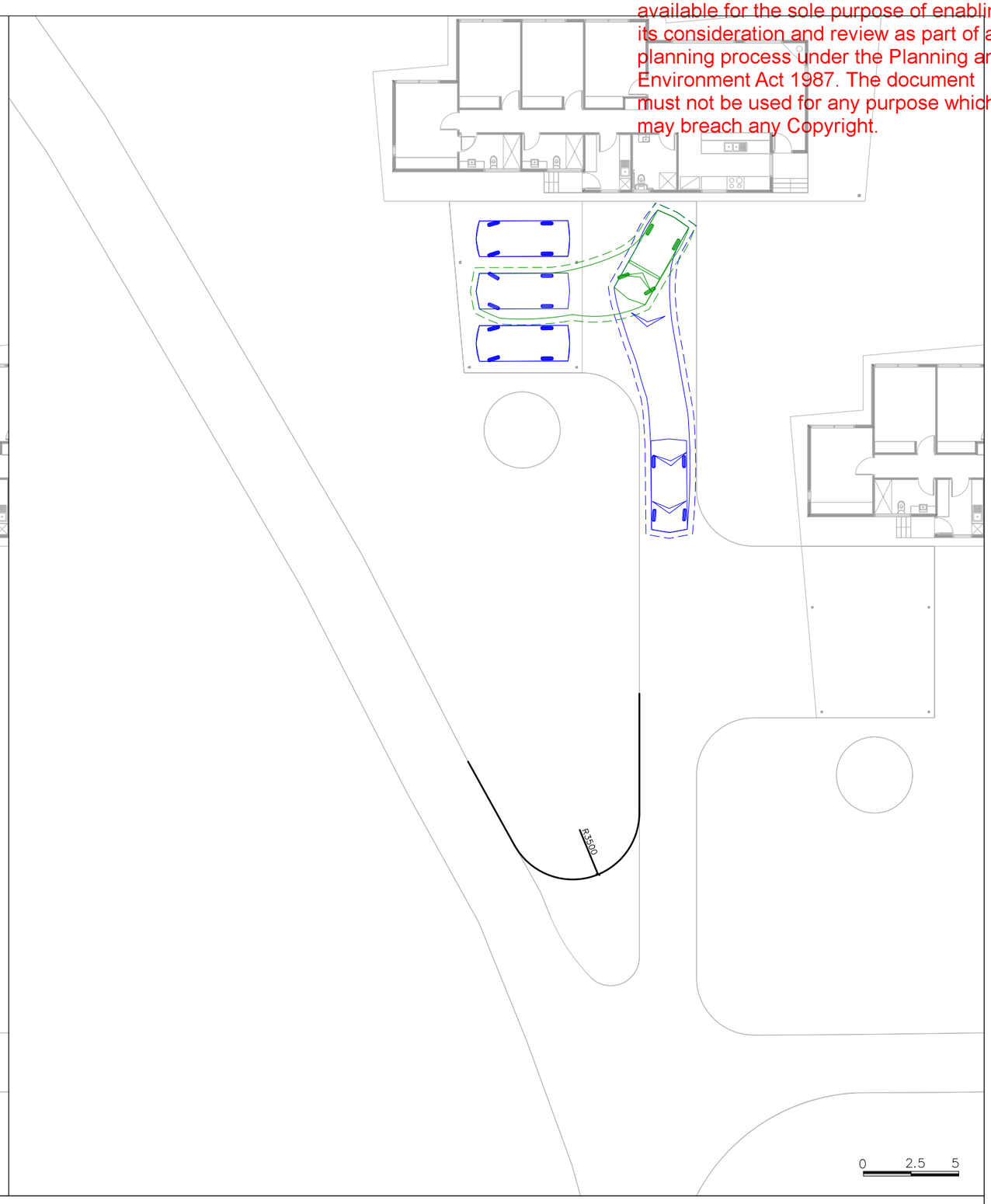
Overall Length	4.910m
Overall Width	1.870m
Overall Body Height	1.421m
Min Body Ground Clearance	0.159m
Track Width	1.770m
Lock to Lock Time	4.00 sec
Curb to Curb Turning Radius	5.80m

Proposed Residential Development
5835 Great Ocean Rd & 45 Old Iluka Access
Swept Path Assessment

NOTE:
1) Base Plan Supplied by Williams Boag Architects
2) Maximum Design Speed 10km/h

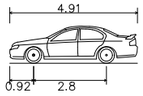
RATIO REFERENCE	SHEET No.	SCALE	DATE
16352T SK03/CLH	6 of 8	1:250@A3	19/09/2019





ratio:
RATIO CONSULTANTS PTY LTD
ABN 005 422 104
8 GWYNNE STREET
CREMORNE, VICTORIA 3121
TELEPHONE (03)9429 3111
FACSIMILE (03)9429 3011

B85 Vehicle (AS/NZS2890.1:2004)



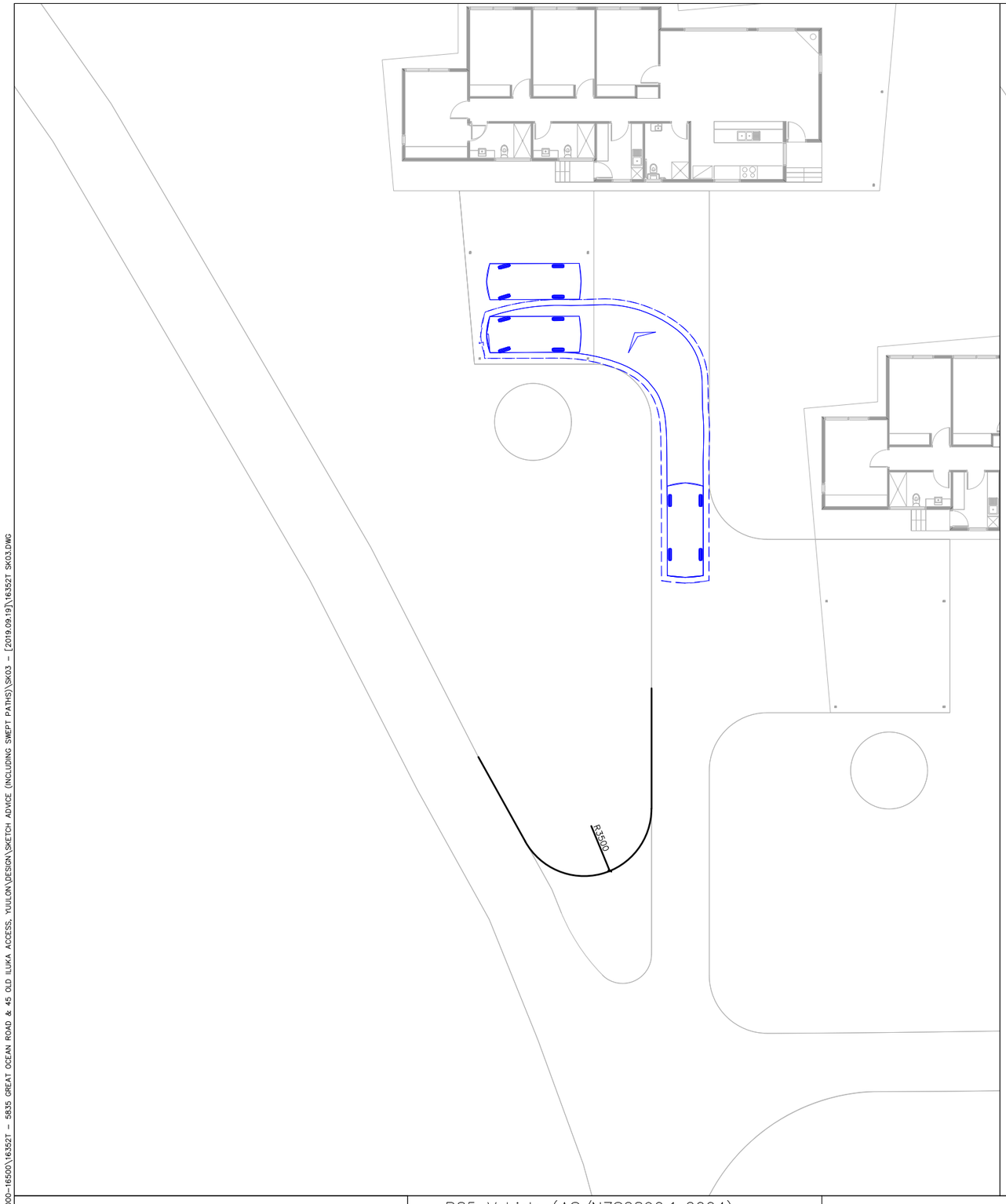
VEHICLE ENVELOPE (FORWARD)
300mm CLEARANCE (FORWARD)
VEHICLE ENVELOPE (REVERSE)
300mm CLEARANCE (REVERSE)

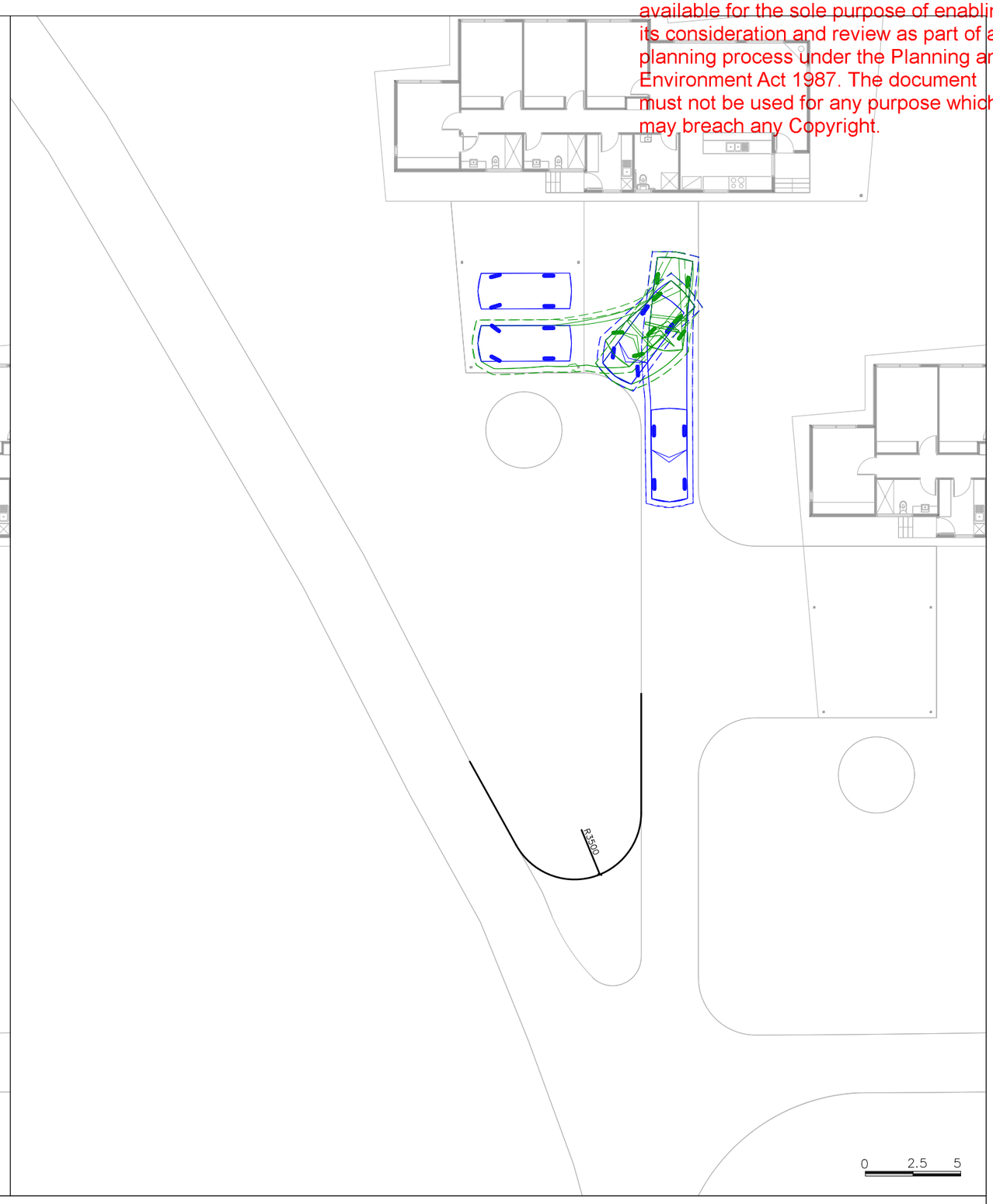
Overall Length	4.910m
Overall Width	1.870m
Overall Body Height	1.421m
Min Body Ground Clearance	0.159m
Track Width	1.770m
Lock to Lock Time	4.00 sec
Curb to Curb Turning Radius	5.80m

Proposed Residential Development
5835 Great Ocean Rd & 45 Old Iluka Access
Swept Path Assessment

NOTE:
1) Base Plan Supplied by Williams Boag Architects
2) Maximum Design Speed 10km/h

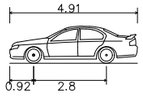
RATIO REFERENCE	SHEET No.	SCALE	DATE
16352T SK03/CLH	7 of 8	1:250@A3	19/09/2019





ratio:
RATIO CONSULTANTS PTY LTD
ABN 005 422 104
8 GWYNNE STREET
CREMORNE, VICTORIA 3121
TELEPHONE (03)9429 3111
FACSIMILE (03)9429 3011

B85 Vehicle (AS/NZS2890.1:2004)



VEHICLE ENVELOPE (FORWARD)
300mm CLEARANCE (FORWARD)
VEHICLE ENVELOPE (REVERSE)
300mm CLEARANCE (REVERSE)

Overall Length	4.910m
Overall Width	1.870m
Overall Body Height	1.421m
Min Body Ground Clearance	0.159m
Track Width	1.770m
Lock to Lock Time	4.00 sec
Curb to Curb Turning Radius	5.80m

Proposed Residential Development
5835 Great Ocean Rd & 45 Old Iluka Access
Swept Path Assessment

NOTE:
1) Base Plan Supplied by Williams Boag Architects
2) Maximum Design Speed 10km/h

RATIO REFERENCE	SHEET No.	SCALE	DATE
16352T SK03/CLH	8 of 8	1:250@A3	19/09/2019

Text